GET BILL SMART – FINAL REPORT

25 May 2016

Compiled by Sustainable Living Tasmania and the University of Tasmania

1.1 Acknowledgements

This project is funded by the Federal Government's Low Income Energy Efficiency Program (LIEEP) which is managed by the Department of Industry Innovation and Science. Mission Australia (MA) has overall responsibility for the project and its governance. Sustainable Living Tasmania (SLT) is responsible for project management and service delivery. The University of Tasmania (UTAS) has overall responsibility for research and analysis. In-kind contributions are being made by each of the partners.

There are many people who collaborated and assisted with the development and implementation of the Get Bill Smart project who we would like to sincerely thank. The GBS project team would particularly like to express our gratitude to: Mission Australia staff; Home Energy Helpers; staff and volunteers at the Clarendon Vale and Rokeby Neighbourhood Centres, the Clarence plan Men's and Community's sheds; the GBS Energy Champions; RED Sustainability Consultants; Kelly at Poco People; Garth Coghlan, Nadish Kariyawasam and project participants.

The GBS Final report was prepared as a team. Contributors are listed alphabetically: Jodi Alexander , Michelle Gabrielle, Todd Houstein, Millie Rooney, Phillipa Watson, Steve Watson, Anton Vikstrom

The Get Bill Smart final report includes separately available sub reports. The sub reports and authorship are as follows

Get Bill Smart Bulk Study, Authors: Michelle Gabrielle, Anton Vikstrom ,Todd Houstein, Millie Rooney, Phillipa Watson

Get Bill Smart Detailed Study, Authors: Millie Roonie, Phillipa Watson, Steve Watson

Get Bill Smart Cost Benefit Analysis, Authors: Anton Vikstrom, Todd Houstein, Phillipa Watson:

Get Bill Smart project processes and organisational analysis, Authors: Millie Roonie, Michelle Gabrielle

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1.2 Acronyms and definitions

Acronyms

AAA showerhead - A water efficient showerhead with a good level of efficiency

CFL - Compact Fluorescent Lighting

CSIRO – Commonwealth Scientific and Industrial Research Organisation

CVR - Clarendon Vale / Rokeby suburban area

EC – Community Energy Champions (sometimes called "Power Rangers" in the field)

EO – Community Engagement Officer

Before Survey – pre-activity survey

After Survey – post activity survey

GH - Greater Hobart area

GBS – Get Bill Smart (the name of this project)

HEH - Home Energy Helper

LIEEP - Low Income Energy Efficiency Project

MA – Mission Australia

SLT – Sustainable Living Tasmania

UTAS – University of Tasmania

Definitions

Consortium - The three organisations implementing the Get Bill Smart Project. These organisations are: Mission Australia, Sustainable Living Tasmania and University of Tasmania. Individuals working on the GBS project are referred to as 'consortium members'.

GBS Approaches - Any of the Get Bill Smart research approaches including the Representative group.

Energy Efficiency Activities - Any of the active energy efficiency approaches undertaken in the Get Bill Smart Project. This includes: In-home education and upgrades and community capacity building (EDUG + CCB), In-home education and upgrades only (EDUG) and community capacity building only (CCB).

Heat pumps - Reverse Cycle Air Conditioners used in heating mode. These are efficient heaters using 1/3 of the energy to heat a space compared to resistive heating.

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GBS Approach group acronyms:

CCB - Community capacity-building – Activities conducted through community engagement approaches that have the intention of influencing behaviour, in this case energy use behaviour and related activities in households.

EDUG - In-home education and upgrades – Visits to houses conducted to encourage energy efficiency. In- home visits helped householders to make changes to their homes and their practices in order to encourage reductions of energy used in the home. Auditors, called Home Energy Helpers, conducted these visits and installed most upgrades.

EDUG +CCB – This is a combined approach that included both in-home education and upgrades and exposure to community capacity building activities.

REP - Representative Group – These participants provided before and after data in the form of a survey and energy bills. Some participants in the detailed study also had data loggers installed and were interviewed. This group received grocery vouchers to recognise their participation.

Approach/research Group	Abbreviation
In-home education and upgrades and community capacity building	EDUG + CCB
In-home education and upgrades	EDUG
Community capacity building	CCB
Representative group	REP

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1.1.1 Table of figures

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1.1.2 Table of tables

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2 Executive Summary

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2.1 Purpose

This report provides a detailed account of the Get Bill Smart project which ran over the period 1 July 2013 to 15 March 2016 in Tasmania, Australia. Get Bill Smart (GBS) was an action research project that operated in the Greater Hobart area of Tasmania. It trialled an innovative community capacity building approach to low income energy efficiency and compared it to a more conventional, well-practiced in-home energy efficiency upgrade approach. GBS trialled approaches to energy efficiency as part of the Low Income Energy Efficiency Program (LIEEP). The LIEEP program primarily aimed to:

- Trial and evaluate a number of different approaches in various locations that assist low incomes households to be more energy efficient;
- To capture and analyses data and information to inform future energy policy and program approaches.

The LIEEP trial also aimed to:

- Assist low income households to implement sustainable energy efficiency practices to help manage the impacts of the carbon price and improve the household's health, social welfare and livelihood;
- Build the knowledge and capacity of consortia members to encourage long-term energy efficiency among their customers or clients, and;
- Build the capacity of Australian energy efficiency technology and equipment companies by maximising the opportunities for Australian Industries to participate in the projects.

The Department of Industry, Innovation and Science provided funding under the Low Income Energy Efficiency Program (LIEEP). The LIEEP program included 20 projects around Australia all of which investigated and evaluated approaches to assist low-income households to be more energy efficient. The detailed findings from these 20 projects will inform future energy efficiency programs and policies.

This Final Report is the 9th milestone report for the GBS project. Submitted to LIEEP for review in March 2016, it was submitted as a final version in May 2016. Submission of this report denotes the end of the main delivery, monitoring and evaluation stages of the GBS project. In order to evaluate the trial approaches, Get Bill Smart collected qualitative and quantitative data using multi-method data collection and analysis techniques. This Final Report was developed from analysis of five sub reports that describe the evaluation undertaken (Bulk Study, Detailed Study, Cost Benefit Analysis, Project Processes and Organisational Analysis, and Finance Report). This Final Report provides overview and background information to contextualise the four sub reports and provides a summary of sub reports, which are contained in the body of this document.

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2.1 Focus

The GBS project operated in the Greater Hobart area of Tasmania, as indicated by the map in Figure 2-1. The community capacity building occurred in the suburbs of Clarendon Vale and Rokeby (CVR) (as circled on the map).

Figure 2-1 Greater Hobart area, population centres in brown. Clarendon vale and Rokeby in red

2.2 Methods

The overall aim of the GBS project was to examine two approaches that were designed to improve energy efficiency in low income households;

1. In-home education and upgrades (EDUG); and
2. Community capacity-building (CCB).

Each approach was trialled alone and in combination with the other approach, which meant that three different energy efficiency approaches were trialled:

1. In-home education and upgrades alone;
2. Community capacity-building alone; and
3. In-home education and upgrades plus community capacity-building together (EDUG + CCB).

All three approaches were compared against a representative group (REP).

Project Objectives

Overall objectives for GBS were to:

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- Understand how a community capacity-building approach can assist low income households to reduce their energy consumption and how this approach compares with and interacts with more common in-home education and upgrade approaches.
- Understand the processes and key determinants for success, barriers, and drivers for each energy efficiency approach.
- Understand how benefits from thermal and energy efficiency improvements are utilised by low-income households in a cool temperate climate; whether households choose reduction of energy use or increased thermal comfort; and, the impacts of these improvements on health and wellbeing.
- Assist low-income households in Rokeby, Clarendon Vale and Southern Tasmania to be more energy efficient.
- Provide employment, training and commercial opportunities for local residents and businesses.

In-home education and upgrade (EDUG)

The in-home education and upgrade approach involved two qualified home energy assessors (Home Energy Helpers or HEH) visiting a household, educating the householder(s), and performing a series of energy efficiency upgrades. The education sessions included discussions about how the home performs, working through tailored booklet, and development of a plan to reduce energy usage. Energy efficiency upgrades were performed by a second HEH (or a subcontractor, and included some, or all, of the following (see Table 4-5, below)

Table 2-1 Energy efficiency upgrades delivered in the Get Bill Smart Project

Upgrade Description
Shower head replacement with equivalent 9L/min model
Hot water storage cylinder insulation with reflective sheeting with bubble-core interior
Hot water pressure relief valve and pipe insulation with ValveCosy (valvecosy.com.au) and foam pipe lagging respectively. Lagging applied to first 2 metres of outlet and pressure relief pipes only
Light globe replacement with high-quality, equivalent light output, warm white compact fluorescent lamps
Accessible power switch installation (EcoSwitch) on home entertainment and IT systems to reduce standby power consumption
Window, door, fan & vent draught-proofing in heated zones
Ceiling insulation to R4

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Curtains (thermally lined with full block out) on a track system that acts as a pelmet (trapping air between curtain and window) in heated zones.
Underfloor insulation

Community Capacity Building (CCB)

The Get Bill Smart project implemented an innovative Community Capacity Building (CCB) to encourage community engagement, facilitate community-wide discussion about energy efficiency, and build the capacity of a community to improve their own energy efficiency.

Get Bill Smart took a strengths-based, participatory approach the Community Capacity Building approach. The strengths-based approach allowed a focus on positive capacity rather than problems. Working with community members (Community Energy Champions) a community engagement strategy was developed that played to the strengths and needs of the community. For example, rather than a negative focus on poor thermal performance due to house design and construction and limited finances, the project focussed on the community's pride in being resourceful and addressed the challenges specific to this community such as low income and cash flow. This focus utilised existing community resources including the neighbourhood centres, child and family centre, health centre, churches, schools, sports clubs and interest groups.

The capacity-building approach was participatory in terms of hiring community members to perform as much of the work as possible and involving them in developing the details and implementation of the community engagement activities. A key to this was recruiting as early as possible into the project 12 households to act as Community Energy Champions (EC). These people received the in-home education and upgrades explained above so they could experience the benefits of energy efficiency and some of the activities other participants would be receiving. The 12 ECs were trained in energy efficiency and communication and drove the focus of the energy efficiency activities and campaign.

The participatory nature of the GBS approach required the capacity building activities to be developed with the involvement of the community. Activities the ECs were involved with included:

- developing a focus for the GBS program in CVR
- recruiting people into the GBS study
- distributing the Stay Warm booklet to householders

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- developing a calendar of community events
- hosting BBQs and information sessions at neighbourhood centres and the community shed
- staffing stalls at community events, the community centres and other public locations within the CVR area
- organising and running sewing workshops
- organising hardware shopping tours
- organising and staffing a quiz night
- door-knocking homes in the local area to raise awareness of the GBS project, support the research component of the project, and to engage with householders
- organising and running home energy efficiency parties (modelled on the Tupperware approach).

Allocation into approaches and research groups

Get Bill Smart was trialled in the Greater Hobart area, with the community of Clarendon Vale and Rokeby (CVR) providing the location of the CCB approach. The Greater Hobart (GH) approach occurred over the whole of the greater Hobart area. CCB was conducted by the 12 ECs and a Community Engagement Officer (EO) employed by the GBS project. The CCB approach occurred only in the communities of CVR for the participants.

The GBS project recruited 504 low income households (the aim was 480). In the first instance, depending on whether they lived within the CVR area, participants were randomly allocated to one of the four approach groups. As discussed in the Project Processes and Organisational Analysis (section 8.9.3) there were some significant challenges to recruitment. While all attempts were made to randomly allocate participants to approach groups at times this was a practical impossibility. Factors that affected random allocations included: landlord permissions in the EDUG groups (either the landlord refused upgrades or participants were unwilling to seek consent); participant requests for specific allocations (we conceded to these requests given the recruitment challenges faced).

One of the practical challenges to participant completion of the GBS project was the transient nature of many of the householders. As a result, different households participated in GBS to different degrees, meaning that completion numbers for different parts of the project vary.

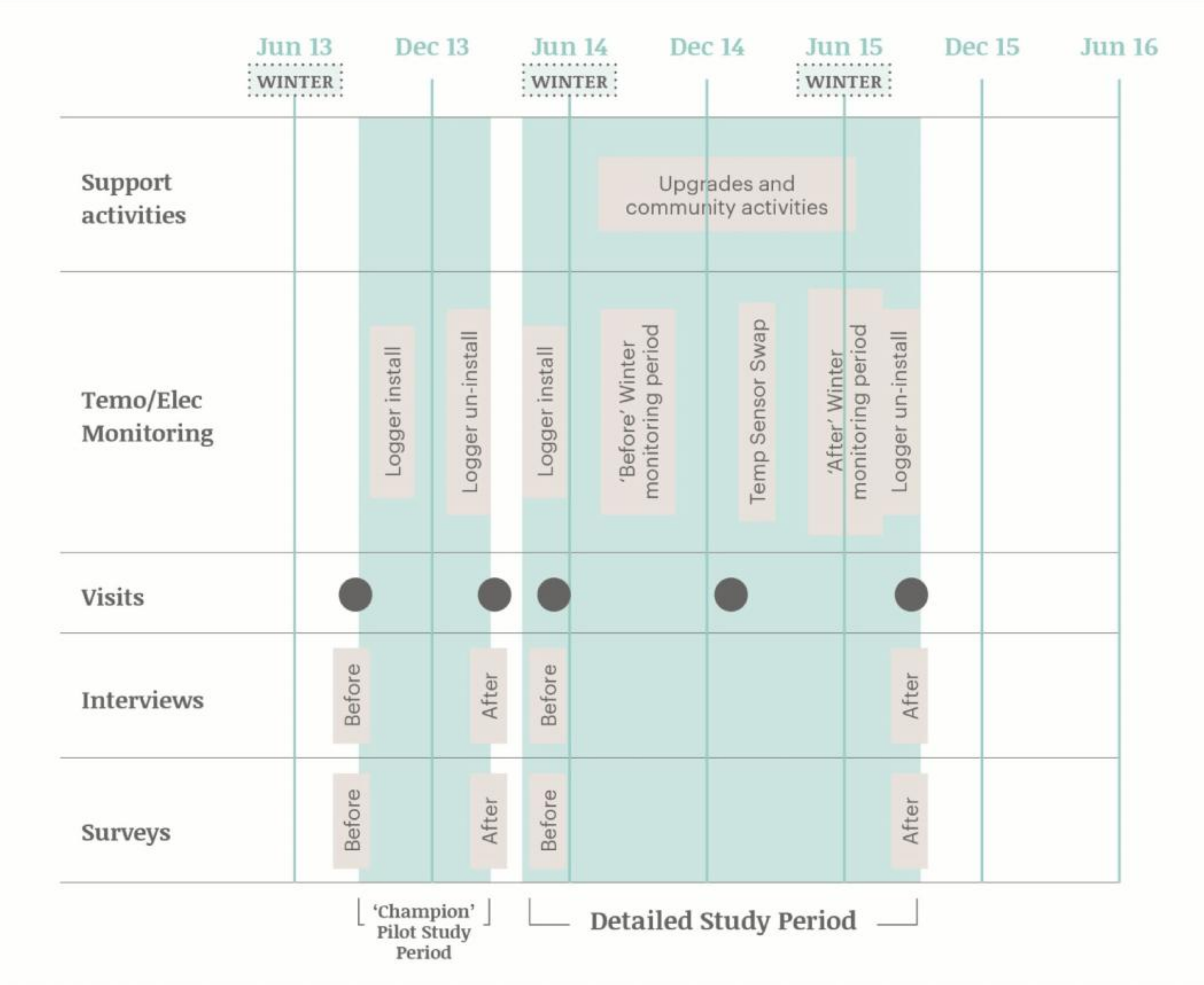
Overall GBS had 510 participants: 88 in EDUG + CCB, 169 in EDUG, 88 in CCB and 165 in REP.

GBS data collection and analysis

The project organised participants into a bulk and a detailed group so that trends and detailed information could be collected together. The bulk study (449 households) entailed 2 surveys and collection of energy billing data from energy suppliers (TasNetworks and Aurora Energy). The Detailed Study involved 51 households spread over the four approach groups and entailed being involved in further (more intensive) data collection in the form of in home energy and temperature monitoring and interviews. Participant's homes were monitored for a 12-15 month period between late 2013 and 2015. Twelve ECs also participated in the detailed style of research, but earlier than the other detailed participants.

Figure 2-2 (below) provides an overview of the timing of the various research activities. The detailed data and analysis for each of these components of the GBS research can be found in the following reports: Bulk Study, Detailed Study, Cost Benefit Analyses, and Project Processes and Organisational Analysis.

Figure 2-2 Timing of research activities for the Get Bill Smart Project



The GBS data collection and analysis aimed to identify:

1. Before and after effects of approaches in terms of household energy use, comfort management, health, wellbeing, financial management and household conditions;
2. The processes, key determinants for success, barriers to, and drivers for each different approach;
3. Comparative effects of approaches against each other and a representative sample of households;
4. Cost benefit ratios of different approaches;

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5. Thermal comfort and energy consumption related housing conditions participants live with;
6. Energy reduction outcomes from the different approaches (particular and trends);
7. More detailed understanding of the context of low income, disadvantaged householders in relation to energy efficiency and thermal comfort in the home;
8. More detailed understanding of working towards energy efficiency in Tasmanian contexts;
9. How energy efficiency gains from approaches are utilised by low income households in a cool temperate climate, especially in relation to thermal and physiological comfort; and
10. Successes, failures, drivers, barriers and capacity issues encountered by program stakeholders and organisations when implementing approaches.

2.3 Outcomes

The outcomes section of the executive summary has been structured according to the initial Get Bill Smart project objectives:

1. Understanding how different energy efficiency approaches can assist low income households to reduce their energy consumption,[1]
2. Understand the processes, key determinants for success, barriers, and drivers for each energy efficiency approach,
3. Understand how benefits from thermal and energy efficiency improvements are utilised by low-income households in a cool temperate climate; whether households choose reduction of energy use or increased thermal comfort; and, the impacts of these improvements on health and wellbeing,
4. Assist low-income households in Rokeby, Clarendon Vale and Greater Hobart to be more energy efficient,
5. Provide employment, training and commercial opportunities for local residents and businesses.

Understanding how different energy efficiency approaches can assist low income households to reduce their energy consumption

Energy consumption changes were calculated as changes in electricity usage over the project period. Figure 2-3 on page 23 shows the average and median changes of each GBS approaches. While the CCB approach was effective in delivering energy saving messages to vulnerable and socially isolated households, the EDUG approach was more effective in delivering actual energy and thermal comfort savings. Notably, when these two approaches were combined, EDUG + CCB, the energy and thermal comfort savings were increased.

[1] This objective has been reworded for clarity and to assist in structuring a response.

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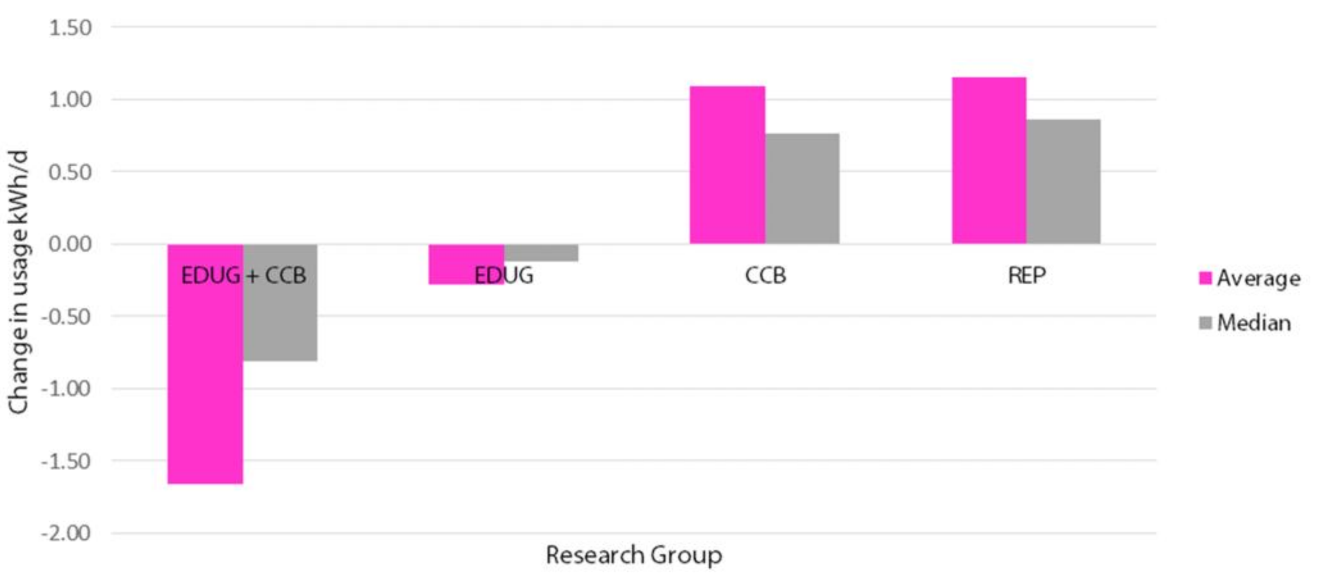
Figure 2-3 Average and median change in electricity consumption



The cumulative energy and water savings from the project have been calculated (see Cost Benefit Analysis). Overall the EDUG+ CCB approach delivers $1596 of savings and the EDUG approach delivers $1400. However the cost-benefit analysis shows the EDUG approach delivering $1 of savings for an investment of $0.86 cents whereas the CCB+EDUG requires $1.32 (see Table 2-2, below).

Table 2-2 Cumulative energy and water savings and cost benefit

	Community Capacity building with in-home education and upgrades	In-home education and upgrades	Community Capacity Building
Total cumulative savings	$1596	$1400	$11
Cost to deliver $1 of savings (cost-benefit)[2]	$1.32	$0.86	$126.93

CCB

The CCB approach provided people with multiple exposures to energy saving conversations with ECs, energy efficiency experts and neighbours.

- The CCB approach emphasised strategies and measures for staying warm, reducing energy and saving money.

[2] Level 3 cost benefit analysis, using cumulative electricity and water savings.

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- The CCB approach did not deliver quantifiable energy and comfort savings.
- CCB group did not have statistically significant energy savings
- The CCB group helped to contextualise formal energy efficiency education within the familiar social context promoting the idea that other people 'like me' are also interested in energy efficiency and thermal comfort.
- $1 of energy and water savings required a $127 investment

Key factors that may have enhanced energy and thermal comfort savings include:

- multiple opportunities to receive energy efficient and thermal comfort messages and consolidate this knowledge;
- more exposure to role models in the local community who have been able to reduce their energy use.

EDUG

The EDUG approach entailed visits from experts who provided education and installed relevant upgrades.

- The EDUG approach emphasised strategies and measures for staying warm, reducing energy and saving money.
- The EDUG approach delivered effective energy and comfort savings. Energy productivity has improved in this group through reduced energy consumption and increased thermal performance/comfort.
- The EDUG group had average electricity saving of 1.4 kWh per day.
- $1 of energy and water savings required a $1.32 investment

Key factors that may have enhanced energy and thermal comfort savings include:

- Hard wired physical upgrades that have lasting energy and thermal savings (eg draught proofing and insulation)

EDUG + CCB

The EDUG + CCB approach entailed visits from experts who provided education and installed relevant upgrades. It also provided people with multiple exposures to energy saving conversations with ECs, HEHs, energy efficiency experts and neighbours.

- The EDUG + CCB approach emphasised strategies and measures for staying warm, reducing energy and saving money.
- The EDUG + CCB approach delivered effective energy and comfort savings. Energy productivity has improved in this group through reduced energy consumption and increased thermal performance/comfort.
- The EDUG + CCB group had average electricity saving of 2.8 kWh per day.
- $1 of energy and water savings required a $0.86 investment
- The EDUG + CCB group helped to contextualise formal energy efficiency education within the familiar social context promoting the idea that other people 'like me' are also interested in energy efficiency and thermal comfort.

Key factors that may have enhanced energy and thermal comfort savings include:

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- multiple opportunities to receive energy efficient and thermal comfort messages and consolidate this knowledge;
- Hard wired physical upgrades that have lasting energy and thermal savings (eg draught proofing and insulation);
- increased capacity to follow-up on measures received through home upgrade; and
- more exposure to role models in the local community who have been able to reduce their energy use.

Processes, key determinants for success, barriers, and drivers for each energy efficiency approach

For a Community Capacity Building approach to be successful, it needs to be:

- A long term approach (3-5 years) that provides opportunities for project staff to trial different approaches and reset project goals (see Project Processes and Organisational Analysis Report section 8.9).
- Community led (see Project Processes and Organisational Analysis Report section 8.9.2 *Energy Champions Community Networks and Integration*).
- Sufficiently resourced to enable training and up-skilling (see Project Processes and Organisational Analysis Report section 8.8.10).
- Embedded in an organisation that can provide HR and information support (see Project Processes and Organisational Analysis Report section 8.7.11).
- Accommodating of individual preferences for communication channels (e.g. one on one communication, community notice boards and social media) (see Project Processes and Organisational Analysis Report section 8.8.1.
- Accommodating of individual preferences for group forums and one on one interactions when delivering education and support (see Project Processes and Organisational Analysis Report section 8.8.1.
- Have strong linkages with organisations with both community development and sustainability skillsets (see Project Processes and Organisational Analysis Report section 8.8.1).

For an in-home education and upgrades approach to be successful, it needs to be:

- Sufficiently resourced to enable upgrades and training and up-skilling of staff (see Project Processes and Organisational Analysis Report section 8.6).
- Delivered by an organisation with administrative and field skills and a strong working knowledge of local context and energy efficiency and thermal comfort (see Project Processes and Organisational Analysis Report section 8.6).
- Utilise skilled home energy helpers who can assess and tailor to householder contexts (see Project Processes and Organisational Analysis Report section 8.6.4).
- Have strong linkages with organisations with both community development and sustainability skillsets (see Project Processes and Organisational Analysis Report section 8.7).

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- Engaging the right staff. Ensure quality advice is provided that is tailored according to need. Householder engagement requires a very particular skillset- we recommend experts with compassion and interpersonal skills. Employ experts who are able to be empathetic (not patronising) in low income/vulnerable household settings. HEHs from GBS have the skills to achieve much of the tailoring needed with the support of systems that support their decision making related to tailoring (e.g. identifying high needs households, and households who need more or less education) (see Project Processes and Organisational Analysis Report section 8.8.3).
- Streamline administration to participants ensuring eligibility criteria are minimised. Ensure programs are open to all home ownership tenures. Reduce blockages to participation (see Project Processes and Organisational Analysis Report section 8.8.3.

How benefits from thermal and energy efficiency improvements are utilised by low-income households in a cool temperate climate; whether households choose reduction of energy use or increased thermal comfort; and, the impacts of these improvements on health and wellbeing.

Overall benefits of GBS energy efficiency activities were gained in a variety of areas related to energy, heating, comfort, confidence with information, thermal and moisture performance of the house, community and personal connections, improved thermal conditions in the home, health and stress, and increased choices/options for energy use and comfort.

In this GBS study most householders were low energy users and these householders took opportunities to use extra energy, rather than save it, in response to energy efficiency measures. They used energy most often in order to attain thermal comfort and support related health needs. Alongside thermal comfort and health householders used extra energy for other reasons, most importantly, to support poor housing and appliance performance, because other occupants were not invested in energy efficiency or there were new occupants, for animal care, or because of a lack of investment by landlords.

Householders were often trying to stay warm enough so they could stay healthy and generally function in their lives. This priority indicates that when given a chance householders want to be well and productive.

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Measured changes were observed in: overall electricity use, heater use, heating efficiency, hot water, change to comfort zone, moisture levels. Overall EDUG +CCB consistently came out with the best performance (in both household and on a per occupant basis).

Findings noted below are drawn from the detailed study unless otherwise noted (for a more comprehensive examination see Detailed Study report).

Overall electricity use

The detailed study report looked predominantly at winter (cold) periods before and after the GBS approach was delivered. Peak cold weather electricity use increased for all four groups after the GBS approach was implemented. It is recognised that this is primarily as a result of an unusually cold winter in 2015. CCB and EDUG + CCB (the community based groups) increased less than the REP group. EDUG (in greater Hobart) increased more. When factoring in household occupant rates, the EDUG + CCB households recorded a 22.7% reduction in energy consumption compared to the REP group in the after period (see Detail Report section 4.2 for closer examination). EDUG used slightly more than the REP group and CCB a little more again than EDUG.

Heater Use

Overall heating energy increased in all groups compared to the representative group in household comparison. These increases relate to the colder winter in the 2015 after period– householders warned us that the cold winter led to more heater use. EDUG+CCB were the only group with heating increases over that of the REP group on a household basis. However EDUG +CCB's increases correlated with increased time spent in the comfort zone (compared to other groups). The EDUG group had the greatest reduction in heater use, but also had a correlating reduction in time in the comfort zone. When assessed on a per occupant basis outcomes changed with all groups actually reducing heating energy compared with the REP group. The EDUG+CCB group had the biggest reduction on a per occupant basis.

Of note is that HEHs successfully encouraged many householders to shift heating strategies. HEHs suggested that householders transfer heating to more efficient heaters that were available in the house (see Detailed Report section 4.3.1)

Heating efficiency

Excluding houses that used wood fire and gas as their main heating, the EDUG + CCB group had the most significant increase in heating efficiency (25%) (see Detailed Report section 4.3.5 for an explanation of heating efficiency calculations and data). The EDUG group's average efficiency increased by 7.6%, CCB's by 0.5% and the REP group's efficiency decreased. Before and after heating efficiency changes showed a clear pattern of diminishing returns from

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extra heating energy input into house. As increased energy was pumped in, less came back as improvements to indoor temperatures. This pattern was related to the poor standards of thermal resistance of the building shells of the houses.

Hot water

On a household comparison of all households in the detail group, hot water increased most notably in the CCB group compared to REP group. The EDUG group's use also increased. The EDUG + CCB group's use was minimally different to the REP group. On a per occupant basis compared to the REP group, the EDUG + CCB group was the only one that reduced its use. Both the CCB and the EDUG increase their use when compared to the REP group on an occupant basis.

In home visits HEHS had retrofitted water efficient shower heads, hot water insulation and pipe insulation. These upgrades did support improvements in a range of houses (when viewing houses case by case). The bulk data also suggests that Hot Water (Tariff 41) usage decreased in the EDUG + CCB and EDUG groups. However neither the detailed or bulk data attributed statistical significance to this pattern.

Comfort

When looking at all households including those with non-electric heating and comparing them with the REP group only EDUG+CCB improved their comfort levels as a group. Both the CCB and the EDUG groups had slightly reduced comfort on average. When all houses with wood and gas heating as their main heating are taken out the same outcomes are still observed. The EDUG +CCB group had the most increased comfort and other groups had slight reductions of comfort levels. However, EDUG +CCB's time in the comfort zone did come with a correlating increase in heater use.

Whilst the linkages between thermal comfort and health outcomes was not directly measured in this project, research indicates that:

- Warmer homes reduce unnecessary deaths from cold
- Reducing condensation can reduce mould and resulting respiratory disease
- Improvements to thermal comfort can save more to the health system than money it will save on energy bills

As discussed in the Cost Benefit Analysis report (Section 5.9.2) these thermal improvements may be the most significant outcome of the project.

Moisture levels

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Surface condensation, moisture and mould issues were reported by a range of householders from all groups in both before and after surveys and interviews (see Bulk Report section 5.4.4 and Detailed Report section 5.1.6). The bulk study survey reported a reduction in window condensation for the EDUG group over the project period

Humidity and moisture were acceptable in most houses but were actually borderline problems that require further investigation. Most people in the detailed group living in older and under-insulated houses presented with temperatures that only just stayed away from meeting dewpoint (and therefore stayed just away from serious condensation problems). Management by householders helped to limit moisture issues. Newer houses temperatures stayed well away from dew point in general when graphed. The EDUG approach did not seem to affect moisture levels adversely in general – but more investigation of the GBS data is needed on moisture levels and mould. One house with moisture and mould issues did report increased mould and moisture after an in-home education and upgrade visit, but there were other construction issue impacting this outcome.

Trade Offs between energy saving and improving comfort

Trade-offs between energy savings and comfort were made by many houses when the opportunity arose. When energy efficiency improved or energy costs went down householders used the extra 'slack' available. Householders tended to use any positive changes to energy efficiency or affordability to improve thermal comfort, particularly for wellbeing and health. We observed that in their complicated lives householders want, in general, to be healthy and functional (see Detailed Report section 5.2.10). If their situations allowed them a chance to make a positive change for health or wellbeing, they used it. Householders traded energy and comfort against each other (see heating comparisons in Detail Report section 5.3), but they also traded energy saving with other things too (including other household bills, groceries and treats for children and household performance related to moisture and mould).

Assist low-income households in Rokeby, Clarendon Vale and Greater Hobart to be more energy efficient.

This project worked with 498 low income householders many of whom were unemployed and living below the poverty line.

The project assisted low income households in Rokeby, Clarendon Vale and Greater Hobart in the following ways:

- 272 houses received an in-home education and upgrades by participating in the EDUG and EDUG + CCB approaches.
- In total 61houses received improved insulation.
- In total 26 houses received new curtains.

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- A further 15 houses who participated in the REP group received an in-home education and upgrade as a prize after the study period.
- 498 households who completed surveys received grocery vouchers (these were distributed after various participation requirements were met).
- Approximately 340 people received a Stay Warm booklet during the project..
- A range of minor energy efficient measures were provided to people at community forums.

The project also provided intensive assistance to twelve low income people in Rokeby and Clarendon Vale who were recruited to be local energy champions. The champions were employed casually throughout the duration of the community capacity building implementation. They received:

- Training in energy efficiency and communication.
- In-home education and upgrade.
- 4 received improved insulation.
- 4 received new curtains.

Provide employment, training and commercial opportunities for local residents and businesses.

The Get Bill Smart Project provided 34 jobs for residents in the Greater Hobart region. 12 of these were specifically targeted at the project area in Clarendon Vale and Rokeby. The project also engaged and spent $277,000 on local Tasmanian businesses. In detail the project:

- casually employed 12 local energy champions over 15 months ($56,457)
- casually employed 10 local energy auditors over 12 months ($89,488)
- contracted energy data analysis that employed 7 people over a period of 3 years ($100,458)
- employed 2 research staff at the University of Tasmania for monitoring and evaluation (average 1 FTE)
- employed 9 project staff at SLT(various levels of commitment) over the project (average 2.5 FTE)
- purchased technical data logging equipment and commissioned product development from 4 companies ($126,761)
- purchased $64,013 worth of energy efficiency materials from Australian businesses
- subcontracted an additional $90,955 of energy efficiency materials (mainly insulation and curtains) from Tasmanian business
- spent in total $277,487 on Tasmanian businesses (NB excludes UTAS and SLT staff)

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2.4 Conclusions

Get Bill Smart successfully trialled a community capacity (CCB) approach with an in-home visit approach (EDUG)in Greater Hobart. Through monitoring this trial we now better understand (with evidence) the processes, key determinants and possible outcomes that affect energy efficiency interventions program like Get Bill Smart in the Tasmanian context.

Despite householders often living in very poor housing stock and despite working with householders with limited capacity to make energy and comfort changes, GBS activities were still able to create various positive outcomes for householders. GBS evidence showed that in-home education and upgrade visits by Home Energy Helpers improve energy productivity by reducing energy use and increasing thermal comfort. The EDUG approach delivered 1.4 kWh/day of energy savings and had a simple payback of 10.3 years and cumulative cost benefit ratio of 0.8 Community Capacity Building (CCB) combined with in-home education and upgrade visits (EDUG) delivered 2.8 kWh/day of energy savings and had a simple payback of 9.7 years and cumulative cost benefit ratio of 1.3. This is an impressive result given that the CCB component, is new, novel, and has not been subject to years of review, reflection and project delivery efficiency gains.

Given the greater possible energy savings from the combined approach, and the potential for delivery improvements in the community capacity building component it is argued that a successful future program should include all aspects of the in-home energy efficiency visits and modified components of the community capacity building.

GBS evidence has outlined key structural barriers challenging moves made for energy efficiency in the Tasmanian context. Critically poor thermal performance of the stock and persistent socio-economic challenges still undermine energy efficiency and comfort efforts by householders and NGOs. Participants live at relatively low indoor temperatures, often under World Health Organisation recommendations and on very low incomes. It cannot be emphasised enough the significant limitations that such poor housing stock places on the capacity of householders to engage in energy efficient behaviours and to be comfortable in their homes. Just achieving one of these aims is difficult in such poor housing, with such limited financial capacity, while achieving both together seems near impossible.

GBS showed that for low income householder's affordability and health needs are closely affected by home energy use and comfort and therefore also need to be engaged with in energy efficiency in housing is to be achieved.

To overcome structural barriers the GBS team suggest to following policy initiative:

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- **Improve thermal performance of houses**
- **Develop a long term energy efficiency program based on current practice**
- **Refine and develop community engagement within a long term energy efficiency program, and**
- **Integrate health priorities with energy efficiency aims through all policy initiatives.**

Through a long term energy efficiency program with community engagement, improvement of the housing stock, and recognition of health priorities embedded in home energy use and home comfort there is an opportunity to transition householders towards better health and better productivity.

2.5 Recommendations

Recommendations are listed below.

Improve the thermal performance of houses in Tasmania (and southern Australia) through:

- Phase out energy-intensive hardwired resistive heaters in cold climates as they are inefficient, expensive and ineffective (see Detailed Report sections 4.3.1 and 4.3.2).
- Subsidise heat pump purchase (see Detailed Report section 4.3.2).
- Ensure minimum rental standards include roof insulation, reasonable draught proofing, hung curtains in the living area and hot water efficiency (the Detailed Report section 5.2.2 shows the significant benefits of these retrofits).

Develop a long-term energy efficiency program:

Programs need to be tailored to climatic conditions and to key capacity issues (rent/own, income, chronic or recurring health issue, disability, elderly, overshadowed house, thermally poor dwelling, old heaters, limited community networks/isolation). Contextual understanding is important to identify what tailoring is needed. For example, as shown in the Project Processes and Organisational Analysis Report (section 8.8.1 - Doorknocking), Community Energy Champions were key to program success ensuring access to those harder to reach or isolated individuals.

Develop community engagement and capacity building further by:

- Ensuring all community capacity building projects have sufficient time for recruitment and training, and to integrate key ideas, concepts and behaviours into the community (see Project Processes and Organisational Analysis Report sections 8.8.4 and 8.8.1).
- Providing strong local leaders in low income areas who are physically situated within the community and with significant resourcing and support, to manage, mentor and train low capacity community members to become (and continue to be) community champions (see Project Processes and Organisational Analysis Report sections 8.8.5 and 8.8.9).
- Acknowledging key priorities and drivers of behaviour within different communities and demographics (see Project Processes and Organisational Analysis Report sections 8.3.4 and 8.8.8, and Milestone 4).

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- Genuinely valuing the importance of respect and care for the successful engagement of people with energy efficiency and thermal comfort behaviours by ensuring appropriate time and capacity for initiating and maintaining relationships (see Project Processes and Organisational Analysis Report section 8.7.4).
- Ensuring that metrics designed to measure program success go beyond simple attendance numbers and easily measurable engagements (see Project Processes and Organisational Analysis Report section 8.9.2).
- Placing a value on difficult to measure such as the slow movement of knowledge through social networks, the small changes that happen over time as a result of exposure to ideas and norms, the motivation people give each other through good experience and the shift to different 'normal' ways of doing things (see Detailed Report case studies).
- Identifying ways that governments can work with community networks, being sensitive to the fact interactions with government in low-income areas are generally avoided by community members (see Project Processes and Organisational Analysis Report section 8.9.2).
- Ensuring that existing knowledge about local culture, practices, limitations, expertise and challenges are integrated into program design and implementation (see Project Processes and Organisational Analysis Report section 8.9.2 – Energy Champion community networks and integration in community).
- Supporting capacity exchange within the community to allow existing knowledge to be shared and developed (see Project Processes and Organisational Analysis Report section 8.9.2

Integrate health priorities with energy efficiency aims:

Trades offs in GBS and overseas evidence shows that benefits of energy efficiency upgrades in cold climates are predominantly taken as thermal gain (see Detailed Report section 5.3). Energy savings are taken in this way because health and function are important to householders. This take-back can improve health outcomes on a broad scale reducing the drain on health systems.

The health gains from improved thermal comfort are significant. Studies from New Zealand have linked energy efficiency programs (such as installing insulation) with savings to the health system. A study of 1350 households that installed ceiling insulation, concluded that:

"Insulating existing houses led to a significantly warmer, drier indoor environment and resulted in improved self rated health, self reported wheezing, days off school and work, and visits to general practitioners as well as a trend for fewer hospital admissions for respiratory conditions." (Howden-Chapman et al. 2007).

In the GBS study we observed participants using energy saving techniques and technologies to enable them to heat their home to higher degrees or for longer for the same price.

For many participants, the need for greater heating was directly linked to health requirements such as the need to manage chronic illness, seasonal colds and flu or significant health emergencies. Examples of these behaviours can be seen in the case studies presented in the Detailed Report (see case studies 2,6,8, 6,14,17,20,24, 41, 44, 49, 113).

This linkage is strong and the health benefits tend to overwhelm the energy benefits by several magnitudes. In a review of the NZ "Heat Smart" Program the health benefits are attributed to be 99% of the project benefits. These

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health benefits include reduced mortality, less hospitalisations and reduced pharmaceutical use. Based on these findings for every $8 of energy saving their was $608 in health benefits[3] Grimes, A., Howden Chapman, Pet al (2011)

We argue that thermal comfort changes are a significant component of the GBS program and the impacts of these should not be discounted relative to changes in energy use. In fact health outcomes are likely larger than energy outcomes. In order for this to be recognised at a program **level improving thermal comfort needs to be treated as a "health intervention".**

Opportunities for linking thermal comfort and energy efficiency with health programs are currently limited, especially as preventative health or so called "Social determinants of health" receive much less funding than emergency or general practice care. A potential policy initiative could be the creation of Social Impact Bonds[4] issued at a population level to change health incomes by improving the thermal performance of households. We have not critically examined this possibility however further research into this may help to consolidate linkages and improve further policy directions.

[3] Low scenario, Table 30, pp 26 http://www.healthyhousing.org.nz/wp-content/uploads/2012/05/NZIF_CBA_report-Final-Revised-0612.pdf

[4] http://www.socialventures.com.au/investment/social-impact-bonds/

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3 Introduction

3.1 The LIEEP Program

Get Bill Smart (GBS) is one of 20 projects funded by the Australian Government's Department of Industry Innovation and Science, Low Income Energy Efficiency Program (LIEEP). This competitive funding was distributed by the Federal Government in 2013 to identify strategies to overcome barriers to the uptake of energy efficiency measures in low-income households. All 20 of the LIEEP programs undertook extensive data collection and analysis and are to be completed by June 2016. The findings of the LIEEP projects will inform the development of future energy efficiency programmes and policies that assist low-income households in Australia.

The objectives of the LIEEP are to:

- Trial and evaluate a number of different approaches in various locations to assist low-income households to be more energy efficient; and
- Capture and analyse data and information for future energy efficiency policy and program approaches.

The intended benefits that result from the LIEEP program are to:

- Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households;
- Build the knowledge and capacity of consortium members to encourage long-term energy efficiency among their customers and clients; and
- Build capacity of Australia's energy efficiency technology and equipment companies by maximising the opportunities for Australian industries to participate in the projects.

GBS is the only LIEEP program in Tasmania and, through two main intervention approaches, seeks to improve energy efficiency and thermal comfort in low income households in Greater Hobart, Tasmania. These interventions have been monitored and evaluated through a comprehensive research component to the project.

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3.2 Get Bill Smart

Get Bill Smart was an Action Research project that trialled an innovative, community capacity-building approach to educating, informing and motivating energy efficiency and thermal comfort behaviours in low income households in the Greater Hobart area of Tasmania. This was compared to a more conventional approach of in-home education and upgrades, a tried and tested approach from Sustainable Living Tasmania's energy efficiency projects. The aim of GBS was to:

- Improve householder engagement and education levels regarding energy efficiency; and
- Empower low income households to be more energy efficient.

The GBS project examined two approaches to improve energy efficiency in low income households;

1. In-home education and upgrades (EDUG); and
2. Community capacity-building (CCB).

Each approach was trialled alone and in combination with the other approach which meant that three different energy efficiency approaches were trialled:

1. In-home education and upgrades alone;
2. Community capacity-building alone; and
3. In-home education and upgrades plus community capacity-building together (EDUG + CCB).

All three approaches were compared against a representative group (REP).

The Community Capacity Building approach (CCB) occurred in the south east Hobart suburbs of Clarendon Vale and Rokeby, areas recognised to be challenged by socio-economic disadvantage with a high proportion of government and social housing. The remaining study area was in Greater Hobart and included low income households in the Kingborough, Clarence, Hobart and Glenorchy Council areas (see Figure 3-1). The project participants were allocated into bulk and detailed study groups, which determined the level of data that was collected about their household energy consumption and behaviours.

The outcomes and benefits to participating households and communities of Get Bill Smart were aligned with those of the LIEEP and also include:

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- Greater capacity to be more energy efficient (knowledge, skills and motivation);
- Reduced energy bills;
- Increased thermal comfort;
- Improved health, social welfare and livelihood;
- Greater sense of one's own situation; and
- Access to grocery vouchers.

Figure 3-1 Greater Hobart (Population areas in brown)

3.2.1 Consortium members

The management of GBS involved three key organisations. Mission Australia oversaw the project, ensuring good governance, financial controls, and risk management practices. Sustainable Living Tasmania managed the project and delivered the energy efficiency services and community capacity building activities. The University of Tasmania managed the research component of the project.

3.2.2 Project objectives

The GBS project trialled and evaluated three GBS approaches (community capacity building (CCB) and In-home education and upgrades (EDUG) and a combination of the two (CCB+EDUG)) with the objective to:

1. Understand how a community capacity-building approach can assist low income households to reduce their energy consumption and how this approach compares with and interacts with more common in-home education and upgrade approaches.
2. Understand the processes, key determinants for success, barriers, and drivers for each energy efficiency approach.
3. Understand how benefits from thermal and energy efficiency improvements are utilised by low-income households in a cool temperate climate; whether households choose reduction of energy use or increased thermal comfort; and, the impacts of these improvements on health and wellbeing.
4. Assist low-income households in Rokeby, Clarendon Vale and Greater Hobart to be more energy efficient.
5. Provide employment, training and commercial opportunities for local residents and businesses.

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3.2.3 Project outputs

Over the course of the 3 year project, Get Bill Smart produced the following outputs listed in Table 3-1.

Table 3-1: Get Bill Smart project outputs

Educational materials on energy efficiency specifically targeting people with low literacy.
In-home education and energy efficiency upgrades for 272 households.
Additional energy efficiency upgrades for households considered to be of high needs.
Detailed case studies of upgrades documented with at least 12 champion households.
Training in energy efficiency and communication skills for 12 champion households.
Half hourly time step temperature and energy use data over 15 months for 51 households, and 3 months for an the 12 champion households.
Analysis of temperature and electricity consumption monitoring equipment for quality and functionality.
Qualitative data from 2 in-depth interviews each with 60 households before and after the Get Bill Smart approach, with transcriptions of these interviews.
A quantitative and qualitative analysis of aforementioned data and interviews that investigates the trades-offs made between energy reduction, affordability, thermal comfort and other housing needs.
Comprehensive community engagement activities in Clarendon Vale and Rokeby.
Collation of energy billing data over >2 years for all participating households.
Qualitative survey data of housing stock, occupant particulars, attitudes, activities and behaviours for all participating households.
A comparative assessment of approaches trialled, describing overall success and failure rates of the entire group of houses studied.
Tabling of costs of approaches trialled against the reported energy efficiency and related thermal comfort outcomes.
Descriptive analysis of processes, key determinants for success, challenges, drivers and the repeatability of the approaches.
Casual employment for at least 12 people within Rokeby and Clarendon Vale.
Employment for 53 project staff, totalling 15 FTE years at Sustainable Living Tasmania.
Casual employment for 4 project staff totalling 3.7 FTE years at UTAS.

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3.3 Project Rationale

This section provides background as to why: interventions are pursued for energy efficiency and comfort; a community partnership and champion approach is being examined; and, examines critiques of community capacity building approaches in relation to the Get Bill Smart approach.

3.3.1 Activities to encourage energy efficiency and comfort in Tasmania

Due to economic, social and environmental imperatives, governments and stakeholders in Australia have sought to achieve energy reductions in the residential sector through energy efficiency programs with a current focus on understanding how to engage with low income households through the LIEEP program.

Energy productivity is increasingly the lens through which energy efficiency is being analysed. Energy productivity is defined by COAG (Council of Australian Governments (COAG) 2009: 9) as economic output divided by energy used. This formula is not so useful at the household level where there is a long history of undervaluing or not valuing the household economy. A more effective understanding of energy productivity is the concept of achieving better outcomes with the same or reduced energy inputs. In this context improved energy productivity would encompass improvements in thermal performance of homes with households maintaining or reducing daily energy consumption.

Tasmania has a high proportion of low income householders who tend to live in the poorest quality housing stock in Tasmania (in relation to thermal comfort and energy efficiency) and with inefficient appliances (Watson 2013). The negative social, physical and economic impact that energy inefficient and uncomfortable housing stock and energy inefficient appliances have on householders and the broader community is well recognised as is the significant difficulty low income households have trying to change this (KPMG, Brotherhood of St Laurence et al. 2008; Elliott and Stratford 2009; Office of the United Nations High Commissioner for Human Rights 2009; Howden-Chapman, Crane et al. 2011). Overall we are aware that:

'… housing deprivation seems to pose health risks of similar proportions to smoking and, on average, greater than that posed by excessive alcohol consumption. Children seem to be particularly vulnerable to prolonged exposure to poor housing.' (Howden-Chapman 2004:163).

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Energy bills are often a significant proportion of living expenses for low income households. Overall a low income household may not use a lot of energy when compared with more affluent households. Despite their comparative frugality, Tasmanian low income householders' energy bills take up far too much of their income (ABS 2013).

In an already socio-economically disadvantaged state such as Tasmania the benefits of improving indoor comfort (especially in winter) and energy efficiency through both home improvements and behaviour changes can provide critical improvements in health and living affordability.

Energy efficiency programs are usually enacted by Governments and social support organisations and are designed and implemented where there are recognised barriers that stop people from making changes. Activities are designed to support households who have difficulty making change for energy efficiency and comfort themselves. In Get Bill Smart it is recognised that, among other challenges, households living on low incomes will face financial barriers and are also likely to face information/knowledge and time barriers. Householders, for example may not be able to afford new curtains, may not understand the benefits of prioritising certain home management behaviours or may have limited time to think through energy and comfort improvements.

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 (Ambrose 2000; Sustainable Development Commission 2006; Brotherhood of St Laurence 2008; Elliott and Stratford 2009; Maller and Horne 2010). A house with improved thermal efficiency, for example, will support householders to use less energy and be more comfortable. These benefits can lead householders to reduce heating, improve comfort and reduce energy bills. In turn this might lead to reduced stress for the householder, less doctor visits and less environmental burden from energy use. These outcomes are of benefit to all sectors of society and make a significant difference to those who are disadvantaged due to low incomes. Overall these changes create a more productive household with residents able to successfully engage in more elements of society and the economy.

In Australia, large-scale energy efficiency programs have predominantly focused on the provision of energy efficient product information and subsidies for the installation of energy efficient measures, with limited focus on the needs of low income households.

Focus groups conducted by Watson (2013) for a previous Tasmanian investigation highlighted that a more refined understanding is required if Tasmanians are to progress and engage in large scale energy efficiency activities. LIEEP trials have been developed to learn what support activities are most successful at a large scale. GBS has worked to

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learn and build on previous lessons learnt through practical experience at SLT, previous research project and through literature.

3.3.2 Comfort, health and wellbeing in housing

Supporting change in homes through interventions has mainly focused on energy, rather than comfort, improvements, yet often these issues are closely related. The most common approaches have been focussed on building standards around new build and retrofit of housing, sporadic programs aimed at minor upgrades in buildings (often by councils and the Australian Government), information about energy efficiency and application of an appliance standard through star ratings (Watson 2013). Comfort has been an extra outcome from some of these approaches, often not an emphasised or aimed for one.

Paradoxically, the Australian Bureau of Statistics found repeatedly (in 2002, 2005 and 2008) that Australian's main reason to install energy changes in the home were to improve comfort (Australian Bureau of Statistics 2002; Australian Bureau of Statistics 2005; Australian Bureau of Statistics 2008).

Physiological comfort is important for health. An international systematic assessment of deaths attributable to 'non-optimum temperatures' found that approximately 3-8% of deaths could be attributed to excess cold and heat (higher percentage proportions were found to correlate with excess cold) (Gasparrini, Guo et al. 2015). Notably:

> '***Seasonal differences in temperatures have a greater impact on avoidable mortality in winter in temperate countries than in colder countries, where houses are more thermally efficient and outdoor clothing is worn more systematically.***' (Howden-Chapman 2004: 163)

Moisture management in homes is also recognised as a health issue if the levels get too high and mould grows:

> ***'Damp housing is clearly related to respiratory conditions in both adults and children… Mould and fungi have been shown to have a small, but significant respiratory effect on children. There is a dose-dependent risk increase of visible mould for respiratory infections, lower respiratory symptoms, and asthma.'***
> (Howden-Chapman 2004:163)

3.3.3 The community approach

Despite the benefits that come from improving thermal comfort and energy efficiency in homes, householders can be hard to engage in such change. Intervention programs have typically tried to support individual households and individualised decision making. Interest in community-based energy efficiency programs has grown in recent years because the approaches potentially offer a way to better engage in such change. In the UK, for example, community action has been a prominent theme in carbon and energy policy programs over the past decade (Department of Energy and Climate Change 2014).

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Drawing on SLT's years of experience working in energy efficiency interventions and engaging with the community and on literature on community capacity building and community energy action, we anticipated that a community-partnership approach could deliver opportunities lost with other approaches. In particular, in comparison to one-on-one engagement a community approach could:

- facilitate local ownership of the program;
- establish the legitimacy of energy efficiency and thermal comfort as relevant to the community;
- reach a wide pool of people through established community networks;
- ensure the project was well-targeted towards community priorities;
- ensure energy saving messages were translated into language relevant to the community;
- facilitate new leadership and community networks around energy use;
- help to sustain energy efficiency messages in the community into the future.

Working through community also offered a way to respond to previous observations and literature that showed that decisions made about homes and home practices were influenced by connections with communities. Communities were observed to be intricately involved with individual decision making of householders *in* their households. Neighbours, friends, local wisdom bringers, local shops, newspapers, local government and many other connections influenced the decisions and understandings householders had of their homes, energy efficiency and comfort (Watson 2013). How we learn and change is critically affected by our communities and our context and therefore communities are important to learning and change.

GBS engaged with an initial focus on place-based, localised suburban community. Our examination of community is therefore geographically based. Like any other community, the Clarendon Vale/Rokeby local suburban community is a dynamic and shifting community that contains real people and their real and complicated lives.

GBS focuses on a community action/community partnership approach in order to support the capacity of the community and individual households to make change in their homes. GBS aimed to generate community capacity that could be sustained after GBS activities were finished. Skinner (2006) describes community capacity building as "activities, resources and support that strengthen the skills, abilities and confidence of people and community groups to take effective action and leading roles in the development of communities". Chaskin (2001, p295) defines community capacity as "the interaction of human capital, organizational resources, and social capital existing within a given community that can be leveraged to solve collective problems and improve or maintain the well-being of a given community". He notes that this process can occur either through "informal social processes and/or organized effort". In describing community capacity, Chaskin draws out common issues raised within this research, including:

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the existence of resources; networks of relationships; leadership; and support for mechanisms for participation by community members in collective action and problem solving.

Risks exist in community capacity building approaches because inherently a strengths-based approach implies that the community is "deficient – in skills, knowledge and experience" (Craig 2007,Tedmanson 2003). Building participation into program design, as well as providing more clarification of capacity building objectives may go some way to addressing these criticisms. For example, program managers might reject the notion of a general deficiency with the community, in favour of addressing specific capacity gaps through information sharing and delivery of training whilst at the same time acknowledging just what the community has to offer. There is also a need to move away from engagement based on delivering 'expertise' to lay people to a knowledge exchange between people with different areas of expertise.

Being aware of the risks of starting from the position of assume deficiency the GBS team attempted to engage with this conflict through its community approach that includes locals in the project. This included

- Local employment and engagement of community champions
- Champions designing and developing plans and strategies and establishing language and priorities

3.3.4 Champions in community partnership approach

Connecting with communities through local people as 'champions' for a project offers a variety of potential benefits. Champions are likely to have a more subtle understanding of their context, can personalise contact with individuals (with individual needs) and are likely to be seen as more trustworthy than an outsider. Local champions can bridge the gap between external 'expert' or outsider and internal community members making an energy efficiency approach more effective (so its benefits are sustained into the future). Champion involvement assists to overcome critical barriers to engagement. They can help to establish validity of a project in a community and provides access to tacit everyday understanding (expertise) of a local community (Chaskin, 2001). Their understanding can provide insight into critical social normative behaviour, key community practices and knowledge (Glanz and Bishop 2010) which allows engagement approaches to: be contextualised and appropriately tailored; use appropriate language; and be respectful (Hirshfield et al 2012, Watson 2013). Further, as champions, there are opportunities to contribute to building capacity in themselves and in their own community (Fraser 2003), which can be attractive to people who care about their local community.

There has been substantial growth in community-based energy programs in the UK and the USA (Burchell et al, 2014; DECC, 2014; Silicon Valley Energy Watch, 2013). Some programs have explored local 'Energy Champions' as a

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delivery mechanism for behavioural change and transition/adaptation programs. For example The Community Energy Champions Grant program (CECG) launched in the USA in California 2010. This project views community organisations as community champions and so has somewhat different working definition of champions to the GBS project. Like GBS, the CECG project works from the basis that champions are a valid community engagement pathway and 'can accomplish deep and lasting energy use behavior changes' (Hirshfield and Iyer 2012: 6-105). This program suggests that community members are likely to be more receptive to energy efficiency messages when they are promoted with an awareness of local priorities and outlines the advantages of leveraging community-based organisations (CBO) for the delivery of energy programs suggesting they: establish trust within communities; are vital liaisons between government and local people; and are adept at addressing participation barriers.

Other organisations that have focussed on champions as part of community engagement:

- US Department of Energy and Climate Change's Community Energy Strategy: People Powering Change. details the role of local partnerships and the importance of community access to information and expertise.
- Action At Home, an energy efficiency program, operates in the UK and engages through local champions to run weekly talks to support change
- EnergyMark, developed by CSIRO from the previous WaterMark project, gathered interested community members to be discussion leaders/coordinators and to run discussion groups. Groups met in homes for regular meetings to share information around climate change, energy use and water use.

No existing programs trialled Community Energy Champions in the same way as GBS. As with other terms described 'local champions' is a term that could describe various roles a person might take in an engagement project. In GBS local Champions are people from the case study community of Clarendon Vale Rokeby who have trained by GBS to share energy efficiency ideas through a variety of community activities. The local champions where originally described as "energy champions" however during the project they self-identified as "Power Rangers"

Exploring the part champions play in developing community partnerships and community capacity is a novel aspect of the GBS project. Involving champions in GBS allows us to progress understanding of the potential of champions in community engagement. We recognise that engaging champions had to be done cautiously because organisations can overlook important issues and ignore champion needs or positions. GBS is attempting to explore positive and negative outcomes of champion involvements (for further details see Watson et. al. 2015).

3.4 Milestone 9 Reporting Requirements

In accordance with the Milestone 9 requirements and reporting period up to 1st March 2016 (extended to 15 March), the Get Bill Smart team have:

- Submitted analysis of the data collected for the entire Activity period (this report);
- Submit the Final Report (this report) that includes:

- Bulk comparative assessment of Activity approaches – Chapter 5 Bulk Study
- Detailed study of energy efficient home improvements – Chapter 6 Detailed study
- Cost versus outcomes of Activity approaches – Chapter 7 Cost Benefit Analysis, and
- Assessment of Activity processes from an organisational perspective- Chapter 8

These four individual reports are contained within the final report and address the requirements of the LIEEP final report stipulations and the reporting commitments within the original GBS Project Plan for meeting Milestone 9.

4 Trial Methodology - Overview

The overall aim of the GBS project was to examine two intervention approaches to improve energy efficiency in low income households;

1. In-home education and upgrades (EDUG); and
2. Community capacity-building (CCB).

Each approach was trialled alone and in combination with the other approach which meant that three different interventions were trialled:

1. Home education and upgrades alone (EDUG);
2. Community capacity-building alone (EDUG); and
3. Home education and upgrades plus community capacity-building together (EDUG + CCB).

All three approaches were compared against the representative group (REP) which were exposed only to research participation.

Get Bill Smart was trialled in the Greater Hobart area, with the community of Clarendon Vale and Rokeby (CVR) providing the location of the community capacity building intervention approach (see Figure 3-1 on page 37).

The community capacity building approach was conducted by 12 local residents (employed as Community Energy Champions) and a Community Engagement Officer (EO) employed by the GBS project. The community capacity approach occurred only in the communities of CVR.

4.1 Data Collection and Analysis

Data collection and analysis plans were reported and approved in the Milestone Three report. The GBS project recruited 510 low income households (the aim was 480 participants) into one of four research approaches: community capacity building (CCB); in-home education and up-grade (EDUG); community capacity building and in-home education and up-grade (EDUG + CCB); and the representative group (REP).

Both quantitative and qualitative data were collected and analysed with the aim to identify:

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1. Before and after effects of different approaches in terms of household energy use, comfort management, health, wellbeing, financial management and household conditions;
2. The processes, key determinants for success, barriers to, and drivers for each approach;
3. Comparative effects of the different approaches against each other and a representative sample of households;
4. Cost benefit ratios of different approaches;
5. Thermal comfort and energy consumption related housing conditions participants live with.
6. Energy reduction outcomes from the different approaches (particular and trends);
7. More detailed understanding of the context of low income, disadvantaged householders in relation to energy efficiency and thermal comfort in the home;
8. More detailed understanding of working towards energy efficiency in Tasmanian contexts;
9. How energy efficiency gains from different approaches are utilised by low income households in a cool temperate climate, especially in relation to thermal and physiological comfort; and
10. Successes, failures, drivers, barriers and capacity issues encountered by program stakeholders and organisations when implementing different approaches.

4.1.1 Qualitative and quantitative data

People, communities and housing issues are known to be complex and messy to monitor and analyse. The complex, or wicked, nature of the subject matter (Rittel 1973) GBS was investigating led to the use of multiple methods to collect data in both quantitative and qualitative forms and from a ranges of sources (Foulds *et al.* 2013). Using multiple methods allowed exploration of participant experiences, housing situations, GBS stakeholder and the community context all at once. We were able to capture multiple sources of information and capture a complex suite of experiences and changes (Franklin 2006, Crosbie and Baker 2010).

Qualitative data was collected to establish participant and stakeholder experiences of GBS, of their energy use and comfort in their homes and of their perceptions of their community.

Quantitative data collected for GBS focused on energy use and thermal performance of participant's homes and establishing trends in the surveys. The bulk and detailed sub reports in section 5 and 6 respectively, analyse the results of these data sets.

GBS methods follow a now well established approach to energy cultures – both quantitative and qualitative are required. This approach focuses on the interactions between norms (beliefs and understandings about energy), material culture (appliances and energy technology) and energy practices (behaviours and habits) as a basis for understanding energy consumers and their resistance to or acceptance of change. The framework identified by Stephenson (2010) provides useful insight into the way cultures and practices relating to energy are developed and entrenched and how they relate to consumption, and thus give indications of potential methods for influencing behaviour change.

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4.1.2 Bulk study and detailed study groups

The project organised participants into a bulk and a detailed group so that trends and detailed information could be collected together. The bulk study (449 households) entailed 2 surveys and collection of energy billing data from energy suppliers (TasNetworks and Aurora Energy).

All participants in the project completed a before and after survey as well as provided their electricity consumption data to GBS via the energy retailer Aurora Energy. Twelve households in each of the four approach types (48 households in total) were also involved in the detailed study which entailed more intensive data monitoring. The detailed investigation involved: 2 surveys, collection of energy billing date from energy suppliers (Aurora Energy), 2 qualitative interviews with the householder; observations of the house (with the householder present); and the installation and removal of energy use, temperature and humidity loggers around the home. Participant's homes were monitored for a 12-15 month period between 2013 and 2015.

A pre and post (before/after) assessment system has been used to establish understanding of comparative effects of the different GBS approaches. 'Before' interviews, 'before' surveys and house observations were made June to September 2014 and 'after' interviews and 'after' surveys were conducted in August and September 2015. This data was collated to establish a baseline for the 'follow up' comparison of change data.

The twelve community energy champions also participated in the detailed style of research, but earlier than the other detailed participants. Figure 4-1 (below) provides a summary of the research activity timing across the GBS project.

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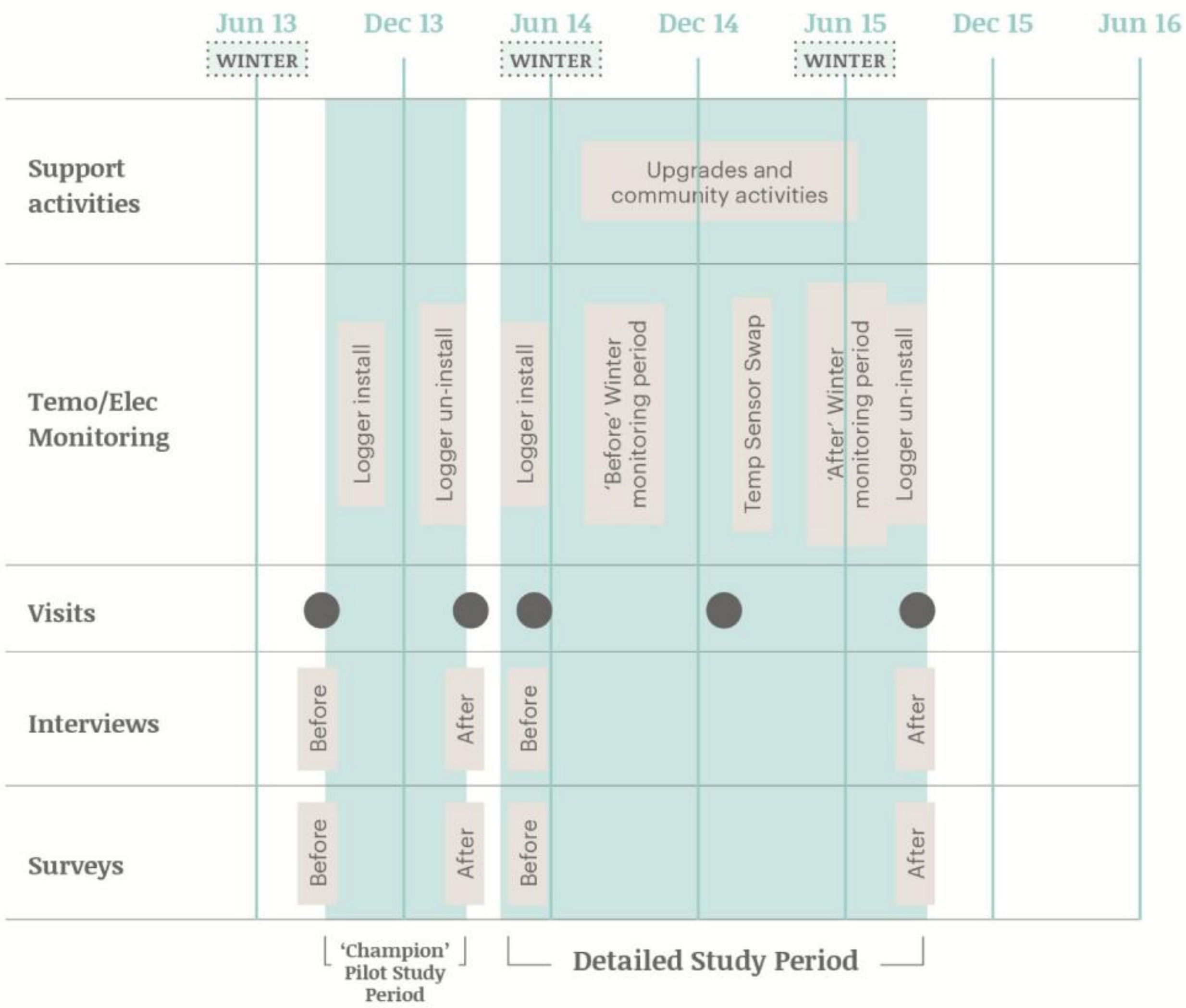
Figure 4-1 Timing of research activities



4.1.3 The iterative approach

An iterative approach was taken to data collection so that we could test research approaches and data collection tools before embarking on the main study. To achieve this, data collection techniques were trialled on the champion group early on in the project and prior to the main study beginning. Any issues identified when collecting data from the champions was used to adjust data collection tools before the main data collection processes began (with the bulk and detailed household participants). Trialling not from a theoretical position but from a practical standpoint generated from experience helped to ensure a smoother data collection process for the main study.

This approach allowed for understanding to be developed of the current community and housing conditions experienced by participants; to establish a baseline; and to compare this baseline against effects measured after the energy efficiency activity.

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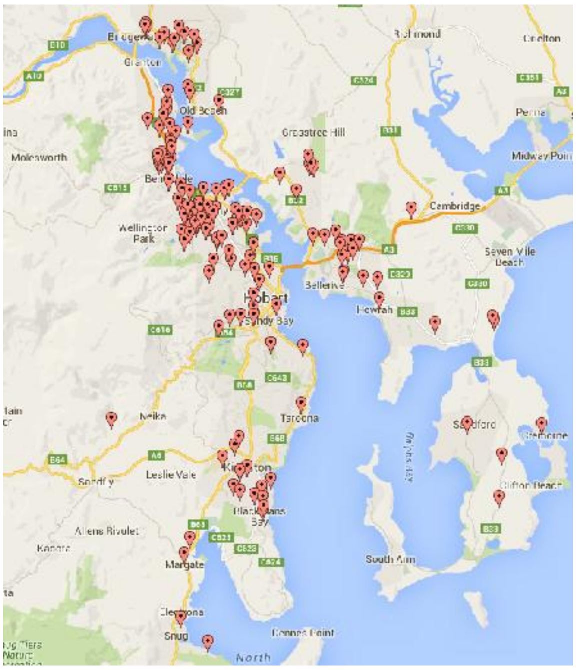
4.2 The Research Area

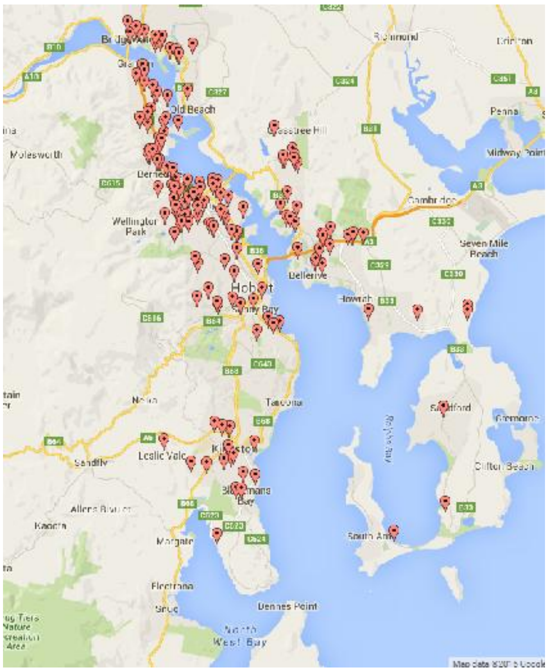
The research was conducted in the Greater Hobart Area. Greater Hobart was defined as the local government Areas of Hobart, Glenorchy, Clarence and Kingston. The Community Capacity Building Approach was conducted in the suburbs of Clarendon vale and Rokeby. Figure 4-2 on page 49 shows the location of each participant by research approach .

Figure 4-2: Street Location of participants by research group

In-home education and upgrades



Representative Group



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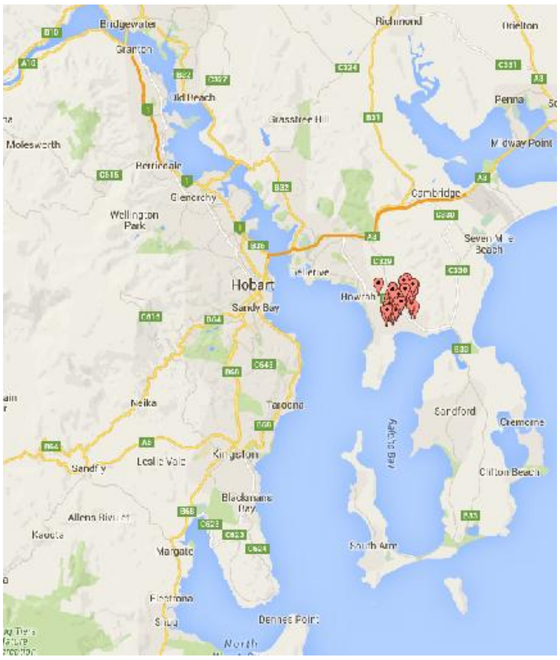
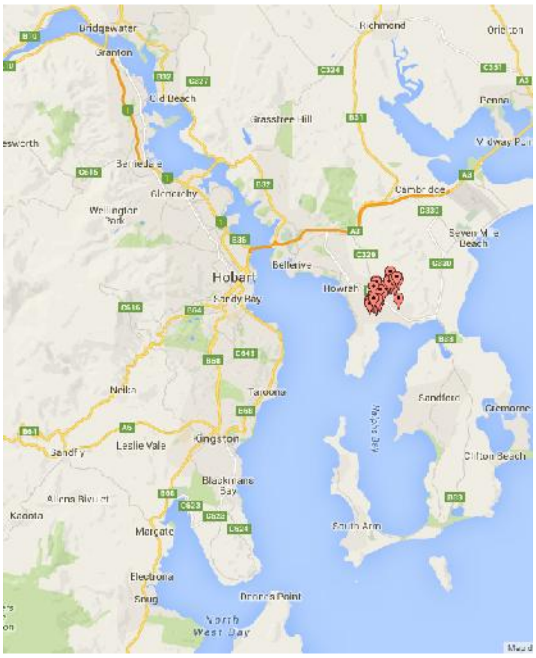
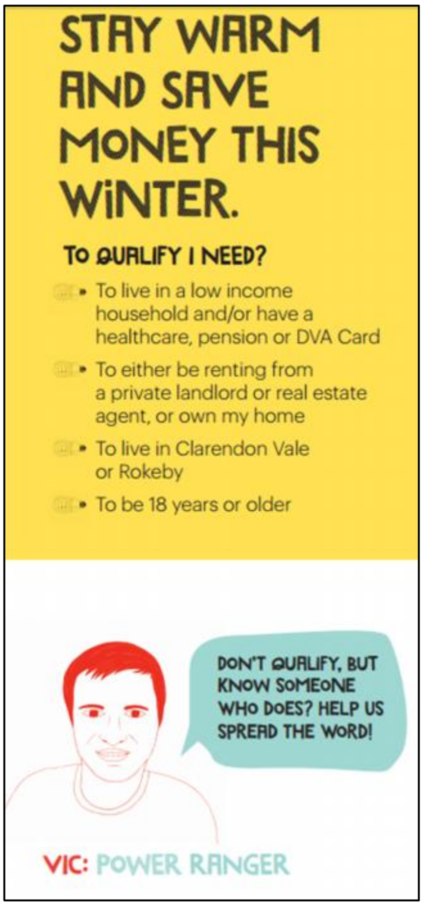
In-home education and upgrades with Community capacity building



Community capacity building



4.2.1 Recruitment to Get Bill Smart



The recruitment to GBS involved two distinct groups with two distinct roles, the Community Energy Champions and the participants in the main research project who were divided into the bulk and detailed study groups. All participants to the project needed to live within the Greater Hobart area (which encompasses Clarendon Vale and Rokeby) and meet the household criteria shown in the recruitment materials in **Error! Reference source not found.**.

4.2.1.1 Recruitment of Community Energy Champions

The neighbourhoods of Clarendon Vale and Rokeby were the site of the community capacity building intervention and the home of the Community Energy Champions (CEC). The recruitment of the 12 Community Energy Champions was the first critical stage of the project and was completed on 1 November 2013. The CECs were employed by the project to:

- Contribute to developing the community engagement activities;

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- Raise awareness of GBS and recruit their local community to the project;
- Deliver community events and activities about energy efficiency and thermal comfort; and
- Clearly communicate simple ways to live in an energy efficient way.

The project's Community Engagement Officer (EO) had an office within the Clarendon Vale Neighbourhood Centre for the duration of the community strategy and managed the CECs and the engagement strategy roll out. Detailed information and analysis about the recruitment of the CECs is provided in Chapter **Error! Reference source not found.** (Project Processes and Organisational Analysis).

4.2.1.2 Recruitment of bulk and detailed study participants

Get Bill Smart recruited 498 (excluding champions) households to the project, with 49 people in the detailed study and 449 people in the bulk study. The detailed study participants were recruited first, and randomly allocated to either the upgrades or no- upgrades group via a randomised database sorting mechanism. Once the 49 detailed study participants were recruited, participants were allocated to the bulk study group and randomly placed into either the upgrades or no-upgrades group via the database. The database was developed specifically for managing the GBS project and allowed for the management of over 700 applicants to the project.

Table 4-1 shows the allocations to each of the groups. The dark grey areas represent those in the detailed study group with the remaining people that are not highlighted in the bulk study group. The trial methodology for each of the detailed and bulk study groups are explained in detail in section 5 and 6.

The allocation to each project group was allocated based firstly on geographic area (Clarendon vale and Rokeby Vs greater Hobart). Within each geographic area allocation to the group that received upgrades was randomly allocated.

While all attempts were made to randomly allocate participants to approach groups at times this was a practical impossibility. Factors that affected random allocations included: landlord permissions in the EDUG groups (either the landlord refused upgrades or participants were unwilling to seek consent); participant requests for specific allocations (we conceded to these requests given the recruitment challenges faced).

Table 4-1: Allocations to Get Bill Smart research groups.

		Community capacity building approach	
		Off (Greater Hobart)	On (Clarendon Vale / Rokeby)
In-home education and upgrades approach	Off	(Representative) 153	76
		12	12
	On	12	13
		157	63

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The recruitment of low income householders to the project began in February 2014 and was completed in December 2014. The recruitment of householders in Clarendon Vale and Rokeby was managed by the Community Engagement Officer (EO) with the help of the Community Energy Champions (ECs). Details about the recruitment processed in Clarendon Vale and Rokeby are described in Chapter 8 (Project Processes and Organisational Analysis). The recruitment to the Greater Hobart study area was managed by the Get Bill Smart project manager from Sustainable Living Tasmania. The project employed the services of a local design company to create legible, eye catching, engaging promotional material in the form of posters, flyers, stickers, banners, newspaper advertisements, newsletters and events calendars as shown in Figure 4-3. The promotional material contained simple language and imagery suited to those with low literacy levels.

Figure 4-3: Examples of promotional materials used for recruitment and community events

Recruitment activities in Greater Hobart generally followed the Recruitment Strategy that was outlined in project Milestone 3. The following activities (Table 4-2) were carried out to promote GBS to Greater Hobart households

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Table 4-2: Summary of GBS participant recruitment activities for Greater Hobart

Activity	Dates and results
Media Releases	June 24th, August 5th, September 25th 2014 ABC radio coverage, Southern Cross TV News coverage, State and local newspaper coverage.
Community and shopping centre stalls	9 stalls in Greater Hobart: direct applications on the spot and contact with many low income earners.
Presentations	13 presentations in Greater Hobart at community centre events, Council meetings and service provider meetings: Direct applications on the spot to eligible residents, contact with service providers and community centre managers who refer people to the GBS project.
Visits to community and neighbourhood centres	17 face to face visits with community centre managers and staff to introduce GBS and maintain relationships, including provision of promotional material and forms.
Low income service providers	Specific flyers and posters made for Colony 47 Hobart housing support centre. Regular communications with Aurora Hardship phone staff. Promotion of GBS at Anglicare Tasmania State wide forum. Promotion of GBS through COTA (Council on the Ageing)
Social Media and Internet	Get Bill Smart webpage, SLT webpage and GBS Facebook .
Promotion through other SLT energy projects	Utilizing the Home Energy Helper staff to promote GBS to friends and family of Housing Tasmania tenants. Contacting helpful landlords who have worked with SLT projects previously to alert them of GBS and to pass onto their tenants.

During each recruitment activity, project staff recorded to the best of their abilities how many people were informed about the GBS project. The number of people reached via the mass media in ABC radio coverage, Southern Cross News coverage and local newspaper articles is difficult to account for. The only way that this stream was able to be recorded was through the increased online registrations and phone calls during the media releases. Table 4-3 (below) shows an estimate of the project recruitment efforts over the course of the recruitment period for both Greater Hobart and Clarendon Vale and Rokeby communities. Participation rates are described as people who provided an expression of interest to the project. Some of these people did not complete the full stage of recruitment to the project due to them either being ineligible for the project or lack of continued communication.

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Table 4-3: Estimated recruitment outcomes for Get Bill Smart (Feb – Dec 2014)

Recruitment outcomes	
Number low income households approached about Get Bill Smart	3512
Percentage of approached households that participated in Get Bill Smart	20%

*Note: includes both Greater Hobart and Clarendon Vale interactions with GBS potential participants.

4.2.1.3 Vouchers and incentives for participation

It was recognised that some of the GBS approaches would not deliver any benefits to the household in terms of thermal comfort or energy savings. Where an impost in time was incurred without an improvement in energy efficiency then grocery vouchers were offered. Table 4-4 (below) shows the voucher values that were offered to each participant on completion of each project element.

Table 4-4 - Grocery vouchers for project participants

	1st survey	1st interview	Install datalogger	2nd survey	2nd interview	Remove datalogger
REP – bulk	$75			$75		
REP - detailed	$75	$25	$25	$75	$25	$25
EDUG - bulk				$25		
EDUG - detailed		$25	$25		$25	$25
CCB - bulk	$75			$75		
CCB - detailed	$75	$25	$25	$75	$25	$25
EDUG + CCB - bulk				$25		
EDUG + CCB -		$25	$25		$25	$25

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detailed						

In addition to the vouchers specified in Table 4-4 an incentive prize was offered for completion of the final survey. An additional 40 x $100 grocery vouchers were offered and 15 complete in-home education and upgrades. Perhaps unsurprisingly the grocery voucher prizes where more sought after than the EDUG approach. These incentives led to a 68% of surveys being returned on time, and overall 82% of participants returned their second survey.

4.2.2 Types of data collected

Overall Data was collected through:

- Observations of housing
- Billing data of householders (Aurora Energy)
- Observations of community activities
- Surveys of participants
- Surveys of champions
- Interviews of participants
- Interviews of champions
- Interviews with GBS staff
- Review of project documentation
- Review of demographics
- Other responses from participants

Data for the bulk component of the study was collected via:

- Surveys pre and post intervention
- Energy bill data collected (with permission) from the energy suppliers (Aurora Energy)

Data for the detailed component of the study was collected via:

- Surveys pre and post intervention
- Energy bill data collected (with permission) from the energy suppliers (Aurora Energy)
- Semi structured interviews pre and post intervention
- Logging of energy use and thermal performance of houses
- Home observations

Data for the organisational component of the study was collected via:

- Interviews with champions and stakeholders
- Review of project documentation
- Written surveys/questionnaire

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4.2.3 Approvals for research and Privacy

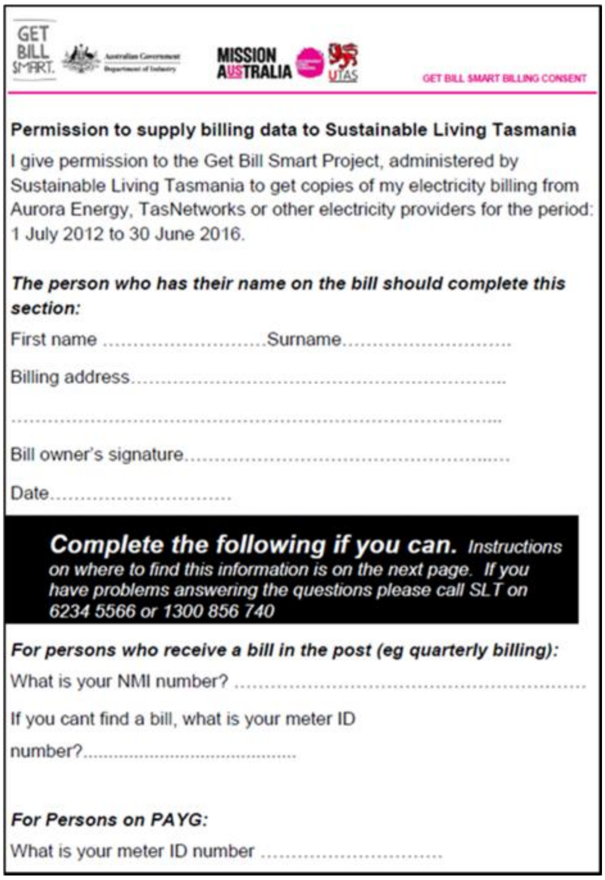
All recruitment processes and data collection techniques have been approved by the University of Tasmania's Social Science Human Research Ethics Network (Tasmania) through application H13682. In addition the project has progressed through approval stages with the Australian Government. All data collected and intended analysis processes are listed in a data plan approved as part of the GBS contract process. The project ensured the following research principles were met:

- invitations were sent out through a third party organisation (SLT);
- UTAS only contacted people who expressed an interest to be involved;
- People were well informed about the project and what the data collected will be used for before deciding to participate (through extensive information packages provided to interested people)
- Participants had all necessary contact details of UTAS and SLT;
- Participants gave consent before participating and completing surveys;
- Respect was always maintained in all relationships related to the project;
- Participants remained anonymous in any public presentation of data through unique identification ID's;
- Data was kept secure;
- Participants could seek further information and clarification about the study; and
- Participants could pull out of the research when they needed to (and indeed some did due to illness or change of address).

All participants are protected by both Human Research Ethics guidelines and Australian Government privacy laws.

All low-income householders were required to provide permission for GBS to access their billing data and electricity consumption data from their energy provider in order to participate in the project. A simple form (Figure 4-4) was provided to project recruits that clearly explained the process and asked for their details and permission. If participants did not want their data to be collected, or they did not have a separate electricity metre that tracked their electricity consumption, then they were unfortunately unable to join the project. This only happened in very few cases.

Figure 4-4 Sample billing consent form


GET BILL SMART — MISSION AUSTRALIA — UTAS — GET BILL SMART BILLING CONSENT

Permission to supply billing data to Sustainable Living Tasmania

I give permission to the Get Bill Smart Project, administered by Sustainable Living Tasmania to get copies of my electricity billing from Aurora Energy, TasNetworks or other electricity providers for the period: 1 July 2012 to 30 June 2016.

The person who has their name on the bill should complete this section:

First name .... Surname ....

Billing address ....

....

Bill owner's signature ....

Date ....

Complete the following if you can. *Instructions on where to find this information is on the next page. If you have problems answering the questions please call SLT on 6234 5566 or 1300 856 740*

For persons who receive a bill in the post (eg quarterly billing):

What is your NMI number? ....

If you cant find a bill, what is your meter ID number? ....

For Persons on PAYG:

What is your meter ID number ....

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SLT provided a copy of all of the participants' signed forms to TasNetworks and Aurora Energy who exchanged electricity consumption data (Kwh) for each customer, across a variety of tariffs and billing periods from 1 July 2012 to 30 June 2016. Major trends in the consumption of electricity across the project are explained in the Bulk Study Report.

4.3 Project Delivery

4.3.1 In-Home education and upgrades

Booking and scheduling

Once a participant was allocated to a research group and the project was in its "delivery phase" (after April 2014) householders where contacted to schedule a home visit. The original contact was made by Sustainable Living Tasmania and over 3 telephone contacts where attempted before any attempts to contact via post. The appointments where scheduled for between 2 days and 3 weeks in advance (depending on householder preference). Some participants were not contactable and as such did not receive in-home education and upgrades. In this situation they were re-allocated to the most appropriate research group for them (REP or CCB). A text message was sent 24 hours prior to the appointment as a reminder and a courtesy call made by the HEH in the hours before the appointment. In the case of a participant not attending an appointment, attempts were made to reschedule.

The Home visit

This approach involved two qualified home energy assessors (Home Energy Helpers or HEH) visiting a household, educating the householder(s), and performing a series of energy efficiency upgrades. From past experience, we found that low-income clients respond more positively to the title of Home Energy Helper, since "assessor" or "auditor" can conjure images of having one's possessions or lifestyle judged, rather than being assisted to reduce their energy bills and improve the thermal comfort of their home.

Education

One Home Energy Helper (HEH) sat down with the householder(s) and discussed an educational booklet. Advice specific to the household was discussed and noted inside the booklet. A copy of the booklet is available at Appendix 1. The education session focused time and attention according to the amount of energy used by that area of the house. Roughly speaking 50% of time was spent on heating and approaches to staying warm, 25% on hot water usage and 25% on all other energy using appliances.

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The HEH also provided the householder(s) with a thermometer and showed them how to use it. Thermometers are an important tool for ongoing energy efficiency education and behaviour change. They allow householders to directly monitor the temperature of their home, refrigerator and hot water system, and are particularly useful where a heater without a thermostat is being used. Shower timers where also supplied alongside the educational activities.

The HEH assisted the household to develop a personalised power savings plan, consisting of a simple checklist of actions that mirror the individual points of advice included in the educational document. The HEH recorded the information on the personalised power plan for later input into the database for monitoring and evaluation purposes.

Upgrades

While the first HEH educated, the second performed a range of simple energy efficiency upgrades to the household. SLT used a team of qualified and experienced home sustainability assessors trained in each of the upgrade procedures and with a wealth of experience in performing them for thousands of Tasmanian households. The exceptions were ceiling insulation, curtains and extractor fans; for which we used suitably qualified subcontractors. A maintenance contractor and lighting electrician were also used on two occasions.

Our Home Energy Helper assessed whether or not an upgrade was suited to each household. If so, they explained it, including pros and cons, and allowed the householder to make their own informed decision as to whether or not to proceed with the upgrade. The upgrade list (Table 4-5, below) shows the range of energy efficiency upgrades that where delivered.

Table 4-5 Energy efficiency upgrades delivered in the Get Bill Smart Project

Upgrade Description	Performed When	Monitoring and Evaluation
Shower head replacement with equivalent 9L/min model	Flow rate of existing shower head is ≥10L/min	Flow rate before and after replacement recorded. Householder's estimate of average time shower used per day
Hot water storage cylinder insulation with reflective sheeting with bubble-core interior	Hot water cylinder is accessible. This work will be completed by HEH if it is a user serviceable "bung" type thermostat.	Size of cylinder. Location of cylinder

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Hot water pressure relief valve and pipe insulation with ValveCosy (valvecosy.com.au) and foam pipe lagging respectively. Lagging applied to first 2 metres of outlet and pressure relief pipes only	Pipes are accessible and not already insulated.	Location of pipes. Length of pipes insulated
Light globe replacement with high-quality, equivalent light output, warm white compact fluorescent lamps[5]	Existing light globes are less efficient (e.g. incandescent or halogen). In regularly occupied rooms only	Type and power rating of light globe(s) replaced. Householder's estimate of average time lights used per day
Accessible power switch installation (EcoSwitch) on home entertainment and IT systems to reduce standby power consumption	Standby power is >3W and there is not already an easily accessible switch.	Standby power. Householder's estimate of average time system used per day
Window, door, fan & vent draught-proofing in heated zones [6]	Draughts are present. Residual risk of mould due to condensation from trapped humidity is minimal [7]	Number and type of door/window draught-proofing applied to
Ceiling insulation to R4	Existing ceiling insulation is less than R2.0. Roof cavity is accessible and installation is safe. One or more occupants are classified as 'high needs'[8]	Type, thickness, coverage & condition of existing insulation. R value of Insulation added.
Curtains (thermally lined with full blockout) on a track system that acts as a pelmet (trapping air between curtain and window) in heated zones.	Existing window coverings are non-existent, venetian blinds, horizontal blinds, or light curtains. One or more occupants are classified as 'high needs' Only in heated zones.	Type and condition of window coverings before upgrade. Size of window. Location of window
Underfloor insulation	No floor coverings present, large cracks in floorboards, accessible to underfloor	Estimate of R value of existing floor materials. R value of Insulation added.

Reporting and data collection

Following the delivery of the In-home education and upgrades the HEH entered their visit data into the project management database. This kept track of stock use as well as recording information on upgrades performed, building structure and confirmation of electricity billing data.

Table 4-6 Upgrades delivered through the Get Bill Smart Project

Upgrade Description	# of households that received this upgrade
Shower head replacement with equivalent 9L/min model	142
Hot water storage cylinder insulation with reflective sheeting with bubble-core interior	58
Hot water pressure relief valve and pipe insulation with ValveCosy	171
Foam pipe lagging applied to first 2 metres of outlet and pressure relief pipes only	210

[5]While incandescent light globes are no longer being sold in Australia, halogen globes branded as "efficient" are being sold even though they use 3 times more energy to produce the same amount of light as a compact fluorescent lamp (CFL). Further, many householders are turning away from CFLs due to approximately experiencing poor quality light from cool white and/or cheap products. Giving people a good experience of CFLs can influence their future purchasing decisions.

[6] Our draught-proofing techniques use a variety of screw-fixed brush strip, adhesive backed v-strip, adhesive backed foam tape, and door snakes depending on the application.

[7] Householders were educated on managing humidity and condensation and asked to monitor it. All draught-proofing measures are easily reversible if ever necessary.

[8] The Home Energy Helper will rate the household's likely thermal improvement from having curtains installed (recording a score between 1 and 5), and the susceptibility of occupants to ill-health due to cold (recording a score between 1 and 5). Households will be classified as high-needs when the product of these two ratings is 16 or greater.

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Light globe replacement with high-quality, equivalent light output, warm white compact fluorescent lamps (i)	237
Accessible power switch installation (EcoSwitch) on home entertainment and IT systems to reduce standby power consumption	75
Doors draught proofed	223
Windows draught proofed	44
Exhaust fans draught proofed	12
Ceiling insulation to R3.5	61
Curtains (thermally lined with full blockout) on a track system that acts as a pelmet (trapping air between curtain and window) in heated zones.	26
Underfloor insulation	0

Note, one home was recommended for underfloor insulation however the tenant would not remove obstacles stored under the house and suitable arrangements for the subcontractor to install could not be made.

4.3.2 Community Capacity Building

Phase one of CCB: Building capacity of Energy Champions

The first phase of CBB entailed employing a Community Engagement Officer (EO) and 12 community representatives as Energy Champions (ECs). The role of the EO was to recruit the ECs and to support them to develop a community engagement program and raise awareness about GBS and energy efficiency.

On joining the GBS project, the ECs received training in energy efficiency and communication from experts in these fields. As part of this training, the ECs were involved in some practical exercises in order to develop their knowledge and skills. The EO also facilitated a number of workshops that familiarised the ECs with what community capacity building entails and how to develop and implement a community engagement strategy.

In order to extend their understanding of home energy saving, all ECs received in-home education and upgrades in their own homes. This increased the ECs' understanding of the GBS project and objectives, practical measures to reduce energy use and improve thermal comfort, and the effectiveness of energy efficiency measures. Full details of the recruitment and training of energy champions can be found in Chapter 8.

Phase two of CCB: Building capacity in the local community

The EO and the ECs met regularly during late 2015 to develop a Community Engagement Strategy. During this stage the ECs were supported to make a video about the GBS project and their role in the project. The ECs also worked with the EO to develop a calendar of home energy community events and activities.

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The EO then supported the ECs to run community events and to raise awareness about GBS in the Clarendon Vale/Rokeby community over an eleven month period (Feb– Dec 2014).

Activities the ECs were involved with included:

- recruiting people into the GBS study
- distributing the Stay Warm booklet to householders
- developing a calendar of community events
- hosting BBQs and information sessions at neighbourhood centres and the community shed
- staffing stalls at community events, the community centres and other public locations within the CVR area
- organising and running sewing workshops
- organising hardware shopping tours
- organising and staffing a quiz night
- door-knocking homes in the local area to raise awareness of the GBS project, support the research component of the project, and to engage with householders
- organising and running home energy efficiency parties (modelled on the Tupperware approach).

Reporting and data collection

Details of the activities of the EC's and the participation at events where recorded by the EO and communicated with UTAS researchers or recorded in the GBS database.

4.4 Aims of project sub-reports

There are four sub-reports prepared under the GBS final report. Each one of these reports allows the reader to understand an aspect of the project from a particular perspective. Details of each sub-report and its aims is provided below

Chapter 5 – Bulk Study

The Bulk Study, reviews broad scale outcomes of the Get Bill Smart (GBS) project through before and after surveys and householder energy billing information. The report presents the methods, findings and discussion of findings from

1. Before and after surveys conducted with GBS participants; and
2. GBS participants' energy billing data.

The surveys and energy billing data collected for GBS allow pictures of the effects of GBS activities to be developed and to understand outcomes, including energy affordability as trends.

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Read this report if you would like an insight into broad patterns of energy use over time in relation to different program approaches.

Chapter 6 - Detailed study

The Detailed Study, provides in-depth examination of 51 participant households and the change that occurred for them after involvement with Get Bill Smart (GBS). These detailed households are a subset of the participants from the broader GBS study. This report assists in the evaluation of GBS by providing further insight into householder experiences and the conditions householders were living with, addresses gaps in understanding of the effects of GBS energy efficiency support activities, identifies key drivers affecting energy and comfort outcomes and the trade-offs made by householders at the individual household level.

The detailed report has been formatted as a stand alone report. If it is not attached to this report please download it from www.slt.org.au/get_bill_smart

Read this report if you would like an insight into the different ways that individuals and households manage energy efficiency and thermal comfort and respond to different program approaches.

Chapter 7 – Cost Benefit Analysis

The Cost Benefit report identifies cost effectiveness, cost benefit and co-benefits of GBS energy efficiency activities. Cost effectiveness is a technique that relates costs of a program to its outcomes, including its benefits. Cost effectiveness uses units that are non- monetary to measure impacts. Cost benefit is a technique that relates the costs of a program to its financial outcomes/benefits. This technique is used to identify the most cost effective option for achieving a particular outcome or benefit. Both techniques are used to identify the most cost effective options for achieving a particular outcome or benefit. Together cost benefits, cost effectiveness and co-benefits are being described to support future development of energy efficiency programs.

Read this report if you would like insight into the financial, social and health costs and benefits associated with different program approaches.

Chapter 8 – Project processes and organisational analysis

The Organisational analysis measured the success of the GBS project against four key questions

1. What were the capacity and constraint issues experienced by participating organisations?
2. What were the key successes and challenges associated with implementing the GBS project?
3. What impact did participating in a national trial evaluation have on project implementation?
4. What were the key lessons for future low income energy efficiency projects?

Read this report if you would like insight into the detailed implementation of each different approach and an understanding of how such programs are facilitated in practice.

Details of the data collection and analysis methodologies are contained within each sub-report:

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5 Bulk Study

5.1 Introduction

This report, The Bulk Study, reviews broad scale outcomes of the Get Bill Smart (GBS) project through before and after surveys and householder energy billing information.

The report presents the methods, findings and discussion of findings from

3. Before and after surveys conducted with GBS participants; and
4. GBS participants' energy billing data.

The surveys and energy billing data collected for GBS allow pictures of the effects of GBS activities to be developed and to understand outcomes, including energy affordability as trends. This report is one of four reporting on Get Bill Smart activities and outcomes. The other three are:

1. The Get Bill Smart detailed study report
2. Cost benefit analysis
3. Assessment of support approaches used from an organisational perspective

Along with these other three reports, this makes up part of the final report being submitted for the Get Bill Smart project. This Bulk Study report assists to meet the GBS objectives of: comparing outcomes of the approaches and support activities trialled; understanding how community capacity-building can assist to improve energy efficiency; understanding better drivers and barriers that effect energy and comfort changes; understanding how energy and comfort outcomes are utilised by low income householders. Overall GBS is working to assist in advancing understanding of energy use and thermal performance to improve the design of support activities for application in Tasmania and Australia.

The Get Bill Smart (GBS) project trialled two energy efficiency approaches that aimed to improve energy efficiency in households with low incomes:

1. Direct engagement with households through home energy visits that include education, auditing and physical upgrades to the house, fittings and appliances; and
2. Community capacity building that involves employing 12 local energy champions and conducting a community engagement strategy.

GBS also trialled how these approaches worked in combination.

This report assists in the evaluation of GBS by providing further insight of householder experience and providing key outcomes in relation to energy use and thermal comfort and a comparison of outcomes between GBs approaches.

5.2 Bulk study data collection and analysis methods

This section outlines the methods used to collect, process and analyse data for the bulk study component of the Get Bill Smart project. Data collection and analysis of before and after surveys are described as are the analysis processes for the electricity billing data.

5.2.1 Recruitment of bulk study participants

Low income households in Greater Hobart and Clarendon Vale/Rokeby were contacted and recruited through a combination of methods including: self-identification (in response to targeted advertising), referrals from community service providers (including but not limited to Mission Australia), extensive community engagement initiatives, local newsletters, letterbox drop of target communities, Community Champions (local advocates), online social networks, and advertising in popular media. There were incentives for people to participate in the project, including a free home energy audit, education and upgrades; or grocery vouchers. The project recruited a total of 498 project participants (plus twelve community energy champions) (See Figure 1.2.a).

5.2.2 Energy efficiency approaches and groups

Two energy efficiency approaches were evaluated in isolation and in combination. In order to undertake these comparative evaluations, project participants were randomly allocated into four distinct groups when they were recruited into the project in early 2014. The groups they were allocated to were:

1. In-home education and upgrades (EDUG)
2. Community capacity building (CCB)
3. In-home education and upgrades plus community capacity building (EDUG+CCB);
4. Representative group (REP) (no GBS energy efficiency activities were undertaken with this group)

The project recruited low income households from two comparable geographic areas: Greater Hobart and Clarendon Vale/ Rokeby. Clarendon Vale/Rokeby was the trial site for community capacity building. Households from Clarendon Vale /Rokeby were randomly allocated into GBS groups 2 and 3. Households from Greater Hobart were randomly allocated into GBS groups 1 and 4.

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Originally the project was designed to have equal numbers (n=120) in each research group. However given the limited recruitment pool in the Clarendon vale and Rokeby (community) areas the final research numbers were smaller in Clarendon Vale and higher in Greater Hobart (see Table 5-1 below).

Table 5-1 GBS approaches and numbers of households involved

		Community capacity-building	
		Off	On
In-home education and upgrades	Off	REP 165 households	CCB 88 households
	On	EDUG 169 households	EDUG+CCB 76 households

5.2.3 Survey methods

5.1.1.1 Administering before and after activity surveys

The first stage of the GBS evaluation entailed collecting comprehensive baseline data from the 498low income households participating in the project. Undertaking the survey was a condition of project participation and hence we were able to achieve a 100% response rate for the 'before' survey. The survey was available online at a survey collection website and posted as a paper version to participants prior to the commencement of the GBS activities (in-home education and upgrade visits; and community capacity building activities).

Before and after surveys asked participants about dwelling characteristics; motivation for participation in project; financial hardship; heating and cooling appliances; insulation; presence of moisture and mould; knowledge of thermal comfort and energy efficiency; capacity for and barriers to improving thermal comfort and energy efficiency; views on their local community; and socio-demographic information.

The second stage of the GBS evaluation entailed collecting comprehensive post-activity data. Paper surveys were sent to all participants. A small number of surveys were returned to sender because participants had moved (and not notified GBS). These participants were contacted wherever possible and were asked to fill out the survey on the time

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they had lived in the home they had moved from (noting dates the householders moved). Participants who did not respond to the paper version of the survey were contacted via phone. Overall we received/conducted 408 after surveys; which was a response rate of 82%.

The majority of participants chose, for both before and after surveys, to complete paper based versions of the survey. The online survey site acted as a cloud data repository for surveys so answers received on paper versions of surveys were entered into the online survey by researchers. Survey databases were then downloaded from the survey collection site to conduct analysis. Before analysis was conducted some pre-processing of data occurred in spread sheets.

Table 5-2 Participants who completed before and after surveys (by GBS approach)

		Community capacity-building	
		Off	On
In-home education and upgrades	Off	144 households	65 households
	On	143 households	56 households

5.1.1.2 Before and after survey data analysis

Survey data was analysed using IBM SPSS software. Descriptive statistical procedures were undertaken including frequencies and cross-tabulation. Bivariate analysis and some regression modelling was undertaken to test hypotheses of association between variables. Tests of statistical significance, Chi square (X^2) tests, were undertaken to determine the level of confidence that any observed associations between variables were valid rather than an outcome of chance.

5.1.1.3 Ethics and privacy guidelines

The research team obtained ethics approval for the project from the University of Tasmania's Social Science Human Research Ethics Network (Tasmania) in application H0013682. Participants were sought through government and Ethics committee approved recruiting activities. Participants submitted expression of interest so the GBS project manager could check suitability criteria.

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On enrolment in the project, participants were informed about the purpose and nature of the project; each stage of data collection; their right to withdraw from the project at any time; how the data they provide will be used; and how the data they provide will be stored. They were reassured that any information they provided would be treated confidentially. They were required to sign a consent form and the Federal Government's Privacy Notice prior to participating in any project or research activity.

Upon enrolment householders also provided permission for the Tasmanian electricity retailer to provide SLT with their household energy billing data.

5.2.4 Energy billing data methods

Electricity billing data was used to evaluate changes in energy usage for project participants before and after the energy efficiency activities. All data was supplied by electricity suppliers with permission from each participant. Energy billing analysis was undertaken by SLT project staff. SLT had previous experience obtaining and processing energy billing data from the supplier and was therefore well placed to conduct this analysis.

GBS was able to access electricity billing data for 437 of the 498 GBS project participants (88%). Due to availability of data varying for each participant and different tariffs having to be treated differently when analysing, each analysis conducted has some variation in the sample size.

5.1.1.4 Tasmanian electricity tariffs

The majority of participants received quarterly bills from their electricity retailer, with the remainder on a Pay As You Go (PAYG) system.

Of the participants billed quarterly, the majority used a general light and power tariff (31) and a second cheaper tariff either for hot water (41) or for hot water and hard-wired heating (42). Other quarterly-billed tariffs are described in Table **5**-**3**.

The PAYG system has special meters installed in homes that require a prepaid electricity card to run. The process for PAYG is similar to pre-paid mobile phones. PAYG uses a time-of-use tariff structure, so its data outputs are structured according to time of use.

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Table 5-3 Electricity tariffs used by project participants

Tariff name	Description	Number of participants with sufficient billing data for analysis				
		EDUG	CCB	EDUG+CCB	REP	Total
T31 – Light and power	Quarterly residential light and power circuits (often combined with Tariff 41 or 42).	128	39	38	88	293
T41 – Hot Water	Quarterly tariff with discount for hard-wired hot water systems. Households on this tariff tend to have wood or gas as their main source of heating.	40	16	11	31	98
T42 – Heating discount (hot water and space heating)	Quarterly tariff with discount for hard-wired hot water systems and heaters. Households on this tariff tend to have electricity as their main source of heating.	86	21	26	57	190
T22 – Business LV general	Quarterly business general tariff. First 500kW per month at higher rate.	0	0	0	1	1
T61 – Off-peak with afternoon boost	Quarterly off-peak heater and hot water.	8	3	3	7	21
T62 – Off-peak night period only	Quarterly off-peak heater and hot water.	1	0	0	0	1
TASX1I – Solar export – Transitional	Quarterly one-to-one feed in tariff.	16	7	2	10	35
PAYG	Pay As You Go pre-paid electricity with time-of-use rates.	19	26	19	35	99
	All tariffs combined	**143**	**64**	**54**	**122**	**383**

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5.1.1.5 Billing analysis tool

For previous projects, Sustainable Living Tasmania had worked with the Australian Bureau of Statistics to develop a Microsoft Excel tool with generalised formulae and macros to efficiently and accurately clean, process and analyse billing data. This tool was further developed by SLT staff for the GBS project.

5.1.1.6 Meter reading estimates

The supplied raw meter data included meter reads that had been estimated – where the meter reader wasn't able to actually read the meter for some reason, and so had generated an estimate for the period. These estimates were generally derived from the previous year's or the previous period's usage, so were unsuitable to be used in the analysis. A macro was written in the billing analysis tool that removed all estimates from the data series and only used real data points.

5.1.1.7 Determining before and after periods

If complete billing data were available for a household, the tool compared energy usage for the whole year after the assessment with the whole year before the assessment. If less data was available, the tool used the longest equivalent periods of data before and after the assessment (i.e. same date range exactly one year apart). This ensured the season was the same for the before and after data for each house, however the seasons may have been different between houses.

5.1.1.8 Minimum comparison periods

The analysis tool allowed the minimum comparison period (in days) to be specified. Any houses that had insufficient data to meet the minimum comparison period were omitted from the analysis.

Longer minimum comparison periods increased the reliability of the comparisons as anomalies tend to be averaged out over longer periods, but also reduced the number of houses analysed due to limited data availability for some houses (e.g. due to them moving out during the study).

5.1.1.9 Dividing a billing period into 'before' and 'after' periods

If there was more than one year of billing data before and after the energy efficiency activity, then the billing period that the activity occurred in was omitted from the analysis. Otherwise, the energy for that billing period needed to be divided into before and after periods.

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In previous projects, SLT had used a basic method in which the power consumption within the billing period was assumed to be constant. The drawback with this approach arises from the fact that Tasmanians typically using several times more power in winter than summer, and so power consumption can change markedly over the course of a billing period (particularly autumn and spring as the climate cools and warms). This is illustrated in Chart 5-1.

To overcome this, for the GBS project, a new methodology was developed using linear interpolation. This is illustrated in Chart 5-2

Chart 5-1: Demonstration of basic method used in past projects

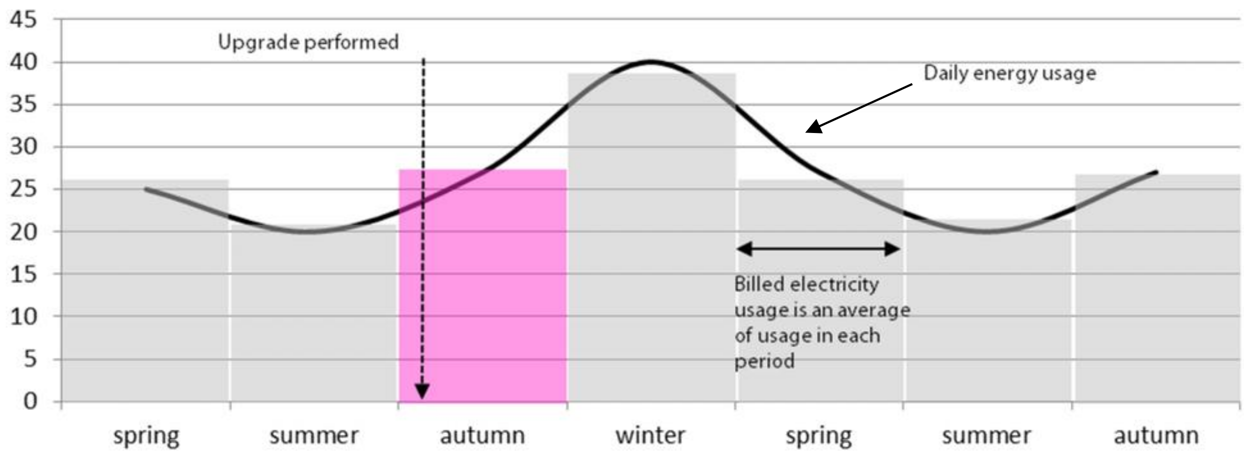
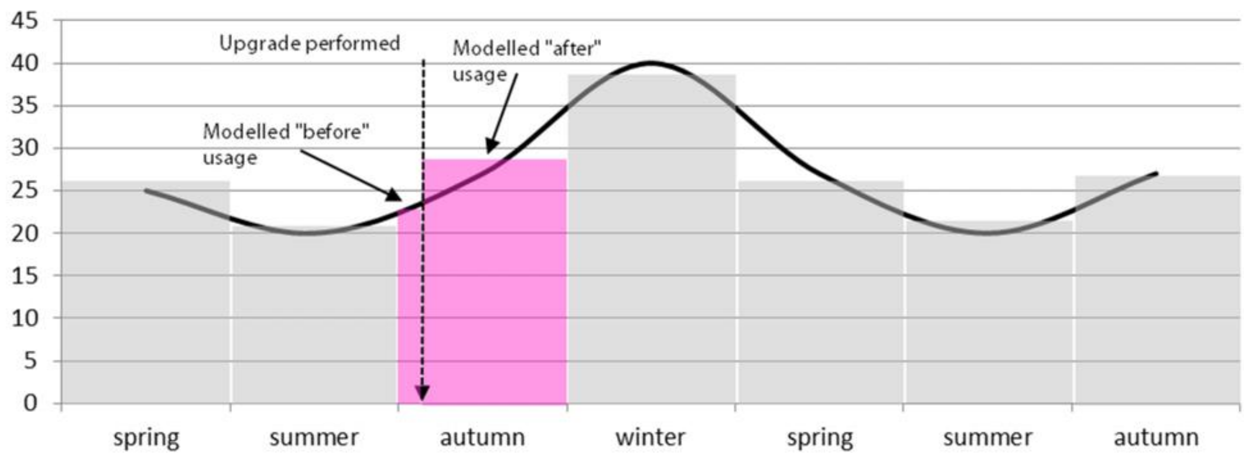


Chart 5-2: Demonstration of linear interpolation method used in this project



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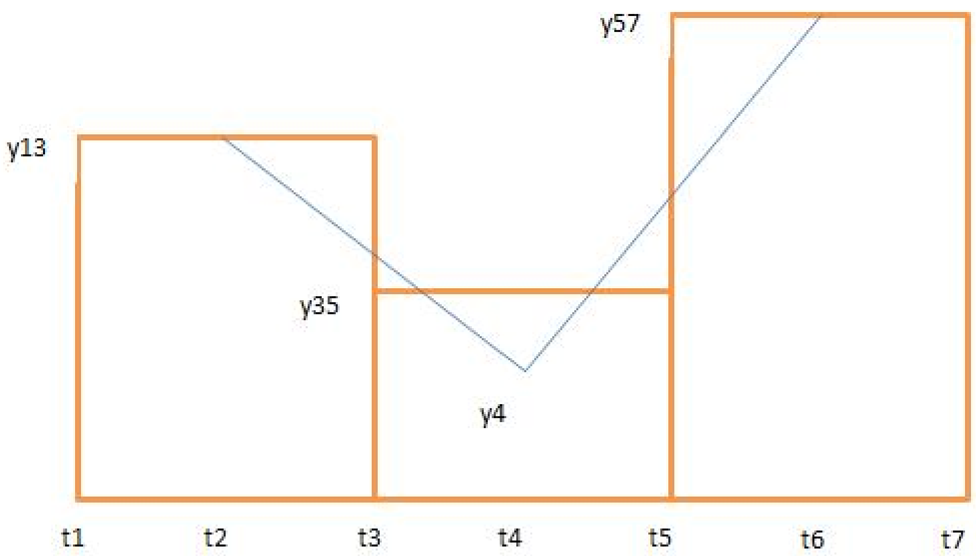
Linear interpolation between billing periods was performed using standard mathematical formula as explained below.

Figure 5.3-1: Interpolation model schematic



Linear interpolation between billing periods was performed using standard mathematical formula as explained below.

Figure 5.3-1 (above) represents three billing periods, with average usage of y13, y35 and y57 respectively. The first billing period starts at t1 and finishes at t3, with a midpoint at t2.

The blue line is the interpolation line which is fixed at the midpoints of the adjacent billing periods: points (t2, y13) and (t6, y57).

The average of the interpolation line between t3 and t5 needs to equal y35. This is why y4 does not necessarily equal y35.

To calculate y4, the area under the interpolation line between t3 and t4 must be equal to the total usage across that period

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$$y_{35}(t_5 - t_3) = A_{left} + A_{right}$$

where 'Aleft' and 'Aright' are the areas under the interpolation line but within the read period.

$$A_{left} = \frac{1}{2}(t_4 - t_3)\left\{y_4(1 + \frac{t_3 - t_2}{t_4 - t_2}) + y_{13}(1 + \frac{t_3 - t_2}{t_4 - t_2})\right\}$$

$$A_{right} = \frac{1}{2}(t_5 - t_4)\left\{y_4(1 + \frac{t_6 - t_5}{t_6 - t_4}) + y_{57}(1 + \frac{t_6 - t_5}{t_6 - t_4})\right\}$$

These can be rearranged to solve for y4.

$$y_4 = \frac{y_{35}(t_5 - t_3) - \frac{1}{2}y_{13}(t_4 - t_3)\left(\frac{t_3 - t_2}{t_4 - t_2}\right) - \frac{1}{2}y_{57}(t_5 - t_4)\left(\frac{t_6 - t_5}{t_6 - t_4}\right)}{\frac{1}{2}(t_4 - t_3)\left(1 + \frac{t_3 - t_2}{t_4 - t_2}\right) + \frac{1}{2}(t_5 - 4)\left(1 + \frac{t_6 - t_5}{t_6 - t_4}\right)}$$

Each of these five parts were calculated in their own column in the spreadsheet tool, then used to calculate y4. The left (y3) and right (y5) values were also calculated using simple linear interpolation between y4 and y13, and between y4 and y57.

From there, there were six possible options for the comparison periods. Comparison periods could:

1. end in the left half of the current read period
2. end in the right half of the current read period
3. start in the left half of the current read period
4. start in the right half of the current read period
5. cover the whole of the left half of the current read period, or
6. cover the whole of the right half of the current read period.

For each of the first four cases, a linear interpolation was used to calculate the daily usage to apply. The result was then multiplied by the number of days overlap to get total usage. For cases 5 & 6, the average of y3 and y4 or y4 and y5 was used, as appropriate.

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If an interpolation couldn't be calculated (e.g. if the current read did not have a preceding or following read), then the basic method assuming constant power use over the billing period was used.

5.1.1.10 Houses with photovoltaic solar

Solar Photovoltaic (PV) energy generation in participant homes further complicated billing analysis. Billing data included the energy exported to the grid and the energy imported from the grid (e.g. via Tariffs 31 and 41), but not the energy generated or the energy consumed. Any energy generated by PV that was used onsite to meet a house's consumption was not metered.

There are two ways of calculating net energy consumption (variables shown in green are available from the billing data):

Net energy consumed = **Energy imported** – **Energy exported**; and

Net energy consumed = Energy consumed – Energy generated

Therefore:

Energy consumed = **Energy imported** – **Energy exported** + Energy generated

So, if the energy generated were known, the energy consumed could be calculated. Estimating energy generated from PV systems using their rated power output was considered, however the approach was not adopted given the number of influencing variables such as tilt, orientation and shading.

As such, it was deemed impossible to accurately determine the energy consumed of houses with PV systems, and so they were omitted from analyses that involved energy consumption figures (e.g. Chart 5-4, Chart 5-5, and Chart 5-6).

However, the *change* in energy consumed between the before and after periods could still be calculated, by assuming the energy generated by PV systems was equal in the before and after periods.

Change in energy consumed = (**Energy imported after** – **Energy exported after** + Energy generated after) – (**Energy imported before** – **Energy exported before** + Energy generated before)

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= (**Energy imported after** – **Energy exported after**) – (**Energy imported before** – **Energy exported before**)

This was a reasonable assumption given both periods covered the same seasons, however it is important to note that differences in 'before' and 'after' solar generation may have arisen from changes in climate (e.g. cloudier one year than the other), shading (e.g. a tree cut down), or system performance (e.g. degradation or failure of the PV system). As such, some analyses were conducted both with and without houses with PV.

5.2.5 Data sources

Sustainable Living Tasmania obtained electricity billing data from Tas Networks and Aurora Energy. Tas Networks is the state-owned electricity distributor. Aurora Energy is the state-owned electricity retailer. The two were originally one organisation that split in July 2014 to comply with National Electricity Market requirements. Currently Aurora is the only electricity retailer in Tasmania for residential customers.

5.1.1.11 Tas Networks

Tas Networks provided guidance for billing analysis and supplied the energy data free of charge to the project. Tas Networks provided 4 data sets as follows:

- March 2014 – Sample data set
- December 2014 – Major data matching set
- May 2015 – Initial analysis data, and
- November 2015 - Final Billing and CDN Data.

5.1.1.12 Aurora Energy

Aurora Energy supplied data for PAYG customers. Because of the split between Aurora and Tas Networks, Aurora energy had a much better data set for PAYG customers. Aurora Energy provided guidance for billing analysis and supplied the energy data free of charge to the project. Aurora provided one PAYG data set in October 2015.

5.2.6 Data matching and cleaning

Matching the supplied billing data to the correct project participant required a significant amount of work. In some cases the project had access to correct billing names, address, meter ID# and National Meter Identifier (NMI). However, in many cases participants supplied incorrect billing names or poor quality meter or NMI details. Some participants also moved house during the project period as well as changing account names whilst remaining in the same residence

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The National Meter Identifier (NMI) was matched to the participant household. A major complication is that the data provided for each NMI was not always tied to a particular customer. If someone moved in or out of a house during the period covered by the data set, the data set included data from the previous or next occupant, who were not project participants.

To overcome these occupant mismatches, the billing data was reconciled with the move-in and move-out dates for each house. Three sources of data were used for this: connection-disconnection (CDN) data from Tas Networks, UTAS's survey data and SLT's project management database (SLT database).

5.2.7 Setting dates

5.1.1.13 Energy efficiency activity date

"Energy efficiency activity dates" needed to be determined in order to separate the before and after periods.

EDUG and EDUG+CCB: For participants receiving in-home education and upgrades (with or without community capacity building), the energy efficiency activity date was taken from the SLT database (i.e. the date that the in-home education and upgrades were conducted).

CCB: For participants receiving community capacity building only, the energy efficiency activity date was taken as the transfer date from the SLT database (i.e. when the participant was recruited). If the period between the move-in date and transfer date was less than thirty days then the energy efficiency activity date was taken to be the move-in date plus thirty days. If the allocated date was less than thirty days from the move-out date then the energy efficiency activity date was taken as the move-out date minus thirty days.

REP: For the representative group, the energy efficiency activity date was taken to be the average of all energy efficiency activity dates from the other groups – 29/09/2014. If the period between the move-in date and the allocated date was less than thirty days then the energy efficiency activity date was taken as the move-in date plus thirty days. If the allocated date was less than thirty days from the move-out date then the energy efficiency activity date was taken to be the move-out date minus thirty days.

5.1.1.14 End dates

The end date for analyses on each household was assumed as the survey return date unless:

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- the survey data indicated the participant moved out prior to project end; or
- the database notes indicated the participant moved out before project end; or
- the participant did not return a survey.

In these cases connection/disconnection data from Tas Networks was referenced to find appropriate a move-out date for the participant.

If the participant did not return the "after" survey and there was no corresponding connection/disconnection data then the move-out date was assumed to be 01/01/2016.

5.3 Before and after survey results

5.3.1 Socio-demographic description of participants

In this section, we examine the socio-demographic characteristics of households participating in the Get Bill Smart project. In particular we examine: household type, size and age; household income; education; employment; place of birth; cultural identity and language; whether or not there is someone with chronic illness and disability in the household; tenure; and length of residence.

5.1.1.15 Household type

There were a range of household types participating in the Get Bill Smart project as shown in Table 5-4. Most households were stable, with 81.3% of households (n=321) reporting the same household type across the two surveys.

Table 5-4 What household type best describes this household?

	n	%
Single person	125	31.5
Single parent and dependent/s	91	22.9
Couple	79	19.9
Couple and dependent/s	73	18.4
Group / share household	19	4.8

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Other	10	2.5
Total	**397**	**100.0**

Missing cases=11

The household size varied among participating households, as shown in Table 5-5. In relation to household size most households were stable, with 84.5% of households (n=338) reporting the same number of people living in the home across the two surveys. Only 6.25% of households (n=25) reported an increase in household size and 9.25% (n=37) reported a decrease in household size across the two surveys.

Table 5-5 Household size

	n	%
1	124	30.8
2	120	29.9
3	60	14.9
4	59	14.7
More than 4	39	9.7
Total	**402**	**100.0**

Missing cases = 6

There were a range of households in various age brackets participating in the GBS project as shown in Table 5-6.

Table 5-6 Household age

	n	%
Under 25 years	13	3.3
25-44 years	124	31.1

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45-64 years	140	35.1
Over 65 years	122	30.6
	399	**100.1**

Missing cases = 9

5.1.1.16 Household income

Only low income households were eligible to participate in the Get Bill Smart project. Participants were asked to estimate either their weekly or their annual income. Thirty five per cent of participants (n=141) provided an estimate of their weekly income and 60% (n=245) provided an estimate of their annual income.

The Australian Council of Social Service's report *Poverty in Australia 2014*[9] provides a recent estimate of poverty in Australia. In 2012, the poverty line (50% of median income) for a:

- lone person was $400.30 per week,
- lone parent with 2 children was $640.40,
- couple was $600.40, and
- couple with 2 children was $840.60 (ACOSS 2014: 9).

Even without regard for household type, the tables below highlight that many participating households were experiencing financial hardship. Among the participants who nominated to provide an estimate of their weekly income, Table 5-7 indicates that at least 26.2% of these households (n=37) were living below the poverty line.

Table 5-7 Weekly household income

	n	%
Less than $400	37	26.2
$400 – 599	62	44.0

[9] ACOSS (Australian Council of Social Service) (2014) *The Poverty Report 2014* Strawberry Hills, NSW: ACOSS.

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$600 – 799	27	19.1
$800 and more	15	10.6
Total	**141**	**100.0**

Among the participants who nominated to provide an estimate of their annual income, Table 5-8 indicates that over a third of these households (n=86, 35.1%) were living below the poverty line.

Table 5-8 Annual household income

	n	%
Less than $20,800	86	35.1
$20,800 – 31,199	64	26.1
$31,200 – 41, 599	32	13.1
$41,600 - 51,999	35	14.3
More than $52,000	28	11.4
Total	**245**	**100.0**

By combining weekly and annual income data to generate an estimate of the weekly income for all valid cases (n=347) we were then able to compare this data by household type. The results indicate that substantial proportions of each household type were below the poverty line. There were:

- 50.0% of single persons living on less than $400 a week (n=57);
- 63.3% of single parents living on less than $600 a week (n=57);
- 56.9% of couples living on less than $600 a week (n=41); and
- 54.9% of couples with children living on less than $800 a week (n=39).

Table 5-9 Weekly income by household type

	Single person	Single parent and	Couple	Couple and dependent/s	Total

		dependent/s			
Less than $400	57	26	19	9	111
	50.0%	28.9%	26.4%	12.7%	
$400-599	50	31	22	14	117
	43.9%	34.4%	30.6%	19.7%	
$600-799	7	17	14	16	54
	6.1%	18.9%	19.4%	22.5%	
$800 and more	0	16	17	32	65
	0.0%	17.8%	23.6%	45.1%	
Total	114	90	72	71	347
	100.0%	**100.0%**	**100.0%**	**100.0%**	

5.1.1.17 Education

In 2011, of Australia's resident population of 14.8 million people aged 15-64 years, 8.4 million (57%) held at least one formal (non-school) qualification. In comparison, just over a third of the households (n= 143, 35.0%) participating in the GBS study reported that either Person 1 and/or 2 held at least one formal (non-school) qualification.

Table 5-10 Highest level of education, Person 1 and 2

	Person 1	%	Person 2	%
Finished high school at year 8	34	9.6	19	10.3
Finished high school at year 10	117	32.9	61	33.0
Finished high school at year 12	75	21.1	53	28.6
TAFE or Polytech	61	17.1	26	14.1
Tertiary degree or diploma	69	19.4	26	14.1

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Total	**356**	**100.0**	**185**	**100.0**

5.1.1.18 Employment

Table 5-11 below indicates that around half of the households participating in GBS were not attached to the labour force (54.9%, n=182). There were only a small proportion of households with one or two full-time employees (10.6%, n=35) and around a third of households (32.3%, n=107) with one or two part-time employees. There was some change in the employment situation of households over the two year study period, with 19.8% of households (n=76) experiencing a change in their employment situation.

Table 5-11 Household attachment to the labour force

	n	%
Household attached to the labour force		
Two full-time workers	1	0.3
One full-time worker	23	6.9
- and one part-time, casual or small business operator	11	3.3
Two part time workers	17	5.1
One part-time worker	83	25.1
- and one casual or small business operator	7	2.1
Two-casual/small business operators	7	2.1
Household not attached to the labour force	182	55.0
Total	**331**	**100.0**

Missing cases=77

5.1.1.19 Cultural identity and language

Households participating in the GBS project were predominantly Australian-born (n=353, 86.5%) and English was the main language at home (n=367, 98.7%). Table 5-12 highlights that there were a small number of households

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participating in the study who were from: the United Kingdom; New Zealand and/or the South Pacific; Asia; Africa and the United States.

Table 5-12 Place of birth

	n	%
Australia	353	86.5
NZ/South Pacific	6	1.5
UK	26	6.4
Europe	7	1.7
Asia	4	1.0
Africa	3	0.7
US	1	0.2
Total	**400**	**100.0**

Missing cases=8

Table 5-13 Language spoken at home

	n	%
English	367	98.7
Language other than English	5	1.3
Total	**372**	**100**

Missing cases=36

While most households (n=278, 89.4%) participating in the GBS project identified as non-Indigenous, 9% identified as Aboriginal (n=28), 0.3% identified as Torres Strait Islander (n=1); and 1.3% identified as Aboriginal and Torres Strait Islander (n=4).

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Table 5-14 Identify as Aboriginal and/or Torres Strait Islander

	n	%
Non-indigenous	278	89.4
Aboriginal	28	9.0
Torres Strait Islander	1	0.3
Aboriginal and Torres Strait Islander	4	1.3
Total	**311**	**100.0**

Missing cases=97

5.1.1.20 Chronic illness and disability

Just under a half of households participating in GBS had a member of the family who had a chronic illness or disability (n=190, 47.7%), with 42.6% of these households (n=81) requiring a carer to support their family member. Most of these households (n=171, 90.0%) had a family member who was experiencing a chronic illness or disability in both 2014 and 2015. There was no significant difference between the health profiles of households across the GBS approach groups.

Table 5-15 Does anyone in your household have a chronic illness or disability

	n	%
No	190	47.7
Yes	208	52.3
Total	**484**	**100.0**

Missing cases=24

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5.1.1.21 Tenure

Around two-thirds of the households participating in GBS (n=253) were home owners, with 31.1% of these households (n=125) owning their home outright and a further 31.8% (n=128) paying off their mortgage. Around a third of households were private rental tenants (n=136). Only a small proportion of households (n=21, 5.3%) changed tenure between the two surveys.

Table 5-16 Tenure

	n	%
Owned outright	125	31.1
Owned with a mortgage	128	31.8
Private rental	136	33.8
Other	13	3.2
Total	**402**	**100.0**

Missing cases=6

5.1.1.22 Length of residence

Over half of the households participating in GBS (54.8%, n=222) had lived in their current residence for over five years, 28.1% (n=114) had lived in their current residence for between 1 and 5 years, and a further 17.0% (n=69) had lived in their current residence for less than a year.

Table 5-17 How long have you lived at your current address?

	n	%
0 - 6 months	32	7.9
6 months - 1 year	37	9.1
1 - 2 years	45	11.1
2 - 5 years	69	17.0

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5 - 10 years	58	14.3
10 + years	164	40.5
Total	**405**	**100.0**

Missing cases=3

As Table 5-18 highlights home owners were more likely than renters to have lived in their current residence for over 5 years.

Table 5-18 Tenure by length of residence

	Owned outright	Owned with a mortgage	Private rental
Less than a year	6.6%	7.0%	37.5%
1-5 years	9.8%	22.7%	47.8%
Over 5 years	83.6%	70.3%	14.7%
Total	**100.0%**	**100.0%**	**100.0%**

Missing cases=19

5.3.2 Description of dwelling condition

In this section, we examine the characteristics of the dwellings of households participating in the Get Bill Smart project, including dwelling age; house structure; insulation; and the household's hot water system.

5.1.1.23 Dwelling age

Over half of the dwellings participating in the GBS project were over 30 years old (54.2%, n=220), with only 10.6% (n=43) less than 15 years old.

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Table 5-19 Dwelling age

	n	%
Less than 15 years	43	10.6
15-29 years	143	35.2
30-49 years	128	31.5
50 years and over	92	22.7
Don't know	43	10.6
Total	**406**	**100.0**

Missing cases=2

5.1.1.24 House structure

The majority of dwellings participating in GBS were free-stranding houses (88.7%, n=346), with only a small proportion of flats, units, townhouses and apartments (11.2%, n=44). The majority of dwellings were single storey dwellings (86.2%, n=350), with only a small proportion of multi-storey dwellings (13.8%, n=56).

Table 5-20 Dwelling structure

	n	%
Free standing house	346	88.7
Co-joined house	24	6.2
Flat in two or more storeys	20	5.1
Total	**390**	**100.0**

Missing cases=18

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Table 5-21 How many storeys is your house?

	n	%
One storey	350	86.2
Two storey	52	12.8
Three or more	4	1.0
Total	**496**	**100.0**

Missing cases=2

Just under two-thirds of dwellings participating in GBS were three bedroom dwellings (61.2%, n=249), with 13.5% of dwellings with four or more bedrooms (n=55) and 25.3% of dwellings with one or two bedrooms (n=103).

Table 5-22 How many bedrooms are in your house?

	n	%
1	23	5.7
2	80	19.7
3	249	61.2
4 or more	**55**	**13.5**

Missing cases=1

5.1.1.25 Insulation

In general, homes were inadequately insulated given that Hobart experiences low temperatures throughout winter. Around two-thirds of participants were aware that they had some form of insulation in their home (65.3%, n=264), with 9.9% of participants (n=40) reporting that their home did not have any insulation.

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Table 5-23 Does your house have any insulation (2014)?

	n	%
Yes	264	65.3
No	40	9.9
I don't know	100	24.8
Total	**404**	**100.0**

Missing cases=4

The most common location for insulation was in the ceiling. Almost half of participants noted that their home had insulation in the whole ceiling (49.3%, n=201), with a further 12.5% (n=51) noting that their home had some insulation in the ceiling (11.4%, n=34). Thirty eight per cent of respondents (n=156) did not respond to this question. While some may have been unsure, others may not have had insulation.

Table 5-24 Do you have insulation in your ceiling (2014)?

	n	%
Whole ceiling	201	49.3
Some ceiling	51	12.5
No/unsure	156	38.2
Total	**408**	**100.0**

5.1.1.26 Hot water systems

The majority of homes (90.6%, n=365) in the GBS project had electric hot water systems, with only a small number of homes having gas (4.0%, n=16) or solar (4.2%, n=17) hot water systems. Of those homes with electric hot water systems, the majority were reliant on storage tanks (76.7%, n=280). Thirty participants (7.4%) had a new hot water system installed during the GBS project.

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Notably, few participants reported that they had insulation around their hot water heater and/or hot water pipes in 2014 prior to the assessment (6.3%, n=26).

Table 5-25 Type of hot water system, 2014

	n	%
Electric	365	90.6
Gas	16	4.0
Solar	17	4.2
Other	5	1.2
Total	**403**	**100.0**

Missing cases=5

5.1.1.27 Heating and cooling systems

In 2014, most households (n=317, 88.1%) relied on electric heating to heat their home in winter. In addition, 27.1% of households relied on a wood heater (n=109), with only 3.2% of households (n=13) using gas to heat their home. Of those using electric heating (n=317), 17.0% (n=54) reported using a plug-in heater to heat their main living space.

The type of heating used by GBS participants was similar in 2014 and 2015. In 2015, most households (n=351, 86.0%) relied on electric heating to heat their home in winter. In addition, 23.3% of households relied on a wood heater (n=95), with only 3.4% of households (n=15) using gas to heat their home. Of those using electric heating (n=317), 16.2% (n=57) reported using a plug-in heater to heat their main living space.

Table 5-26 What type of heating do you use to heat your home? 2014 and 2015

	2014			2015		
	n	%	Total	n	%	Total
Electric	317	88.1	360	351	86.0	408

Wood heater	109	27.1	404	95	23.3	408
Gas	13	3.2	402	14	3.4	408

In 2015, we also asked participants whether or not they used a heat pump. We found that over half the GBS participants were using a heat pump (57.-%, n=232).

Table 5-27 Do you use a heat pump? 2015

	n	%
Yes	232	57.0%
No	175	43.0%
Total	**407**	**100.0**

Missing cases=1

In addition, we asked participants in both surveys if they used an appliance to cool their home. Participants reported similar levels of appliance use across the two periods, with 73.3% of participants (n=291) reporting that they use an appliance to cool their home in 2014 and 72.9% of participants (n=293) in 2015.

Table 5-28 Do you use any appliances to cool your home? 2014 and 2015

	2014		2015	
	n	%	n	%
Yes	291	73.3	293	72.9
No	106	26.7	109	27.1
Total	**397**	**100.0**	**402**	**100.0**

2014 Missing cases=11

2015 Missing cases=6

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5.3.3 Draughts

Most participants observed that their home was draughty (72.8%, n=294) prior to any energy efficiency activity, with 27.2% (n=110) reporting that their home was not draughty. Similar levels of draughtiness were reported across Greater Hobart and Clarendon Vale/Rokeby.

Following the implementation of energy efficiency activities, EDUG and CCB, there was an increase in the proportion of participants who felt that their house was not draughty (44.8%, n=181).

Table 5-29 Is your house draughty?

	2014		2015	
	n	%	n	%
Yes	294	72.8	223	55.2
No	110	27.2	181	44.8
Total	**404**	**100.0**	**404**	**100.0**

2014 Missing cases=4

2015 Missing cases=4

Looking at changes in the presence of draughts in the home after the GBS energy efficiency activities, Table 5-30 indicates that around two-thirds of the households (n=268) experienced no change in the draughtiness of their home. In contrast, around a quarter of households (n=102) reported less draught around their home, with 7.5% (n=30) reporting an increase in draught around the home.

Table 5-30 Change in self-reported presence of draught, 2014 and 2015

	n	%
Same	268	67.0

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Less draught[10]	102	25.5
More draught[11]	30	7.5
Total	**400**	**100.0**

Missing cases=8

We then examined the impact of the GBS energy efficiency activities (CCB, EDUG, and EDUG +CCB) on people's reporting of draughtiness. Table 5-31 shows changes in reporting of draughtiness by GBS approach.

Table 5-31 Change in self-reported present of draught by GBS approach

	CCB	EDUG	EDUG +CCB	REP
Same	64.1%	59.3%	67.9%	75.7%
Less draught	21.9%	37.9%	28.6%	13.6%
More draught	14.1%	2.9%	3.6%	10.7
Total	**100.0% (n=64)**	**100.0% (n=140)**	**100.0% (n=56)**	**100.0% (n=140)**

Missing cases=8

We tested each GBS approach separately to see if the changes reported were significant. We found no significant differences between the reporting of draughtiness for those who experienced community capacity building and the representative group ($X^2=3.1$, $p>0.05$).

However, those participants who received in-home education and upgrades (EDUG and EDUG+CCB) were significantly more likely to report less draught than the Representative (REP) group:

- EDUG ($X^2=7.7$, $p<0.05$),
- EDUG+CCB ($X^2=25.2$, $p<0.05$).

[10] "Less draught" here means that, to the question "is your house draughty?", the respondent answered "yes" before the energy efficiency activities and "no" after them.
[11] "More draught" here means that, to the question "is your house draughty?", the respondent answered "no" before the energy efficiency activities and "yes" after them.

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In addition, the groups that received in-home education and upgrades (EDUG and EDUG+CCB) had a significant reduction in reported draughtiness compared with the groups that did not (CCB and REP) (X^2=25.9, $p<0.05$). A higher proportion of participants who received in-home education and upgrades reported less draught (35.2%, n=69) following the activity compared with those who did not (16.2%, n=33). In contrast, a smaller proportion of participants who received in-home education and upgrades reported more draught (3.1%, n=6) following the activity compared with those who did not (11.8%, n=24).

It is important to note that this is self-reported data and as such measures changes in perceived levels of draughtiness rather than actual levels of draughtiness in the home.

Table 5-32 Change in self-reported presence of draught by whether or not in-home education and upgrades were received

Received in-home education & upgrades:	**No**		**Yes**	
	n	%	n	%
Same	147	72.1	121	61.7
Less draught	33	16.2	69	35.2
More draught	24	11.8	6	3.1
Total	**204**	**100.0**	**196**	**100.0**

Missing cases=8

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Air leakage test

While participants subjectively reporting whether or not their houses were draughty before and after the energy efficiency activities provides some useful insight, we wanted to test the effectiveness of the draught-proofing upgrades objectively in a controlled manner. As such, we performed an air leakage test on one GBS participant's house before and after draught-proofing upgrades were undertaken.

The test effectively measured the change in rate of air exchange in the house in compliance with the CAN/CGSB 149.10-2002 standard. It involved attaching a calibrated fan to the house to depressurise it.

Before the draught proofing was installed the household experienced 20.41 air exchanges per hour at 50 Pa. After the installation of basic draught proofing on doors and windows the air exchange rate was reduced to 15.71 exchanges per hour. **This is a 23% decrease.**

GBS draught-proofing upgrades focussed on doors and windows and, to a lesser extent, exhaust fans. Sources of draughts not tackled included skirting boards, light fixtures, and power points.

5.3.4 Moisture

Most participants had observed moisture on their windows during cold weather in the past year (82.0%, n=328) prior to any assessment, with 18.0% (n=72) reporting no moisture on their windows. Of those who observed moisture on their windows during cold weather (n=328), around two thirds of these participants (63.7%, n=209) described the moisture levels in their home as medium or high, with 36.0% (n=118) describing moisture levels as low. There were no significant differences in relation to moisture levels reported in Clarendon Vale/Rokeby and Greater Hobart.

Table 5-33 Observed moisture on windows during cold weather, 2014 and 2015

	2014		2015	
	n	%	n	%

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Yes	328	82.0	263	67.3
No	72	18.0	128	32.7
Total	**400**	**100.0**	**391**	**100.0**

2014 Missing cases=8

2015 Missing cases=17

Looking at changes in moisture observations after the GBS approach, Table 5-34 indicates that the majority of households (77.1%, n=296) experienced no change in their observation of moisture on their windows in cold weather. In contrast, 18.8% (n=72) who observed moisture in 2014 did not observe moisture in 2015. Only a small minority (4.2%, n=16) who did not observe moisture in 2014 did observe moisture in 2015.

Table 5-34 Change in observed moisture on windows between 2014 and 2015

	n	%
Same	296	77.1
Moisture observed in 2014 but not in 2015	72	18.8
Moisture observed in 2015 but not in 2014	16	4.2
Total	**384**	**100.0**

Missing cases=8

In terms of reported moisture levels, Table 5-35 indicates that around a quarter of the households (26.6%, n=65) who reported on moisture levels in both 2014 and 2015 experienced a decline in moisture levels either from high to medium/low or medium to low following the energy efficiency activities. In contrast, 18.4% of participants reported an increase in moisture levels between 2014 and 2015.

Table 5-35 Change in level of moisture on windows, 2014 and 2015

	n	%

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Same	130	53.3
Less moisture	65	26.6
More moisture	45	18.4
Total	**240**	**98.4**

Missing cases=23

We then examined the impact of the GBS energy efficiency activities (CCB, EDUG, and EDUG+CCB) on people's reporting of moisture. Table 5-36 (below) shows changes in observed moisture on windows between 2014 and 2015 by GBS approach.

We tested each GBS approach separately to see if the changes in moisture observation were significant when compared with the representative group. While a weak relationship did exist between moisture observation and all three GBS approaches, we found no significant differences for:

- Community capacity building (X^2=5.8, $p>0.05$),
- Community capacity building and in-home education and upgrades (X^2=4.8, $p>0.05$).

However, the in-home education and upgrade approach did have a statistically significant impact on people's observation of moisture compared with the representative group (X^2=11.1, $p<0.05$). People who received in-home education and upgrades were less likely to report moisture in 2015 compared with the representative group.

Table 5-36 Change in observed moisture on windows during cold weather by GBS approach

	CCB	EDUG	EDUG +CCB	REP
Same	71.0%	75.7%	76.5%	81.5%
Moisture observed in 2014 but not in 2015	24.2%	22.8%	21.6%	11.1%
Moisture observed in 2015 but not in 2014	4.8%	1.5%	2.0%	7.4%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

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	(n=62)	(n=136)	(n=51)	(n=135)

Missing cases=24

Further analysis comparing the participants who received in-home education and upgrades (EDUG and EDUG+CCB) and those who did not (CCB and REP) also highlighted that in-home education and upgrades did have an impact on reducing moisture observations in people's homes (X^2=8.5, $p<0.05$).

Table 5-37 Change in observed level of moisture on windows by whether or not in-home education and upgrades were received

Received in-home education & upgrades:	No		Yes	
	n	%	n	%
Same	71	57.3	59	50.9
Less moisture	28	22.6	37	31.9
More moisture	25	20.2	20	17.2
Total	**124**	**100.0**	**116**	**100.0**

Missing cases=23

5.3.5 Heating practices and thermal comfort in winter

Heating practices across the study period, 2014 and 2015, were relatively stable. The most popular time to heat the main living space over winter was in the evening, with over half of GBS participants heating their main living space in the evenings in 2014 (54.7%, n=223) and in 2015 (56.1%, n=229). In contrast, only a minority of participants heated their main living space in the middle of the day in 2014 (9.3%, n=38) and in 2015 (12.0%, n=49). Similar heating practices were reported across Greater Hobart and Clarendon Vale/Rokeby.

Table 5-38 During what times of the day do you heat your home in winter? 2014 and 2015

	2014		2015	
	n	%	n	%

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Early morning	150	36.8	169	41.4
Late morning	46	11.3	52	12.7
Midday	38	9.3	49	12.0
Afternoon	102	25.0	110	27.0
Evening	223	54.7	229	56.1
Overnight	49	12.0	45	11.0
Most of day and night	162	39.7	169	41.4
Total	**408**	**100.0**	**408**	**100.0**

Most participants observed that without heating their home was rarely or never comfortable (71.9%, n=280) in winter prior to any assessment. Similar levels of thermal comfort in winter were reported across Greater Hobart and Clarendon Vale/Rokeby.

There was a decrease in the proportion of EDUG+CCB group participants who described their home as rarely or never comfortable (65.6%, n=161).

Table 5-39 In winter without heating my house is? 2014 and 2015

	2014		**2015**	
	n	%	n	%
Always comfortable	7	1.8	10	2.5
Mostly comfortable	27	6.9	38	9.5
Sometimes	75	19.3	90	22.6
Rarely	99	25.4	100	25.1

Never	181	46.5	161	40.4
Total	**389**	**100.0**	**399**	**100.0**

2014 Missing cases=19

2015 Missing cases=9

Looking at changes in participants' assessment of the thermal comfort of their home in winter, Table 5-40 indicates that just under half the participants (47.8%, n=182) reported the same level of thermal comfort in 2014 and 2015, with 30.2% of participants (n=115) reporting improvements in thermal comfort and 22.0% of participants (n=84) reporting decreased thermal comfort.

Table 5-40 Change in assessment of thermal comfort of home in winter, 2014 and 2015

	n	%
Same	182	47.8
Increased comfort	115	30.2
Decreased comfort	84	22.0
Total	**381**	**100.0**

Missing cases=27

We then examined the impact of the GBS approaches (CCB, EDUG, and EDUG+CCB) on people's assessment of the thermal comfort of their home in winter. Table 5-41 shows changes in reporting of thermal comfort by GBS approach.

Table 5-41 Change in assessment of thermal comfort of home in winter by GBS approach

	CCB	EDUG	EDUG +CCB	REP
Same	48.3%	41.0%	49.1%	53.7%
Increased	36.7%	36.6%	26.4%	22.4%

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comfort				
Decreased comfort	15.0%	22.4%	24.5%	23.9%
Total	**100.0% (n=60)**	**100.0% (n=134)**	**100.0% (n=53)**	**100.0% (n=134)**

Missing cases=27

We tested each GBS approach separately to see if the changes reported were significant. We found no significant differences between participants' assessment of thermal comfort of home in winter for:

- Community capacity building (X^2=4.9, p>0.05),
- Community capacity building and in-home education and upgrades (X^2=0.4, p>0.05),

However, we did find that the EDUG approach did have a statistically significant increase in people's reporting of the thermal comfort of their home in winter compared with the REP group (X^2=6.9, p<0.05).

The survey also collected data on participants' assessment of thermal comfort in summer. The final results did not provide a clear picture of the impact of the GBS approaches on participant reporting of thermal comfort in summer.

5.3.6 Changes in thermal comfort knowledge

Prior to GBS activities, GBS participants were asked if they agreed with the following statements about thermal comfort:

- I know a lot about keeping my home thermally comfortable in winter,
- I know a lot about keeping my home thermally comfortable in summer,
- I feel that I am doing everything I can to keep my household warm in winter.

In relation to the first statement ("I know a lot about keeping my home thermally comfortable in winter"), in 2014 over half of GBS participants (53.8%, n=208) mostly/strongly agreed that they did know a lot about keeping their home thermally comfortable in winter. In contrast, only 19.7% (n=76) mostly/strongly disagreed and 26.6% (N=103) neither agreed nor disagreed.

Following GBS activities, there was an increase in GBS participants mostly/strongly agreeing that they "know a lot about keeping my home thermally comfortable in winter", with 81% of participants mostly/strongly agreeing

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(n=319). There was also a decline in the proportion of GBS participants who mostly/strongly disagreed, with 5.1% of participants mostly/strongly disagreeing (n=20).

Table 5-42 I know a lot about keeping my home thermally comfortable in winter, 2014 and 2015

	2014		2015	
	n	**%**	**n**	**%**
Strongly agree	46	11.9	111	28.2
Mostly agree	162	41.9	208	52.8
Neither agree nor disagree	103	26.6	55	14.0
Mostly disagree	56	14.5	17	4.3
Strongly disagree	20	5.2	3	.8
Total	**387**	**100.0**	**394**	**100.0**

2014 Missing cases=21

2015 Missing case=14

We then examined the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on people's knowledge of keeping their home thermally comfortable in winter. We tested each GBS approach separately and found that the CCB (x^2=2.1, p>0.05) and EDUG+CCB approach (x^2=4.9, p>0.05) did not have a significant impact on people's knowledge of keeping their home thermally comfortable in winter. In contrast, a comparison of the EDUG approach with the representative group indicated that there was a significant impact on people's knowledge of keeping their home thermally comfortable in winter (x^2=10.7, p<0.05).

Table 5-43 Changes in participant's knowledge of keeping home thermally comfortable in winter by GBS approach

	CCB		EDUG		EDUG +CCB		REP	
	n	%	n	%	n	%	n	%

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Same	32	53.3	48	35.3	17	32.1	56	42.4
Improve	9	15.0	9	6.6	5	9.4	22	16.7
Decline	19	31.7	79	58.1	31	58.5	54	40.9
Total	**60**	**100.0**	**136**	**100.0**	**53**	**100.0**	**132**	**100.0**

Further analysis indicated that in-home education and upgrades did have a significant impact on people's knowledge of where to get information to improve the thermal comfort of their home. Upon comparison of all participants who received in-home education and upgrades (EDUG and EDUG+CCB) with those who didn't (CCB and REP) a stronger correlation between the two variables was observed (X^2=10.7, $p<0.01$).

In relation to the second statement ("I know a lot about keeping my home thermally comfortable in summer"), in 2014 over half of GBS participants (56.0%, n=215) mostly/strongly agreed that they did know a lot about keeping their home thermally comfortable in summer. In contrast, only 18.2% (n=70) mostly/strongly disagreed and 25.8% (n=99) neither agreed nor disagreed.

Following the GBS approach, there was an increase in GBS participants mostly/strongly agreeing that they "know a lot about keeping my home thermally comfortable in summer", with 83.7% of participants mostly/strongly agreeing (n=328). There was also a decline in the proportion of GBS participants who mostly/strongly disagreed, with 4.6% of participants mostly/strongly disagreeing (n=18).

Table 5-44 I know a lot about keeping my home thermally comfortable in summer, 2014 and 2015

	2014		**2015**	
	n	**%**	**n**	**%**
Strongly agree	48	12.5	110	28.1
Mostly agree	167	43.5	218	55.6
Neither agree nor disagree	99	25.8	46	11.7

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Mostly disagree	52	13.5	15	3.8
Strongly disagree	18	4.7	3	0.8
Total	**384**	**100.0**	**392**	**100.0**

2014 Missing cases=24

2015 Missing case=16

We then examined the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on people's knowledge of keeping their home thermally comfortable in summer. We tested each GBS approach separately and found that the CCB (x^2=0.6, p>0.05) and EDUG+CCB approach (x^2=3.1, p>0.05) did not have a significant impact on people's knowledge of keeping their home thermally comfortable in summer. In contrast, a comparison of the EDUG approach with the representative group indicated that there was a significant impact on people's knowledge of keeping their home thermally comfortable in summer (x^2=8.9, p<0.05).

Table 5-45 Changes in participant's knowledge of keeping home thermally comfortable in summer by GBS approach

	CCB		EDUG		EDUG+CCB		REP	
	n	%	n	%	n	%	n	%
Same	23	39.7	51	38.3	17	32.1	55	41.0
Improve	23	39.7	74	55.6	30	56.6	57	42.5
Decline	12	20.7	8	6.0	6	11.3	22	16.4
Total	**58**	**100.0**	**133**	**100.0**	**53**	**100.0**	**134**	**100.0**

Further analysis indicated that the in-home education and upgrade experience did have a significant impact on people's knowledge of where to get information to improve the thermal comfort of their home in summer. Upon comparison of all participants who received in-home education and upgrades (EDUG and EDUG+CCB) with those who didn't (CCB and REP) a stronger correlation between the two variables was observed (X^2=12.1, p<0.01).

In relation to the third statement ("I feel that I am doing everything I can to keep my household warm in winter"), in 2014 over half of GBS participants (65.2%, n=257) mostly/strongly agreed that are doing everything they can to keep

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my household warm in winter. In contrast, only 14.2% (n=56) mostly/strongly disagreed and 20.6% (=81) neither agreed nor disagreed.

Following the GBS approach, there was an increase in GBS participants mostly/strongly agreeing that they “are doing everything they can to keep my household warm in winter”, with 84.3% of participants mostly/strongly agreeing (n=334). There was also a decline in the proportion of GBS participants who mostly/strongly disagreed, with 7.8% of participants mostly/strongly disagreeing (n=31).

Table 5-46 I feel that I am doing everything I can to keep my household warm in winter, 2014 and 2015

	2014		2015	
	n	%	n	%
Strongly agree	91	23.1	141	35.6
Mostly agree	166	42.1	193	48.7
Neither agree nor disagree	81	20.6	31	7.8
Mostly disagree	38	9.6	25	6.3
Strongly disagree	18	4.6	6	1.5
Total	**394**	**100.0**	**396**	**100.0**

2014 Missing cases=14

2015 Missing case=12

We then examined the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on people’s perception that they are doing everything they can to keep their household warm in winter. We tested each GBS approach separately and found that the CCB (x^2=3.1, p>0.05) did not have a significant impact on people’s perception that they are doing everything they can to keep their household warm in winter. In contrast, a comparison of the EDUG+CCB and the EDUG approach with the REP group indicated that there both had a significant impact on people’s perception that they are doing everything they can to keep their household warm in winter:

- Community capacity building and in-home education and upgrades (x^2=6.6, p<0.05),
- In-home education and upgrades (x^2=9.3, p<0.01).

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Table 5-47 Changes in participant's perception that they are doing everything they can to keep their household warm in winter by GBS approach

	CCB		EDUG		EDUG+CCB		REP	
	n	%	n	%	n	%	n	%
Same	33	54.1	53	38.7	17	33.3	60	43.8
Improve	20	32.8	67	48.9	27	52.9	45	32.8
Decline	8	13.1	17	12.4	7	13.7	32	23.4
Total	**61**	**100.0**	**137**	**100.0**	**51**	**100.0**	**137**	**100.0**

Further analysis indicated that in-home education and upgrades did have a significant impact on people's knowledge of where to get information to improve the energy efficiency of their home. Upon comparison of all participants who received in-home education and upgrades (EDUG and EDUG+CCB) with those who didn't (CCB and REP) a stronger correlation between the two variables was observed (X^2=12.3, p<0.01).

5.3.7 Perception of energy use

Prior to any GBS approach, around half of the GBS participants rated themselves as medium energy users (49.8%, n=199), 28.3% of participants (n=113) rated themselves as high energy users, 13.0% (n=52) rated themselves as low energy users, and 9.0% (n=36) were unsure about their energy use.

In Greater Hobart a greater proportion of participants rated themselves as low energy users (16%, n=45), compared with Clarendon Vale/Rokeby (5.9%, n=7) in 2014.

Following the implementation of the GBS approaches there was a small increase in the proportion of participants who rated themselves as low energy users (19.5%, n=77).

Table 5-48 Perception of energy use in the home, 2014 and 2015

	2014	2015

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	n	%	n	%
High	113	28.3	87	22.1
Medium	199	49.8	196	49.7
Low	52	13.0	77	19.5
Don't know	36	9.0	34	8.6
Total	**400**	**100.0**	**394**	**100.0**

2014 Missing cases=8

2015 Missing cases=14

We then examined the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on people's perception of their energy use. We tested each approach separately and found that each of the approaches did have an impact on people's rating of their energy use.

Each of the approaches had a significant impact on the people's perception of energy use (i.e. people were more likely to rate themselves as using lower energy in 2015 compared with 2014) compared with the representative group:

- Community capacity building (X^2=6.4, $p<0.05$),
- In-home education and upgrades (X^2=11.8, $p<0.05$),
- Community capacity building and In-home education and upgrades (X^2=6.9, $p<0.05$).

Table 5-49 Change in perception of energy use in the home following GBS approach, 2015

	CCB	EDUG	EDUG+CCB	REP
Same	62.7%	57.6%	63.8%	57.5%
Improve*	27.5%	31.4%	27.7%	16.8%
Decline**	9.8%	11.0%	8.5%	25.7%
Total	**100.0% (n=51)**	**100.0% (n=118)**	**100.0% (n=47)**	**100.0% (n=113)**

* People who rated their energy use lower in 2015 than in 2014.

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**People who rated their energy use higher in 2015 than in 204.

Missing cases=79

5.3.8 Changes in energy efficiency knowledge

Prior to any GBS approach, 36.9% of GBS participants (n=145) agreed or strongly agreed with the statement that they knew where to get information to improve their energy efficiency, with just over a third disagreeing or strongly disagreeing with this statement (34.4%, n=135).

Following the implementation of the GBS approaches, there was an increase in the proportion of GBS participants (65.0%, n=145) who agreed or strongly agreed with the statement that they knew where to get information to improve their energy efficiency.

Table 5-50 I know where to get information to improve the energy efficiency of my home, 2014 and 2015

	2014		2015	
	n	%	n	%
Strongly agree	37	9.4	80	20.9
Mostly agree	108	27.5	165	43.1
Neither agree nor disagree	113	28.8	83	21.7
Mostly disagree	80	20.4	41	10.7
Strongly disagree	55	14.0	14	3.7
Total	**393**	**100.0**	**383**	**100.0**

We then examined the impact of the GBS approaches (CCB, EDUG, and EDUG+CCB) on people's knowledge of where to get information to improve the energy efficiency of their home. We tested each approach separately and found that the CCB (x^2=1.2, p>0.05) and EDUG+CCB approaches (x^2=3.4, p>0.05) did not have a significant impact on people's knowledge of where to get information to improve energy efficiency. In contrast, a comparison of the EDUG

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approach with the REP group indicated that there was a significant impact on people's knowledge of where to get information to improve the energy efficiency of their home ($x2=7.9$, $p<0.05$).

Table 5-51 Changes in participant's knowledge of where to get information to improve the energy efficiency of my home by GBS approach

	CCB		EDUG		EDUG+CCB		REP	
	n	%	n	%	n	%	n	%
Same	13	25.0	38	30.2	19	31.1	50	37.9
Improve	31	59.6	78	61.9	29	47.5	60	45.5
Decline	8	15.4	10	7.9	13	21.3	22	16.7
Total	**52**	**100.0**	**126**	**100.0**	**61**	**100.0**	**132**	**100.0**

Further analysis indicated that the in-home education and upgrades did have a significant impact on people's knowledge of where to get information to improve the energy efficiency of their home. Upon comparison of all participants who received in-home education and upgrades (EDUG and EDUG+CCB) with those who didn't (CCB and REP) a stronger correlation between the two variables was observed ($X2=9.9$, $p<0.01$).

5.3.9 Affordability and home energy use

In this section, we examine affordability and home energy use: difficulties households experience paying their energy bill; interest in reducing energy bills; and their capacity to reduce energy bills.

5.1.1.28 Difficulties paying energy bill

Over half of participants (54.2%, n=214) had found it difficult to pay their energy bills over the last year in 2014. Following the implementation of the GBS project, 40% of participants had found it difficult to pay their energy bills.

Table 5-52 Have you found it difficult to pay your energy bill over the last year? 2014 and 2015

	2014	2015

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	n	%	n	%
Yes	214	54.2	160	40.0
No	181	45.8	240	60.0
Total	**395**	**100.0**	**400**	**100.0**

2014 Missing cases=13

2015 Missing cases=8

We then examined the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on participants' capacity to pay their energy bill. We tested each GBS approach separately and found that none of the approaches had a significant impact on the participant's capacity to pay their energy bill:

- Community capacity building ($X^2=0.5$, $p>0.05$)
- In-home education and upgrades ($X^2=2.8$, $p>0.05$),
- Community capacity building and In-home education and upgrades ($X^2=1.4$, $p>0.05$).

We also tested whether or not the in-home education and upgrades experience had an impact on people's capacity to pay their energy bill and again the relationship was not significant ($X^2=2.9$, $p>0.05$).

This result is not surprising given that the participating households were low income households, with a substantial proportion living below the poverty line. It is also in-line with our finding from the Detailed Study that low-income households will use energy efficiency improvements to increase utility rather than decrease use.

The consistent improvement in ability to pay energy bills may be linked to decreased electricity prices across the research period, with electricity dropping around 11% from 2012-2015[12]

Table 5-53 Change in capacity to pay energy bill following GBS approach, 2015

	CCB	EDUG	EDUG+CCB	REP
Same	72.1%	72.7%	63.0%	69.3%

[12] Eg: Tariff 31 has dropped from 26.806 cents kWh to 25.2 cents kWh

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Improve	18.0%	22.0%	29.6%	22.5%
Decline	9.8%	5.3%	7.4%	8.3%
Total	**100.0% (n=61)**	**100.0% (n=132)**	**100.0% (n=54)**	**100.0% (n=140)**

Missing cases=21

5.1.1.29 Capacity to reduce to energy expenses

At the beginning of the project, around a quarter of participants (24.8%, n=100) reported that they currently felt able to reduce their energy expenses. In contrast, 35.6% of households (n=144) did not feel able to reduce their energy expenses and a further 39.6% (n=160) were unsure or did not know.

Following the implementation of the GBS project, there was an increase in the proportion of participants who reported that they felt they were able to reduce their energy expenses (35.4%, n=142). There was also a slight increase in the proportion of participants who did not feel able to reduce their energy expenses (39.2%, n=157). In contrast, there was a decline in the proportion of people who were unsure about their capacity to reduce their energy expenses (25.4%, n=102).

Table 5-54: Do you feel you are able to reduce your energy expenses? 2014 and 2015

	2014		2015	
	n	%	n	%
Yes	100	24.8	142	35.4
No	144	35.6	157	39.2
I don't know	160	39.6	102	25.4
Total	**404**	**100,0**	**401**	**100.0**

2014 Missing cases=4

2015 Missing cases=7

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There were a high number of people who reported that they were unsure about their capacity to reduce their energy expenses in both 2014 and 2015. Consequently, there are insufficient cases (missing cases=191) to enable us to undertake analysis on the impact of the GBS approaches on people's capacity to reduce their energy bill.

5.1.1.30 Action to reduce energy expenses

Most participants had tried to reduce their energy expenses both prior to the implementation of the GBS project and following the implementation of the GBS project. In 2014, 84.7% of participants had tried to reduce their energy expenses and in 2015 81.2% had tried to reduce their energy expenses.

Following the implementation of the GBS project, there was only a small decline in the proportion of people trying to reduce their energy expenses.

Table 5-55: In the last year have you tried to reduce your energy expenses? 2014 and 2015

	2014		2015	
	n	%	n	%
Yes	333	84.7	324	81.2
No	60	15.3	75	18.8
Total	**393**	**100.0**	**399**	**100.0**

2014 Missing cases=15

2015 Missing cases=9

In terms of change in trying to reduce energy expenses, 11.0% of participants who had not previously been trying to reduce their energy expenses were now trying in 2015 to do so. In addition, 15.4% of participants who had previously been trying to reduce their energy expenses had stopped trying in 2015.

We were interested in whether this change was evident in relation to each GBS approach. We found less evidence of change in trying to reduce energy expenses among the GBS groups compared with the REP. However, it is difficult to disentangle whether or not reduced effort in reducing energy expenses in 2015 was experienced positively by the

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participant – that is, following the GBS approach they no longer need to reduce energy expenses – or more negatively they had become disinterested in energy efficiency practices.

Table 5-56 Change in trying to reduce energy expenses following GBS approach, 2015

	CCB	EDUG	EDUG+CCB	REP
Same	76.6%	80.0%	80.4%	59.0%
Improve*	4.7%	10.0%	15.7%	15.1%
Decline**	18.8%	10.0%	3.9%	25.9%
Total	**100.0% (n=64)**	**100.0% (n=130)**	**100.0% (n=51)**	**100.0% (n=139)**

Missing cases=24

*Participant who did not try to reduce energy expenses in 2014, but who had tried in 2015

**Participant who had tried to reduce energy expenses in 2014, but was no longer trying in 2015.

5.3.10 Perceptions of community

One of the anticipated benefits of the community capacity building approach was that not only would it have an impact on thermal comfort and energy efficiency of people's homes, it would also contribute to wellbeing through strengthening community relations and building local resources and capacity around home energy use.

In the bulk survey we examined the impact the approaches may or may not have had on the community through three key questions which asked people to agree or disagree with the following statements:

- I live in a strongly connected community.
- There are people in my community who I can ask about how to keep my house warm/cool.
- There are people in my community who I can ask about energy efficiency.

We anticipated that there may have been differences in the responses of participants in the two geographic regions across the study, Clarendon Vale/Rokeby and Greater Hobart, to these questions. However, analysis indicated that there were no significant differences.

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5.1.1.31 Community connectedness

Table 5-57 shows that in 2014 over a third of participants (35.3%, n=139) in the GBS study mostly/strongly agreed that they lived in a strongly connected community, with 28.2% of participants (n=131) mostly/strongly disagreeing that they lived in a strongly connected community.

Table 5-57 I live in a strongly connected community, 2014

	n	%
Strongly agree	42	10.7
Mostly agree	97	24.6
Neither agree nor disagree	144	36.5
Mostly disagree	70	17.8
Strongly disagree	41	10.4
Total	**394**	**100.0**

Missing cases=14

We then examined the impact of the GBS approaches (CCB, EDUG, and EDUG+CCB) on community connectedness. We tested each approach separately and found that none of the approaches had a significant impact on the participant's assessment of community connectedness:

- Community capacity building (X^2=1.1, p>0.05)
- In-home education and upgrades (X^2=0.8, p>0.05),
- Community capacity building and In-home education and upgrades (X^2=5.1, p>0.05).

We also tested whether or not in-home education and upgrades (EDUG and EDUG+CCB) had an impact on community connection, and again the relationship was not significant (X^2=3.1, p>0.05).

5.1.1.32 Knowing someone in the community I can ask about thermal comfort

Table 5-58 shows that over half of the participants (51.2%, n=163) mostly/strongly disagreed that there are people in their community who they can ask about keeping their house warm/cool. In contrast, only 27.8% participants

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(n=110) in the GBS study mostly/strongly agreed that there are people in their community who they can ask about keeping their house warm/cool.

Table 5-58 There are people in my community who I can ask about keeping my house warm/cool, 2014

	n	%
Strongly agree	43	10.9
Mostly agree	67	16.9
Neither agree nor disagree	123	31.1
Mostly disagree	93	23.5
Strongly disagree	70	17.7
Total	**396**	**100.0**

Missing cases=12

We then examined the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on peoples' awareness of people in their community who they can ask about keeping their house warm/cool. We tested each approach separately and found that none of the approaches had a significant impact on participants' awareness of people in their community who know about thermal comfort:

- Community capacity building (X^2=1.3, $p>0.05$)
- In-home education and upgrades (X^2=4.5, $p>0.05$),
- Community capacity building and In-home education and upgrades (X^2=3.7, $p>0.05$).

We also tested whether or not in-home education and upgrades had an impact on participants' awareness of people in their community who know about thermal comfort. We found that those participants who experienced in-home education and upgrades (EDUG and EDUG+CCB) had an increased their awareness of people in their community who they can ask about thermal comfort compared with those who did not (CCB and REP) (X^2=6.3, $p<0.05$).

Table 5-59 There are people in my community who I can about keeping my house warm/cool by whether or not in-home education and upgrades were received

Received in-home education & upgrades:	No	Yes	Total

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	n	%	n	%	
Same	64	35.2	83	42.1	147
Improve	77	42.3	59	29.9	136
Decline	41	22.5	55	27.9	96
Total	**182**	**100.0**	**83**	**100.0**	**379**

Missing cases=9

5.1.1.33 Knowing someone in the community I can ask about energy efficiency

Table 5-60 shows that 39.1% of participants (28.3%, n=155) mostly/strongly disagreed that there are people in their community who they can ask about energy efficiency. In contrast, only 28.3% participants (n=110) in the GBS study mostly/strongly agreed that there are people in their community who they can ask about keeping their house warm/cool.

Table 5-60 There are people in my community who I can ask about energy efficiency, 2014

	n	%
Strongly agree	46	11.6
Mostly agree	66	16.7
Neither agree nor disagree	129	32.6
Mostly disagree	92	23.2
Strongly disagree	63	15.9
Total	**396**	**100.0**

Missing cases=12

We then examined the impact of the GBS approaches (CCB, EDUG, and EDUG+CCB) on peoples' awareness of people in their community who they can ask about energy efficiency. We tested each approach separately and found that

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none of the approaches had a significant impact on participants' awareness of people in their community who know about thermal comfort:

- Community capacity building (X^2=3.1, p>0.05)
- In-home education and upgrades (X^2=1.5, p>0.05),
- Community capacity building and In-home education and upgrades (X^2=0.98, p>0.05).

We also tested whether or not in-home education and upgrades had an impact on participants' awareness of people in their community who know about energy efficiency. We found that experiencing in-home education and upgrades (EDUG and EDUG+CCB) did not impact on people's awareness of people in their community who they can ask about energy efficiency.

Table 5-61 There are people in my community who I can about energy efficiency by whether or not in-home education and upgrades were received, 2015

In-home education and upgrades received:	Yes		No		Total
	n	%	n	%	
Same	69	37.9	82	40.2	151
Improve	72	39.6	62	30.4	134
Decline	41	22.5	60	29.4	101
Total	**182**	**100.0**	**204**	**100.0**	**386**

Missing cases=22

5.3.11 Value of project

In general, participants found the GBS project to be a useful experience. Over two-thirds (65.5%, n=165) felt that the GBS project was very useful to them and a further third of participants (32.5%, n=82) felt the project was somewhat useful. Only 2% did not find the GBS project useful. Looking at the responses of participants involved in the three energy efficiency activities, the people who experienced in-home education and upgrades were more likely to rate the GBS project as very useful. In contrast, participants who experienced CCB only were more likely to rate the GBS project as not useful.

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Table 5-62 How useful did you find the GBS project?

	CCB		EDUG		EDUG+CCB		Total	
	N	%	n	%	n	%	n	%
Very useful	25	39.7	104	77.6	36	65.5	165	65.5
Somewhat useful	36	57.1	27	20.1	19	34.5	82	32.5
Not useful	2	3.2	3	2.2	0	0.0	5	2.0
Total	**63**	**100.0**	**134**	**100.0**	**55**	**100.0**	**252**	**100.0**

Missing cases=12, Representative group not included.

Everyone who experienced in-home education and upgrades received a Stay Warm booklet. Table 5-63 shows that the majority of participants recalled receiving the booklet. Notably, there were many who did not recall receiving the booklet. This may have been due to the length of time between the booklet being distributed and the survey. In relation to the community capacity building approach, most people recalled receiving a Stay Warm booklet. The survey data indicates that 34 of the CCB participants (77.3%) received the Stay Warm booklet from a Power Ranger who knocked on their door.

Table 5-63 Did you receive a copy of the Stay Warm booklet by GBS approach?

	CCB		EDUG		EDUG+CCB		Total	
	n	%	n	%	n	%	n	%
Yes	44	69.8	96	70.6	35	63.6	175	68.9
No	12	19.0	12	8.8	5	9.1	29	11.4
I don't remember	7	11.1	28	20.6	15	27.3	50	19.7
Total	**63**	**100.0**	**136**	**100.0**	**55**	**100.0**	**254**	**100.0**

Missing cases=10, Representative group not included.

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Of those who recalled receiving the Stay Warm booklet, the majority (98.2%, n=164) found this a useful resource, with only 1.8% (n=3) finding it not useful.

Table 5-64 How useful did you find the Stay Warm booklet?

	n	%
Yes	164	98.2
No	3	1.8
Total	**167**	**100.0**

Missing cases = 8. Only cases that reported receiving booklet included (n=175).

5.3.12 Participant reflections on in-home education and upgrades

In general, participants found the upgrades useful. Table 5-65 shows that at least 80% of participants rated each upgrade as useful. The only exception to this was the shower timer, with 61.7% (n=50) finding this upgrade useful.

Table 5-65 Recollection and evaluation of energy efficiency upgrades

Upgrade	Participant recalled receiving upgrade		Participant found upgrade useful	
	n	%	n	%
Draught proofing on doors	167	83.9	144	96.6
Draught proofing on windows	40	20.1	33	82.5
Door snakes	99	49.7	71	80.7
Eco-switch	44	22.1	37	82.2
Thermometer	114	57.3	75	80.6
Energy efficient lighting	123	61.8	96	86.5
Hot water thermostat adjusted to 60 degrees	31	15.6	21	84.0

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Water efficient showerhead	98	49.2	75	89.3
Shower timer	92	46.2	50	61.7
Insulation on the hot water tank pipes	73	36.7	55	94.8
Ceiling insulation	90	45.2	58	86.6
Curtains	49	24.6	41	95.3
Total Upgrade Households	**199**	**100.0**		

When asked 'What did you like the most about the GBS project?', participants who experienced in-home education and upgrades commented on: the effectiveness of the upgrades; the fact that the in-home education and upgrades were provided for free; and the information and tips provided on saving energy.

"The upgrades I received because I could not have paid for them myself. Marvellous!" (GBS347).

"That people came and improved the house for free. Given my disability it was great that both the cost and the work were covered. Also love that it is an intelligent, ecological way of looking at energy consumption" (GBS385).

"Upgrades were very helpful especially being free for us as we couldn't have afforded them otherwise" (GBS 509).

In addition, participants noted that the staff members were friendly, caring, helpful and efficient when performing upgrades. They also appreciated that the program was well-organised and communication about the project was good.

"The friendly approach and the efficient action" (GBS474).

"The very friendly and helpful team that came to my home. The efficient way they worked through my house. A very positive experience" (GBS483).

When asked 'What they didn't you like about the GBS project?', many participants who experienced the in-home education and upgrades did not respond or commented that there was nothing they disliked. However there were concerns raised about specific upgrades, including faulty light globes, and problems with people missing out on particular upgrades, as well as staff failing to follow-up on particular requests from participants.

"Light bulbs were faulty and kept blowing" (GBS553).

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"I like least the fact that some things that were after offered were not followed through. I'd rather a person said for example 'we can't look at the light bulb because we can't do that' or we'll come and do that in 2018 - hate that promise not fulfilled" (GBS298).

A few participants expressed concern about the practice of removing and replacing light globes and throwing working incandescent light globes in the bin.

"The guy who installed all the light bulbs put the old ones straight in the wheelie bin! Total waste. We took them out and put them back in the cupboard. Our globes blow every six months or so, and we used them" (GBS583).

The other major concern raised was that many of the suggestions to improve the thermal performance and energy efficiency of their home were beyond their financial means.

"It's all helpful but without the money so many things are out of reach" (GBS279).

5.3.13 Participant reflections on community activities

There were 121 Clarendon Vale/Rokeby residents who participated in the Community Capacity Building approach, with 56 of these residents also receiving in-home education and upgrades.

During the implementation of the CCB approach, attendance at community events and activities was generally low. This is reflected in the survey data, with Table 5-66 showing that only 14.7% of participants (n=17) attending a GBS event.

Table 5-66 Did you attend events run by GBS and power rangers?

	n	%
Yes	17	14.7
No	99	85.3
Total	**116**	**100.0**

Missing cases=5

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Despite low turnouts at events, the Power Rangers did talk to many residents about energy efficiency through door-knocking. Again, this is reflected in the survey data, with Table 5-67 showing that over two-thirds of participants (69.0%, n=69) recalled a Power Ranger knocking on their door.

Table 5-67 Did a power ranger or GBS representative knock on your door?

	n	%
Yes	69	69.0
No	31	31.0
	100.0	**100.0**

Missing cases = 21

Despite low attendance at many GBS community events and activities, residents were mostly positive about the CCB approach and they would like to see more energy efficiency and thermal comfort activities in their community. Table 5-68 shows that most people (87.4%, n=90) would like more GBS-type activities in their community, with only 12.6% (n=13) not interested in seeing more GBS-type activities in their community.

Table 5-68 Would you like to see more energy efficiency and thermal comfort activities in your community?

	n	%
Yes	90	87.4
No	13	12.6
Total	**103**	**100.0**

Missing cases = 18

When asked 'What did you like the most about the GBS project?', participants who experienced community capacity building and no in-home education and upgrades commented on the helpful information provided through the project. They felt the information was useful, in particular the Stay Warm booklet, and it had made them more aware of their own energy consumption.

"It was informative" (GBS 101).

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"Meet and share tips!" (GBS 561)

In addition, participants commented that the project was well-organised, well-targeted and that they valued the support provided. Participants also commented that project staff members, including the Power Rangers, were friendly and that they didn't feel judged.

"Useful, everyone really nice, didn't look dumb when we didn't know things" (GBS 290).

"The fact it may be assisting people less well-off and educated than myself to make changes that save them money. That's a great community service" (GBS 506).

"I think it beneficial as everybody is struggling with energy bills" (GBS 541)

Others were happy with grocery vouchers provided as part of the project.

When asked 'what didn't you like about the GBS project?', many participants who experienced community capacity building and no in-home education and upgrades did not respond or commented that there was nothing they disliked. Of those who did respond, one participant noted that the events were always on during days she/he worked (GBS 110) and another complained that there were no experts during home visits from Power Rangers.

"No experts used during home visits regarding providing quotes etc" (GBS 549).

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5.4 Energy billing results

5.4.1 Sample size and minimum comparison period

The analysis was first conducted with the minimum comparison period set to 360 days, however there was a low number of houses for 360 days (n=90), particularly in the representative group (n=3). As such changes, statistically significant changes could not be found.

The minimum comparison period was then altered to 180 days, yielding greater sample sizes from which statistically significant correlations could be found. Excluding houses with solar PV, a 180 day minimum comparison period provided a sample size (n=348) and greater representative group size (n=112). Including houses solar PV a 180 day minimum comparison period provided a sample size (n=383) and greater representative group size (n=122).

5.4.2 Average and median changes to energy use

Chart 5-3 shows the average and median changes in electricity consumption by each research group. Table 5-69 presents the difference in electricity usage compared to the representative group. **Error! Reference source not found.** on page **Error! Bookmark not defined.** presents the same information including solar PV customers.

Chart 5-3: Average and median change in electricity consumption (excluding solar PV households)

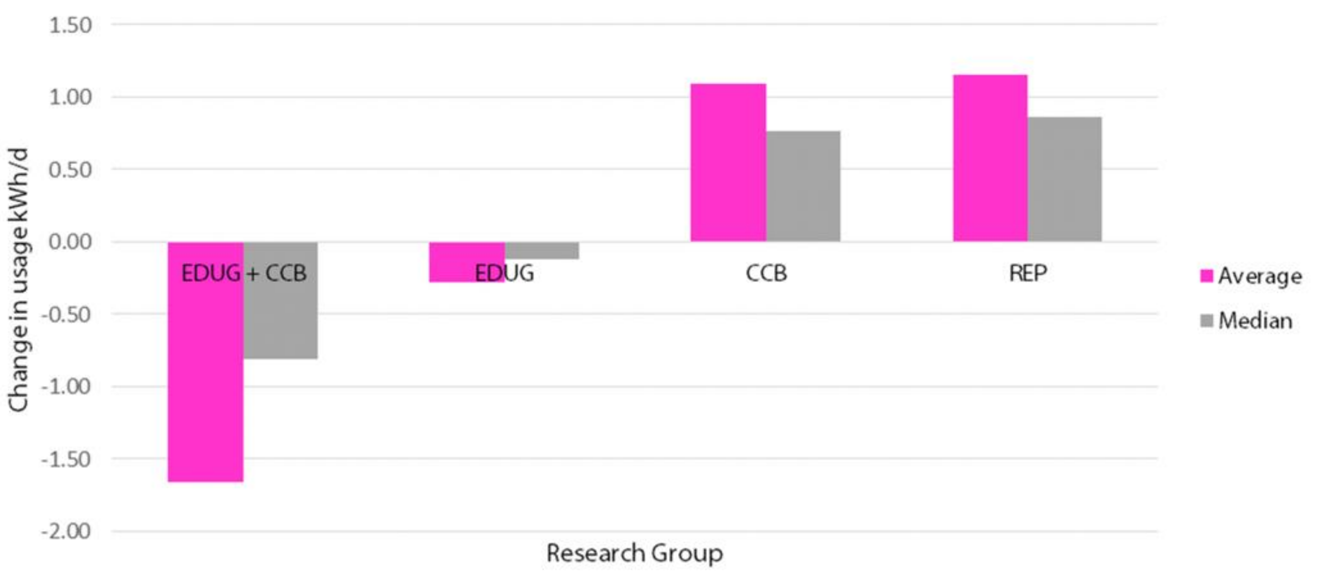

Table 5-69: Billing data analysis results (excluding solar PV households)

	Change in electricity usage (kWh/day)	Change in electricity usage relative to

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					representative group (kWh/day)			
	EDUG+CCB	EDUG	CCB	REP	EDUG+CCB	EDUG	CCB	REP
Average	-1.66	-0.28	1.09	1.16	-2.82	-1.44	-0.07	0.00
Median	-0.82	-0.12	0.77	0.86	-1.68	-0.98	-0.10	0.00

5.1.1.34 In-home education and upgrades plus community capacity building delivered the best energy savings

As demonstrated above, in-home education and upgrades combined with community capacity building delivered the best energy efficiency outcomes. The average improvement over the representative group was 2.82 kWh per day. The median improvement was 1.62 kWh per day (see **Error! Reference source not found. Error! Reference source not found.**)

The changes were demonstrated to be statistically significant. A t-Test (two-sample assuming unequal variances) was used to determine the statistical significance of the approachs. As shown in Table 5-70 (below) the in-home education and upgrades + capacity building demonstrated a highly significant change compared to the representative groups ($p<0.01$).

Table 5-70: Statistical tests of In-home education and upgrades with community capacity building

	Analysis excluding solar PV		Analysis including solar PV	
	EDUG+CCB	**REP**	**EDUG+CCB**	**REP**
Mean	-1.66	1.16	-1.56	1.15
Variance	42.60	30.31	41.41	30.17
Observations	52	112	54	122
p(T<=t) two-tail	0.01		0.01	

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5.1.1.35 In-home education and upgrades without community capacity building delivered substantial energy savings

In-home education and upgrades without capacity building delivered substantial energy savings. The average improvement over the representative group was 1.44 kWh per day. The median improvement was and 0.98 kWh per day (see Table 5-69 above)

As shown in Table 5-71 (below), this improvement was statistically significant when compared to the representative groups ($p<0.02$).

Table 5-71: Statistical tests of in-home education and upgrades only

	Analysis excluding solar PV		Analysis including solar PV	
	EDUG	REP	EDUG	REP
Mean	-0.28	1.16	-0.17	1.15
Variance	15.46	30.31	15.75	30.17
Observations	127	112	143	122
p(T<=t) two-tail	0.02		0.03	

5.1.1.36 Community capacity building delivered similar energy change to the representative group

The community capacity building without upgrades did not deliver significant energy savings, with the improvement over the representative group being only 0.07 kWh per day. The median improvement was 0.10 kWh per day (see Table 5-69 on page 42). As shown in Table 5-72 (below) this improvement was not statistically significant when compared to the representative group.

Table 5-72: Statistical tests of community capacity building only

	Analysis excluding solar PV		Analysis including solar PV	
	CCB	REP	CCB	REP

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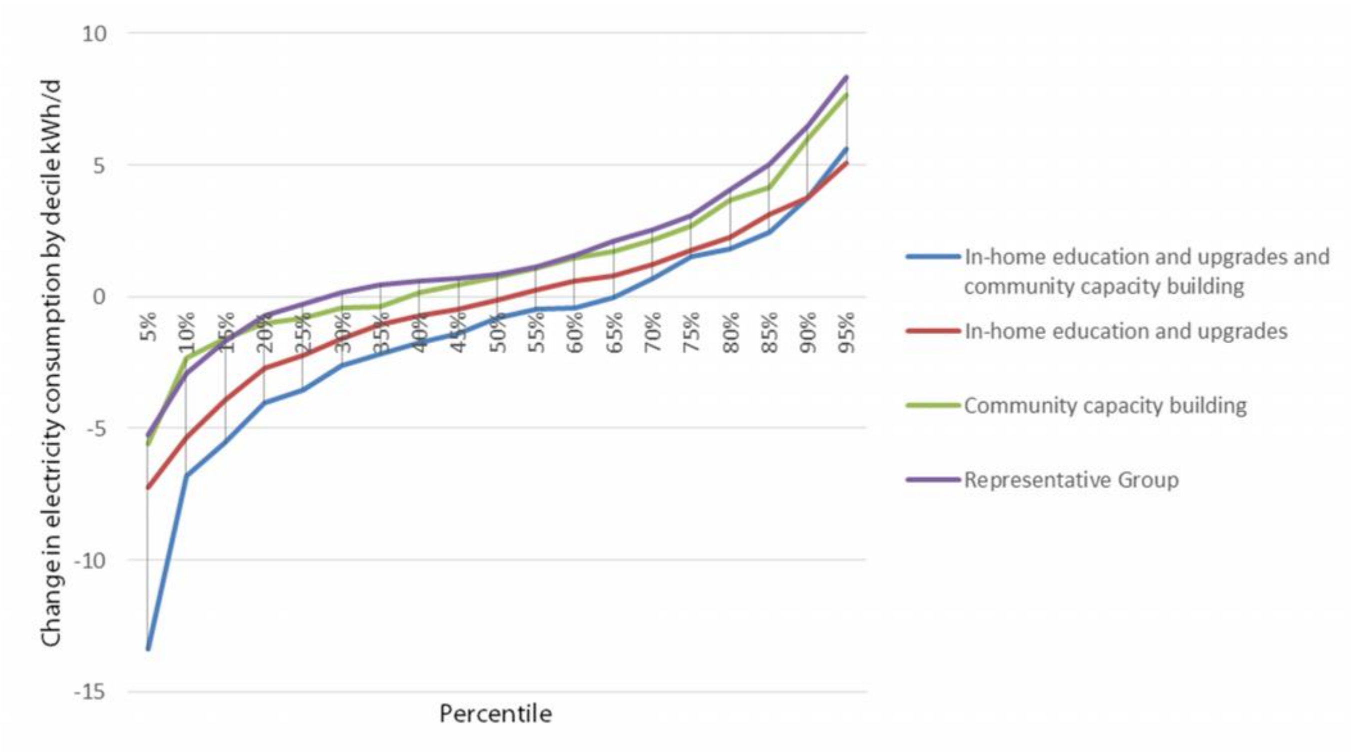
Mean	1.09	1.16	0.91	1.15
Variance	30.20	30.31	27.68	30.17
Observations	57	112	64	122
p(T<=t) two-tail	0.94		0.77	

5.4.3 Changes to energy usage by percentile

Chart 5-4 (below) shows the changes in electricity consumption by percentile. This chart demonstrates that some clients increased energy usage whilst others showed a decrease. Notably only 27% of the representative group showed a decrease in electricity usage, compared to 65% of the EDUG+CCB. All groups had a similar trend with the outliers showing large increases and decreases in energy usage, and the middle percentiles showing a more linear change in energy usage.

Chart 5-4: Changes in electricity consumption by percentile (excluding solar PV households)



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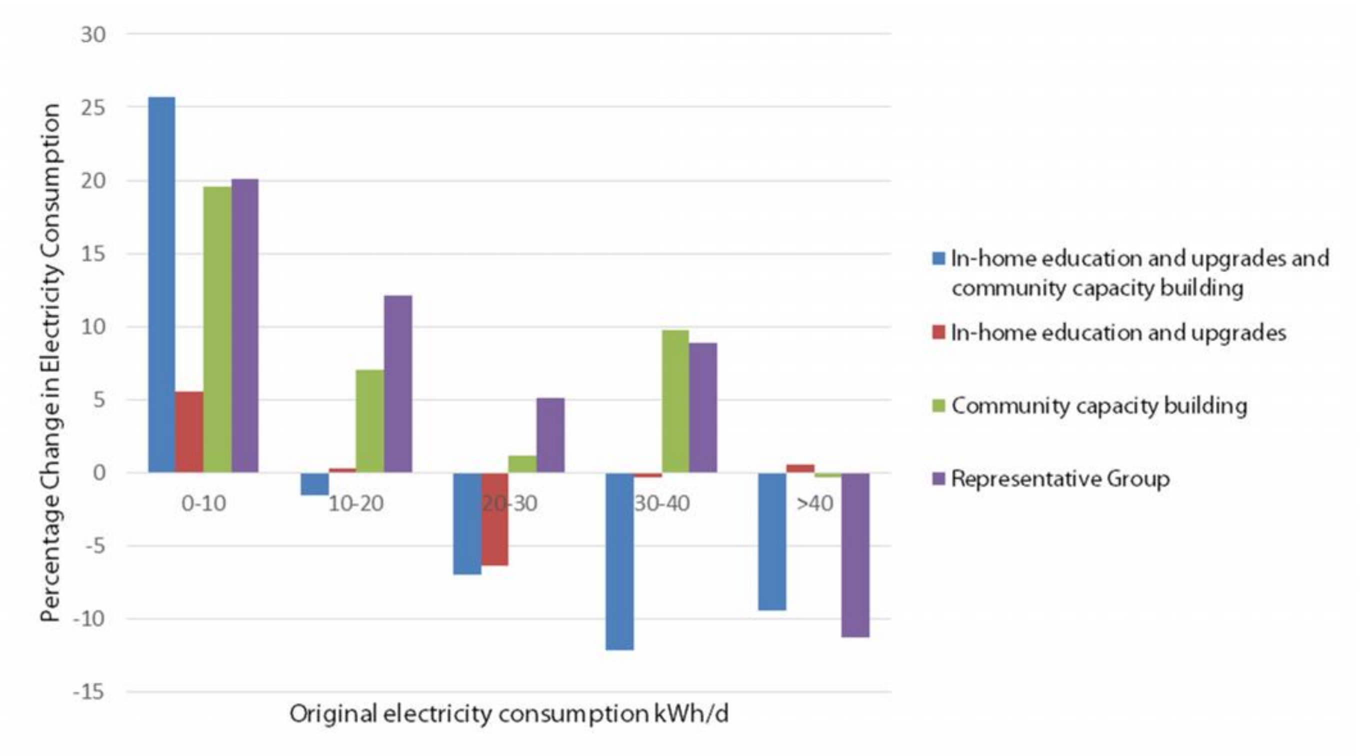
5.4.4 Changes in electricity consumption by original usage

Chart 5-5 (below) displays results categorised by participants' original energy use (i.e. in the 'before' period). This data shows that households with low original energy use generally increased energy use over the project period. For participants with higher original energy usage, those receiving in-home education and upgrades (EDUG and EDUG+CCB) decreased their energy usage. Please note there was only a small sample size of households with original energy use of 40+ kWh/day (n=26) and so these results are less reliable than the households with lower original energy usage.

Chart 5-5: Change in Electricity consumption by original usage (excluding solar PV households)



5.4.5 Percentage change in energy usage

The percentage change in energy use for each participant was calculated and is shown in Chart 5-6 below. It shows largely the same trends as described in Chart 5-5 on page 45.

Of note, for the 50th percentile:

- The REP group showed a 5.8% increase in energy usage
- The CCB group had had a 2.9% increase in energy usage
- The EDUG group had a 0.4% decrease in energy usage
- The EDUG+CCB had a 3.7% decrease. This amounts to a reduction relative to the REP group of 9.6%.

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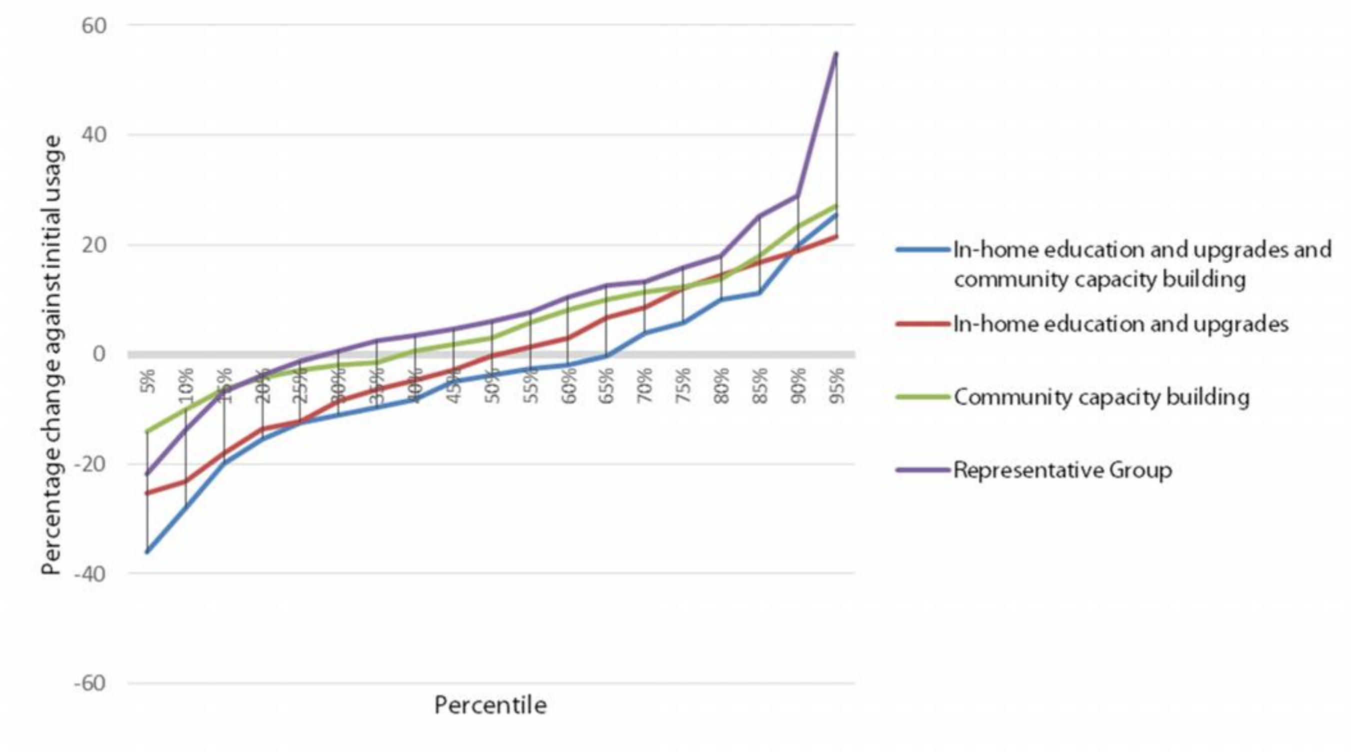
Chart 5-6: - Percentage change in electricity consumption (excluding solar PV households)



5.4.6 Changes in energy usage by tariff and group

Examining differences between tariffs may allow a deeper understanding of the approaches taken and their impacts on participant behaviour. Some discussion of observed differences between tariffs for each group and hypotheses to explain them is given below. However, the number of participants in some approach/tariff combinations was very limited (e.g. there were only 11 participants on T41 within the EDUG+CCB group; see Table 5-3), and so none of the differences were found to be statistically significant. As such, the differences could well be due to chance and so the hypotheses given below should be considered as topics for potential future research rather than evidence-based conclusions from this project.

Table 5-73: Average changes in energy use by tariff and group

Tariff	Absolute change in energy use (kWh/day)				Relative to REP change in energy use (kWh/day)			
	EDUG	CCB	EDUG+CCB	REP	EDUG	CCB	EDUG+CCB	REP
T31	-0.32	1.43	-0.91	0.26	-0.59	1.17	-1.17	0.00

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T41	-0.53	-0.13	-0.49	0.16	-0.70	-0.30	-0.66	0.00
T42	0.18	-0.72	0.59	1.20	-1.02	-1.92	-0.61	0.00
T42-T41	0.71	-0.59	1.09	1.03	-0.32	-1.63	0.05	0.71

First, examining the REP group:

- T41 (hot water) use on average increased slightly (+0.16 kWh/day); likely due to the harsh 2015 winter meaning lower inlet temperatures and greater standing losses for hot water cylinders.
- T42 (hot water and heating) use on average increased more substantially (+1.20 kWh/day). Assuming changes in hot water use were the same as for T41 users, most of this change would be attributable to increased heating; again due to the harsh 2015 winter.
- T31 (lights and power points, which may include plug-in heaters) use on average increased slightly. (+0.26 kWh/day), which may be due to increased use of plug-in heaters in the harsh 2015 winter, or increased uptake of appliances such as large screen televisions.

Now examining the changes for other groups relative to the representative group:

- In-home education and upgrades appear to have been particularly effective at reducing hot water energy use (the average relative change for T41 hot water tariff was -0.70 kWh/day for EDUG and -0.66 kWh/day for EDUG+CCB). This may be attributable to hot water upgrades including shower head replacement and hot water system insulation, and/or education about ways of reducing hot water consumption. By contrast community capacity building appears to have resulted in a smaller relative reduction (-0.30 kWh/day).
- Assuming T42 users experienced the same change in hot water use as T41 users, the differences between the two tariffs would be due to changes in heating. Under these assumptions, heating was not substantially reduced for the EDUG or EDUG+CCB groups, but was substantially reduced for the CCB group (-1.63 kWh/day). This seems an unlikely correlation given the EDUG+CCB group achieved no such reduction in heating, and is most likely due to chance.
- T31 (lights and power points, which may include plug-in heaters) appears to have been reduced for the groups receiving in-home education and upgrades relative to the representative group. This may be due to households learning from the in-home education that heaters on T42 are significantly more cost effective than plug-in heaters on T31. By contrast, T31 use for the CCB group increased substantially. This could be due to a failure of messaging within the community leading to people shifting heater use from T42 to the more expensive T31, but is more likely due to chance arising from the small sample size involved in the analysis.

5.5 Analysis and Discussion

5.5.1 Bulk survey results

5.1.1.37 Household capacity

The GBS project targeted low income households. The bulk survey results show that we recruited a range of household types (e.g. single person, single parent, couples and dependents), households of variable size, as well as younger, middle-age and older households. When compared with the Australian population, the GBS participants had lower education levels and lower employment participation rates. Around half the households that participated

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had a family member with a chronic illness or disability. In addition, the project recruited predominantly Australian-born participants, with only a minority of migrant households participating in the project. Only a small proportion of Indigenous people participated in the GBS project.

The GBS project sought to recruit both home owners and private rental tenants. The bulk survey results show that we recruited a good mix of outright owners, owners with a mortgage and private rental tenants. We also recruited a good mix of residents that had lived in their home for over 5 years and those who had more recently moved.

5.1.1.38 Dwelling quality

Participant's dwellings were predominantly older (built before 1990), free-standing, single-storey, three bedroom homes. In general, insulation was limited to ceilings. Most people relied on electric heating, with around half of the homes having a heat pump installed. Most people had electric hot water systems with a storage tank. Most participants reported that they had observed moisture on their windows in cold weather and that their homes were draughty.

5.1.1.39 Impact of project on dwelling condition

Participants were asked to report on whether or not their home was draughty and whether or not they had observed moisture on their windows in cold weather. Following project implementation, the results indicate that the EDUG and EDUG+CCB approaches did have a significant impact on draughtiness compared with the representative group, with these participants more likely to report a reduction in draughtiness. In contrast, the CCB approach did not have an impact on reporting of draughtiness.

Following project implementation, the results indicate the EDUG approach did have a significant impact on observed moisture compared with the representative group, with these participants more likely to report a reduction in moisture on windows. In contrast, the EDUG+CCB and CCB did not have an impact on reporting of moisture levels.

5.1.1.40 Impact of project on perception of energy use

Participants were asked to assess themselves as high, medium or low energy users. Following project implementation, the results indicate that all the approaches (CCB, EDUG, EDUG+CCB) did have a significant impact on people's perception of their energy use, with CCB, EDUG and EDUG+CCB participants more likely to rate themselves as lower energy users in 2015 than in 2014 compared with the representative group.

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5.1.1.41 Impact of project on thermal comfort and energy efficiency knowledge

Participants were asked if they agreed with the following statements about thermal comfort:

- I know a lot about keeping my home thermally comfortable in winter,
- I know a lot about keeping my home thermally comfortable in summer,

Following project implementation, the results indicate that the EDUG approach did have a significant impact on people's knowledge of keeping their home thermally comfortable in winter and summer compared with those in the representative group. These participants were more likely to strongly/mostly agree with the statements 'I know a lot about keeping my home thermally comfortable in winter' and 'I know a lot about keeping my home thermally comfortable in summer'.

In contrast, the CCB and the EDUG+CCB approaches did not have an impact on people's knowledge of keeping their home thermally comfortable in winter and summer.

5.1.1.42 Impact of project on thermal comfort and energy efficiency capacity

Prior to any GBS approach, GBS participants were asked if they agreed with the following statement about thermal comfort:

- I feel that I am doing everything I can to keep my household warm in winter.

Following project implementation, the results indicate that the EDUG approach did have a significant impact on people's perception that they were doing everything they can to keep their household warm in winter when compared with the representative group. EDUG participants were more likely to strongly/mostly agree with the statement 'I feel that I am doing everything I can to keep my household warm in winter' following project' compared with the representative group. In contrast, the CCB and EDUG+CCB did not have an impact on people's response to the statement 'I feel that I am doing everything I can to keep my household warm in winter' following project'.

Participants were also asked if they felt able to reduce their energy bill. Unfortunately, there were a high number of people who reported that they were unsure about their capacity to reduce their energy expenses in both 2014 and 2015. Consequently, there are insufficient cases (missing cases=191) to enable us to undertake analysis on the impact of the GBS approaches on people's capacity to reduce their energy bill.

5.1.1.43 Impact of project on affordability of energy bills

Participants were asked whether or not they found it difficult to pay their energy bill. In 2014, over half of participants (54.2%, n=214) had found it difficult to pay their energy bills over the last year and following the implementation of the GBS project, 40% of participants had found it difficult to pay their energy bills.

Despite this overall reduction in the proportion of people finding it difficult to pay their energy bills, our examination of the impact of the GBS approach (CCB, EDUG, and EDUG+CCB) on participants' capacity to pay their energy bill found that none of the approaches had a significant impact on the participant's capacity to pay their energy bill. This result is not surprising given that the participating households were low income households, with a substantial proportion living below the poverty line. It is also in-line with our finding from the Detailed Study that low-income households will use energy efficiency improvements to increase utility rather than decrease use.

5.1.1.44 Impact of project on community

In the bulk survey we examined the impact the GBS approaches may or may not have had on the community through three key questions which asked people to agree or disagree with the following statements:

- I live in a strongly connected community.
- There are people in my community who I can ask about how to keep my house warm/cool.
- There are people in my community who I can ask about energy efficiency.

Following project implementation, we tested to see if each of the three approaches (CCB, EDUG, EDUG+CCB) had a significant impact on participants' responses to the three statements in comparison with the representative group. We did not find any significant relationships. However, further data analysis showed that those who experienced in-home education and upgrades were more likely to strongly/mostly agree with the statement that 'There are people in my community who I can ask about how to keep my house warm/cool'.

5.1.1.45 Participant satisfaction with GBS project

The GBS project was valued by the majority of project participants and participants expressed interest in further opportunities to engage in projects like GBS.

Participants who experienced in-home education and upgrades valued the project highly. They were grateful for the energy efficiency upgrades provided through the project and consistently rated these upgrades as useful.

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They raised concerns about specific upgrades, including faulty light globes. They also reported problems with people missing out on particular upgrades and staff failing to follow-up on particular requests from participants.

Participants who experienced the Community Capacity Building approach valued the project. They appreciated the information provided to them through the project. Many participants commented that the project staff members were friendly and helpful. The main concerns raised by participants were the timing of community activities and the lack of energy experts.

5.1.1.46 Summary

In general, the GBS project was valued by the majority of project participants. That said, the approach that had the most impact on people's thermal comfort and energy efficiency perceptions, knowledge and capacity was in-home education and upgrades. In contrast, the CCB had the least impact on people's perceptions, knowledge and capacity and the EDUG+CCB had a more variable effect. When the team conducted further testing that compared those who experienced in-home education and upgrades (EDUG and EDUG+CCB) with those who did not (CCB and REP) we found further evidence to support the view that in-home education and upgrades impacted on people's perceptions, knowledge and capacity in relation to energy efficiency and thermal comfort. The results emerging from the bulk survey provide a sound evidence-base to support the view that in-home education and upgrades are effective regardless of whether this is experienced individually by participants or whether this is embedded within a community action and engagement strategy.

5.5.2 Energy billing data results

5.1.1.47 Low income household energy usage increased in 2015

The representative group was used as our reference for the general low income community. As can be seen by Chart 5-3, energy usage over the project period increased in this group. There were two likely factors at play:

1. Energy prices have decreased over the project period.
2. The 2015 winter was particularly harsh, driving an increase in heating demand.

5.1.1.48 In-home education & upgrades consistently helped houses to reduce energy use

The data (see Chart 5-4) shows that in-home education and upgrades consistently and significantly reduced household energy usage compared to the representative group.

The impact of in-home education and upgrades is a product of two elements:

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1. The physical works that improve the efficiency or productivity of the home or appliance
2. The change in behaviour that results in lower energy usage through approaches like zoning heating

The tariff analysis shows a general increase in heating (T42) across the EDUG. This is likely due to a cold 2015 winter. However this is counteracted by a corresponding drop in T31 (light and power) effectively resulting in an increase in financial savings (because T42 has lower charges), whilst improving thermal comfort.

5.1.1.49 Combination of in-home education & upgrades and community capacity building had the greatest impact on energy use

The EDUG+CCB group had the greatest energy savings. Given that this group had a significant improvement over the EDUG only group indicates that changes in community norms/behaviour have resulted in energy savings of a similar scale as the in-home education and upgrades.

PAYG consumption in the EDUG +CCB group (n=15) shows a large drop. Notably, the PAYG system offers a de facto in-home display, thus a household actively managing power could effectively manage to reduce consumption.

5.1.1.50 Community capacity building is ineffective without in-home education and upgrades

At the overall level, Chart 5-3 (page 42) shows no significant difference in energy use between the representative group and the community capacity building approach.

5.1.1.51 Households with higher original energy usage are able to make greater savings

As demonstrated in Chart 5-5 average energy use increased by more for lower original energy users than higher original energy users. This is likely due to houses with low original energy use being comfort constrained, whereby any improvement in energy productivity is used to improve comfort rather than to save energy and money.

For high original energy users, average energy use decreased significantly. This is likely due to those houses being relatively inefficient / wasteful before, and so the GBS energy efficiency activities were able to help them more. A key recommendation from this could be to target future energy efficiency programs on those with relatively high original energy use (e.g. original energy usage >30kWh/day).

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Conclusion

The Get Bill Smart Project delivered statistically significant energy savings to the in-home education and upgrades group and community capacity building group (EDUG+CCB) (-2.88 kWh/day) as well as the in-home education and upgrades only group (EDUG) (-1.44 kWh/day). There was not a statistically significant difference between the community capacity building only group (CCB) and the representative group (REP).

Energy savings were greatest in households with high original energy usage (>30kWh/day). Within the EDUG+CCB group this was an energy saving of around 12%.

The energy billing data provides a useful policy pointer for future programs including:

- In-home education and upgrades offer effective and measurable reductions in energy usage.
- If energy savings is the key aim, limiting eligibility to high energy users may improve cost effectiveness.
- Targeting messaging for households on particular tariff structures.

The survey data confirms that the GBS project was valued by the majority of project participants. Participants who experienced in-home education and upgrades were grateful for the assistance provided through the project and consistently rated these activities as useful. Participants who experienced the community capacity building approach appreciated the information provided to them through the project. Many participants commented that the project staff members were friendly and helpful. Participants expressed interest in further opportunities to engage in projects like GBS.

Improved Energy Productivity

The survey and billing data shows a statistically significant improvement in energy productivity.

The EDUG+CCB group improved thermal comfort (e.g. reduced draughts (Table 5-31 page 22), less moisture on windows (Table 5-37, page 25), whilst statistically decreasing energy usage by 2.8 kWh per day (Chart 5-3, page 42) approximately 10% at the 50th percentile (EDUG + CCB see Chart 5-4 on page 44).

The EDUG group improved thermal comfort (e.g. reduced draughts (Table 5-31 page 22), less moisture on windows (Table 5-37, page 25), whilst statistically decreasing r energy usage by 1.4kWh per day (Chart 5-3, page 42)

In general, the approach that had the most impact on people's thermal comfort and energy efficiency perceptions, knowledge and capacity was the EDUG approach when compared with the representative group. In contrast, the

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CCB approach had the least impact on people's perceptions, knowledge and capacity. The EDUG+CCB had a more variable effect.

The one area where the CCB approach did have an impact compared with the representative group was 'people's perception of their own energy use'. However, surprisingly, the CCB approach did not significantly increase people's perception of living in a strongly connected community, nor did it significantly increase people's awareness of someone in their community who they could ask about thermal comfort and energy efficiency.

In contrast, the EDUG approach when compared with the representative group did have an impact on people's reporting of draughtiness in their home and moisture, with those in the EDUG approach more likely to report a reduction in draughtiness and a reduction in observed moisture on cold days. In addition, the EDUG approach when compared with the representative group did have an impact on: people's perception of their own energy use; people's knowledge of thermal comfort in winter and summer; people's knowledge of energy efficiency; and people's sense that they were doing everything they could to keep their household warm in winter. The EDUG+CCB approach also had an impact on: participants' reporting of draughtiness; participants' perception of their own energy use; and participants' sense that they were doing everything they could to keep their household warm in winter.

However, neither the EDUG approach nor the EDUG +CCB approach had an impact on people's perception of living in a strongly connected community and people's awareness of someone in their community who they could ask about thermal comfort and energy efficiency.

None of the approaches had a significant impact on people's efforts to reduce their energy bill or on the affordability of their energy bill. Most of the participants were trying to reduce their energy bill prior to the project and around half the participants were experiencing difficulties paying their energy bill prior to the project. Following project implementation, people were persisting in their efforts to reduce their energy bill and they continued to experience problems affording their energy bill. This result is not surprising given the difficult financial circumstances of many households in the study and the substantial proportion of participants who were not attached to the labour force and who were living below the poverty line.

Based on our knowledge of project implementation, we suspected that in-home education and upgrades had an impact regardless of whether the participant was exposed to the CCB approach. We were aware that there were substantial differences in people's direct experience of these two approaches. While in-home education and upgrades were mandatory for everyone in the EDUG and EDUG+CCB groups, the community capacity building activities were optional for the CCB and EDUG+CCB groups, and so some participants had much more engagement in the community capacity building activities than others.

Given this situation, we decided to conduct additional testing that compared those in the project who received in-home education and upgrades (EDUG and EDUG+CCB) with those who did not (CCB and REP group). We found that direct experience of in-home education and upgrades had a significant impact on people's perception, knowledge and capacity of energy efficiency and thermal comfort. The in-home education and upgrades did have an impact on: people's perception of their own energy use; people's knowledge of thermal comfort in winter and summer; people's knowledge of energy efficiency; people's sense that they were doing everything they could to keep their household warm in winter; and people's awareness of someone in their local community who they can ask about thermal comfort. People who experienced in-home education and upgrades were also more likely to report a reduction in the draughtiness of their home and a reduction in observed moisture on cold days.

In short, the Bulk Study report provides a substantial evidence base for the effectiveness of in-home education and upgrades in reducing people's energy usage. It also provides a good body of information on perceptions, knowledge and capacity in relation to energy efficiency and thermal comfort. In-home education and upgrades are effective regardless of whether this is experienced individually by participants or whether this is embedded within a community action and engagement strategy.

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6 Detailed study

Details of the Get Bill Smart DETAILED Study are contained in a standalone report titled “DETAILED STUDY”. The following is an excerpt of the introduction of the detailed report.

Read this report if you would like an insight into the different ways that individuals and households manage energy efficiency and thermal comfort and respond to different program approaches.

6.1 Detailed report introduction

This report, The Detailed Study, provides in-depth examination of participant households and the

change that occurred for these households after Get Bill Smart (GBS) program involvement. The

report presents the methods and findings from qualitative and quantitative detailed research conducted with 51 of the households involved in the broader GBS project. The aim of The Detailed Study is to gain further insight into energy efficiency and thermal comfort behaviours through more nuanced understanding of the conditions that householders experience, the changes (outcomes) that occur over the GBS study period, key influences affecting those changes, and trade-offs made between energy use

and comfort.

The Detailed Study enhances understanding of:

- home energy consumption and energy efficiency change outcomes

- home thermal comfort management and performance changes

- housing conditions participants live with that influence their thermal comfort and energy

consumption

- affordability related to energy use and thermal

comfort - health and wellbeing and its relationship to energy use and thermal comfort

- trade-offs participants make when there is an opportunity for comfort improvement or energy

saving

- comparative effects of GBS support approaches, and

- the context of low income householders and how it affects energy use, energy efficiency and

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thermal comfort in the home.

GBS is working to advance understanding of energy use and thermal performance to improve the design of support activities for application in Tasmania and Australia.

Participants in GBS are divided into four approaches:

1. In-home education and upgrades (EDUG)

2. Community capacity building (CCB)

3. In-home education and upgrades and

community capacity building (EDUG+CCB)

4. Representative group (the no activity, baseline

comparative group) (REP)

Essentially in these four groups GBS tested two key approaches to energy efficiency support: Community capacity building with local energy champions, and in-home education and upgrades supported by expert sustainability assessors. The 51 households who participated in this detail part of the study were drawn from all four GBS approach groups in roughly equal numbers so that differences in the approaches could be compared. Research methods used for the Detailed Study were both qualitative and quantitative. As Foulds et al. (2013: 627) have previously observed, the use of both types of data "provides the depth required to reflect suitably on data collection, theoretical application and analysis-related issues". Change outcomes are examined by comparing key indicators before GBS energy efficiency activities and again after the activities, and through comparisons between the GBS approach groups. The quantitative data collection involved monitoring of household's electrical consumption and temperatures inside and outside the house, over a 15-month period. The electricity and temperature monitoring period was across two winters in order to establish 'before' and 'after' periods of cold weather. The qualitative methods involved before and after interviews with householders in addition to the surveys conducted across all GBS households. Electricity billing data, gathered for all participants in GBS, is also referred to in this report. Detailed study findings are presented in two ways: as individual case studies and as comparative (summative) analysis. Each participant household is described in an individual case study. Each case study describes key characteristics of the participant household, the physical house conditions relevant to the energy/comfort focus, outcomes of the energy efficiency support activities; key influences that affected those outcomes; critical contextual and community considerations; and key domestic considerations within the household. The richness of information presented in this way, while not

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statistically significant, allows examination of varied cases and reveals critical dynamics (differences) in experiences house to house.

A case-based approach, such as we have used, has recently been applied by Gram-Hassen (2010) to understand variation in residential heat comfort practices and energy use across households. By pulling together quantitative aspects of the home with personalised dwelling experiences we are able, as Ellsworth-Krebs et al. (2015, 100) suggest, to “adopt the home (and all the baggage the term comes with) as the focus for investigation, highlighting an appreciation for the socio-technical nature of domestic energy demand”. Comparative summary analyses identify outcomes for different approach groups and outcomes according to key indicators. Comparisons are presented in tables with interpretation. These comparisons:

- illuminate influential relationships between housing/heater performance and electricity use/comfort outcomes
- present outcomes of the four different GBS approaches, and
- assist, in conjunction with case study analysis, to develop overall detail study findings.

In order to compare cases, the Detailed Study includes only the detailed participants that took part in the main study proper and were part of one of the four approaches described above. ‘Energy Champion’ (EC) households are not reported here. The 12 EC households took part in similar research processes to detailed participants but, due to program delays at the outset of the project, the monitoring period for the ECs was a non-winter period. Hence, quality data regarding heating could not be collected from the EC household group. The 12 EC households became a very valuable testing ground for detailed research processes. Understanding from researching champion households was fed back into the research processes for the detailed study.

In this report we present all stages of the detailed study by first outlining methods used for quantitative and qualitative data collection and combined analysis; then presenting detailed case studies and comparative analyses; and, finally, presenting a discussion of findings and conclusions

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7 Cost-Benefit Analysis

7.1 Introduction

This report, the Cost-Benefit report, includes cost-benefit, cost effectiveness, and additional benefit analyses of Get Bill Smart (GBS) energy efficiency activities. These analyses are presented here to offer data that supports the development of future energy efficiency programs.

The Get Bill Smart Final Report consists of an overview report and sub reports (including this one). The sub reports include:

1. The Bulk Study
2. The Detailed Study
3. Cost Benefit Analysis
4. Project processes and organisational analysis, and
5. Financial report.

Cost-benefit analysis is a technique that relates the financial outcomes/benefits of an activity with its financial costs. Cost effectiveness analysis differs in that it relates outcomes/benefits in non-financial terms to the financial costs of the activity. Data for the cost benefits and cost effectiveness analysis mainly comes from the Financial and Bulk Reports.

Some further benefits are that were identified during GBS data collection and analysis, but were not able to be included in cost-benefit and cost effectiveness analyses due to insufficient sample sizes and/or difficultly in quantifying results. Additional benefits discussion in this report draws on findings from the Detailed Study and the Project processes and organisational analysis reports.

This Cost benefit report compares the four approaches used in GBS:

1. In-home education and upgrades (EDUG)
2. Community capacity building (CCB)
3. In-home education and upgrades and community capacity building (EDUG+CCB)
4. Representative group (the no activity, baseline comparative group) (REP)

In addition to the approaches described above, the project yielded a number of benefits to the wider energy efficiency industry and related sectors. These “Trial co-benefits” are also examined in this report. Methods for Trial co-benefits are presented in section **Error! Reference source not found.**.

7.2 Methodology

This section describes processes used to conduct cost-benefit, cost effectiveness and benefit analyses.

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The methods for the GBS cost-benefit analysis and cost effectiveness ratios were developed by the Department of Industry Innovation and Science (the Department) and are described below (sections **Error! Reference source not found.** and **Error! Reference source not found.**). All data from other GBS reports used to calculate cost benefits and effectiveness are presented in this methods section. Limitations to cost benefit and effectiveness analysis is described in section **Error! Reference source not found.**

In addition to the approaches described above, the project yielded a number of benefits to the wider energy efficiency industry and related sectors. These "Trial co-benefits" are also examined in this report. Methods for Trial co-benefits are presented in section **Error! Reference source not found.**.

7.2.1 Cost effectiveness analysis

7.2.1.1 Description of method

Cost effectiveness analysis generates ratios that relate program costs to outcomes to identify the most cost effective approaches. This technique uses non- monetary units to measure impacts/effect. The cost-effectiveness analysis used here involves:

- Identification of trial approaches
- Calculation of the costs of each trial approach (see **Error! Reference source not found.** on page **Error! Bookmark not defined.**)
- Identification of trial benefits (see section**Error! Reference source not found.** on page **Error! Bookmark not defined.**)
- Assessment of the trial approach cost against its benefit
- Comparison of the cost effectiveness analysis outcome for each of the trial approaches to determine the most cost-effective approach within the trial

The cost effectiveness ratio is determined by the following formula:

$$\textbf{Cost effectiveness ratio} = \frac{\textbf{Cost}}{\textbf{Unit of Effectiveness}}$$

Cost effectiveness ratios were calculated for each approach relative to the representative (REP) group, which acted as a control for the study.

7.2.1.2 Effectiveness

Identified benefits that could be used in cost effectiveness ratios were: change in energy consumption; change in heating efficiency; change in time spent in comfort zone; and change in water usage. However, only changes in energy consumption and water consumption could be quantified confidently. The other benefits were only measured for Detailed Study participants, which were too few in number to confidently statistically determine trends and estimate benefits. Instead, these benefits are discussed under heading **Error! Reference source not found. Error! Reference source not found.**.

Change in electricity consumption (kWh/day)
The change in electricity consumption for each research group was calculated as per the methodology described in Chapter 5 (The Bulk Study). The average change in electricity consumption of the representative

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(REP) group was subtracted from the average changes of the other groups to give their impact relative to doing nothing (see **Error! Reference source not found. Error! Reference source not found.**).

Table 7-1: Changes in electricity consumption per house by group relative to representative group (kWh/day)

	EDUG	CCB	EDUG+CCB	REP
Change in electricity consumption (kWh/day)	-1.44	-0.07	-2.82	0.00

Change in water consumption (L/day)

The change in water usage (water savings) for each research group was calculated by measuring the initial water usage of a shower head and subtracting the water usage following the upgrade of the shower. This was multiplied by the amount of time the shower was used each day to give a value in Litres per day.

Table 7-2 Change in water usage per house by group relative to representative group (L/day)

	EDUG	CCB	EDUG+CCB	REP
Change in water consumption (L/day)	-83	0.00	-83	0.00

7.2.2 Cost benefit analysis

7.2.2.1 Description of method

Cost benefit is a technique to relate the costs of a program to its financial outcomes/benefits. It is used to identify the most cost effective option for achieving a particular outcome or benefit. The cost-benefit analysis involves the following steps:

- Identify trial approaches
- Calculate the costs of each trial approach (**Error! Reference source not found.** on page **Error! Bookmark not defined.**)
- Identify direct trial financial benefits (see section (**Error! Reference source not found.** on page**Error! Bookmark not defined.**)
- Assess the trial approach cost against its benefit
- Compare the cost benefit analysis outcome for each of the trial approaches to determine the most cost-effective approach within the trial

The cost benefit ratio is determined by the following formula:

$$\textbf{Cost benefit ratio} = \frac{\textbf{Cost}}{\textbf{Benefit in dollars}}$$

7.2.2.2 Benefits

There are two easily measurable financial benefits to recipients of the project, namely reduction in electricity costs and reduction in metered water charges. While there were a number of other GBS benefits that could sit in a cost benefit analysis, it was beyond the scope of the GBS project to collect information needed to estimate the benefits in financial terms.

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Reduction in electricity costs

The benefit was calculated by multiplying the average changes in electricity use (as specified in **Error! Reference source not found.** on page **Error! Bookmark not defined.**) by the average electricity price. Tariff rates averaged over the project period were used to remove the impact of electricity price rises and falls.

For all the approaches a weighted average of tariff 31 and 41/42 rates was used based on actual billing data from households in the Detailed Study. The weighting was 49% tariff 31 and 51% tariff 41/42, resulting in an average electricity price of 21.259c/kWh.

The cost savings per annum are presented in **Error! Reference source not found.**.

Table 7-3 Change in electricity costs per house by research group relative to the representative group ($/year)

	EDUG +CCB	EDUG	CCB	REP
Reduction in electricity costs ($/year)	219	112	5	-

The EDUG and EDUG+CCB groups also experienced a shift in electricity usage from tariff 31 to the cheaper tariff 2. On average, this amounted to 1.2 kWh/day shift for EDUG+CCB and 0.5 kWh/day for the EDUG group. The value of this shift is between $17/year and $44/year in addition to the figures in **Error! Reference source not found.**. This value was not included because not all customers were on the same tariff structure. Indeed the payback would vary widely depending on the tariff structure. For example, PAYG clients in EDUG+CCB exhibited almost 50% greater electricity savings than those on other tariffs. However, these results were not statistically significant and are not included here because they may skew the statistically significant results.

Electricity savings over time

Electricity savings are expected to accrue over time. For example, the CFL globes used in the project have a rated service life of 6000 hours (approx. 4 years usage). A model was created to accrue the energy savings over time based on the parameters of

- Contribution to total energy savings and
- Likely service life of the upgrade item or approach.

Assumptions used to generate the service life periods for GBS approaches can be seen below in **Error! Reference source not found. Error! Reference source not found.**.

Table 7-4 Assumptions for service life of Get Bill Smart Approaches

	CCB + EDUG Approach		EDUG Approach		CCB Approach	
Approach	Contribution to energy savings (%)	Expected Service Life (years)	Contribution to energy savings (%)	Expected Service Life (years)	Contribution to energy savings (%)	Expected Service Life (years)
CCB	50%	2	0%		100%	2
Education (with upgrades)	10%	2	20%	2		
Lighting	5%	4.1	10%	4.1		
Shower head	8%	10	15%	10		
Draught proofing	10%	5	20%	5		
HWS lag	3%	10	5%	10		

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	CCB + EDUG Approach		EDUG Approach		CCB Approach	
Ceiling Insulation	10%	25	20%	25		
Curtains	5%	10	10%	10		

Based on the assumptions in **Error! Reference source not found.** and the data in **Error! Reference source not found.** calculation can be made that determines the total value of energy savings over the project. Note that this is a simple number that does not account for inflation or changes in future electricity prices.

Please note a very conservative estimate (2 years) has been made to the duration that "educational" activities can deliver energy savings. This could have the possibility of skewing results in favour of the EDUG approach.

Table 7-5 Cumulative reduction in electricity costs

	EDUG +CCB	EDUG	CCB	REP
Reduction in electricity costs ($)	$1292	$1096	$11	-

Reduction in water usage

The change in water usage for each research group was calculated by measuring the initial water usage of a shower head and subtracting the water usage following the upgrade of the shower. This was multiplied by the amount of time the shower was used each day to calculate daily usage and multiplied by 365 to calculate annual usage (**Error! Reference source not found.**, **Error! Reference source not found.**).

The average cost of metered water over a 3 year period of $0.99 per kL is used.. The water usage reduction was multiplied by the water cost to determine annual savings to metered water bills from changing the showerhead.

Table 7-6 Change in water usage per house by group relative to representative group ($/year)

	EDUG	CCB	EDUG+CCB	REP
Savings from showerhead replacement ($/year)	$30.40	-	$30.40	-

Reduction in water usage over time

It has been estimated that the showerhead will have a useful service life of 10 years. Based on this a cumulative savings from replacing a showerhead can be developed.

Table 7-7 Cumulative savings from replacing showerhead ($)

	EDUG	CCB	EDUG+CCB	REP
Savings from showerhead replacement ($/year)	$304	-	$304	-

Cumulative Water and Electricity Savings

The combination of electricity and water savings deliver the total financial savings from the project. These are detailed **Error! Reference source not found.** in **Error! Reference source not found.**.

Table 7-8 Cumulative electricity and water savings by Get Bill Smart Research Group

	EDUG	CCB	EDUG+CCB	REP
Cumulative water and electricity savings ($/year)	$1400	$11	$1596	0.00

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7.2.2.3 Costs

Given that this was a trial project that had additional research expenses above and beyond the “delivery cost” of a standard project, the cost of the project was calculated at four levels. These levels where defined by the Department for the purposes of the project (see **Error! Reference source not found.**).

Table 7-9: Allocating project costs at four levels

Cost level	Cost data Included
Direct trial approach (Level 1)	The cost of delivering the trial approach to a particular participant
Trial Component (Level 2)	The cost of delivering the trial approach to a particular participant, and Costs associated with: i) Recruiting a participant, and ii) Maintaining a participant
Total Business (Level 3)	The cost of delivering the trial approach to a particular participant, and Costs associated with: i) Recruiting a participant, and ii) Maintaining a participant, and Costs of running an organisation to do the above
Total Trial (Level 4)	The cost of delivering the trial approach to a particular participant, and Costs associated with: i) Recruiting a participant, and ii) Maintaining a participant, and Costs of running an organisation to do the above, and Cost of participating in a government funded trial

The GBS project budget was used to allocate project costs for the cost benefit analysis. Final project budget estimates were used from February 2015. The budget line items were allocated across the four levels (as described in Table 7-9 above) and across the four research approach groups.

Expenses were allocated based on loadings derived from the number of participants in each GBS approach (**Error! Reference source not found.**).

Table 7-10: Percentage allocation by research group

Research Group	Number	Percentage	Community development split	Upgrades split
EDUG + CCB	78	16%	47%	32%
EDUG	168	34%		68%
CCB	89	18%	53%	
REP	165	33%		
Total	**500**	**100%**	**100%**	**100%**

The costs for each of the research groups and levels is detailed in **Error! Reference source not found.** (**Error! Reference source not found.**). Further details of the assumptions can be found at APPENDIX 3 .

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Table 7-11: Costs of intervention per house by research group and cost level

Research Group	Level 1 - direct trial	Level 2 - Trial component	Level 3- Total Business	Level 4- Total trial
EDUG + CCB	1,459	1,846	2,121	5,431
EDUG	873	1,006	1,150	3,840
CCB	721	1,104	1,379	4,642
REP	74	75	75	2,939

7.2.3 Limitations of cost effectiveness and cost benefit analyses

The limit of the cost benefit and cost effectiveness approaches is their reliance on universally and easily applied numerical constants. Improvements to households that may increase thermal comfort, health or well-being are not as easily defined or recorded in a project. Even if defined, reducing these variables to a universal constant that can be applied across project approaches is not often possible, and measuring them can be expensive (e.g. data collection and analysis for the Detailed Study was a large expense for the GBS project). An attempt was made in the Detailed study to quantify a range of thermal variables and their relationship to the energy efficiency approaches. However, the impact of independent variables such as home construction, employment, household size and behaviour created too much 'noise' in a relatively limited data set to confidently quantify benefits. Instead other benefits of the project have attempted to be qualified as per section **Error! Reference source not found.**.

7.2.4 Additional project level benefits

Additional benefits have been experienced by the participants in the Get Bill Smart Project. These are described in **Error! Reference source not found.** (**Error! Reference source not found.**). A variety of sources have been used to demonstrate these benefits including in-home data logging, survey questions and expenditure analysis. Each benefit listed in the right hand column of **Error! Reference source not found.** will have evidence supplied to verify the improvements made.

Table 7-12: Additional project level benefits

LIEEP Benefits	GBS Benefits
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	• Greater capacity for low income householders to be more energy efficient (knowledge, skills and motivation) • Reduced energy bills • Increased thermal comfort • Improved health, social welfare and livelihood • Improved sense of community connection • Improved sense of who can go to in community to help with energy efficiency • Access to local energy champion • Access to grocery vouchers.

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7.2.5 Trial co-benefits

Co-benefits are benefits of the activities that experienced by people or organisations other than the low income households that participated in the project. Benefits have accrued to the Tasmanian energy efficiency sector and industry more widely. These are described in **Error! Reference source not found.** (**Error! Reference source not found.**). A variety of sources have been used to demonstrate these benefits including internal interview, training logs and expenditure analysis. GBS benefits listed in the right hand column of **Error! Reference source not found.** will have evidence supplied to verify the improvements made.

Table 7-13: Trial co-benefits

LIEEP Benefits	GBS Benefits
Build the knowledge and capacity of consortium members to encourage long-term energy efficiency among their customers and clients.	Collated data on motivations, barriers and best approaches to energy efficiency projects in low income households in southern Tasmania.
Build capacity of Australia's energy efficiency technology and equipment companies by maximising the opportunities for Australian industries to participate in the projects.	Provided employment, training and commercial opportunities for local residents and businesses.

7.3 Results

7.3.1 Cost effectiveness analysis

Change in energy consumption

For comparison between the research approaches, the Level 3 analysis appears to give the best reference point – the expected cost for a program delivered by an organisation. At this level both the education and upgrades combined with community capacity building (EDUG+CCB) and the education and upgrades by themselves (EDUG) give equivalent ratios. These ratios are $752 per kWh/day for EDUG+CCB and $798 per kWh/day for EDUG. The community capacity building approach delivers a very poor ratio $19,698 per kWh/day. This is due to a lack of energy savings in this group.

Table 7-14: Electricity cost effectiveness analysis (1 year)

Research Group / Approach	Cost effectiveness ratio ($ per kWh/day)			
	Level 1	Level 2	Level 3	Level 4
EDUG +CCB	517	655	752	1,926
EDUG	606	698	798	2,666
CCB	10,302	15,776	19,698	66,321

Change in water usage

The cost effectiveness of reduction in metered water charges[13] can be seen in **Error! Reference source not found.** (**Error! Reference source not found.**). At level 3 reductions of 1 kL/PA in water use will costs $38 to support in the EDUG or $69 in the EDUG+CCB approach.

Table 7-15 Water saving cost effectiveness analysis (1 year)

Research Group/Approach	Cost effectiveness ratio ($ per kL/PA)			
	Level 1	Level 2	Level 3	Level 4
EDUG +CCB	48	60	69	178
EDUG	29	33	38	126
CCB	-	-	-	-

7.3.2 Cost benefit analysis

1 year electricity cost benefit analysis

The cost benefit ratios of electricity use reflect the same findings as the cost effectiveness. At level 3 both the education and upgrades combined with community capacity building and the education and upgrades by themselves give equivalent ratios (10). This gives the project a simple payback period of 10 years (based on energy savings alone). The community capacity building approach delivers a very poor ratio at 254. This is due to the very poor observed energy savings in this group.

Table 7-16: Electricity cost-benefit analysis by group and cost level

Research Group/Approach	Ratio ($ upfront cost per $/year saving)			
	Level 1	Level 2	Level 3	Level 4
EDUG + CCB	6.7	8.4	9.7	24.8
EDUG	7.8	9.0	10.3	34.4
CCB	132.8	203.3	253.9	854.7

Cumulative electricity cost benefit analysis

The cumulative energy savings demonstrate that the EDUG approach delivers $1 of energy savings for $1 of investment at level 3. EDUG+CCB delivers $1 of energy savings for $1.60 of investment and CCB requires $127 to obtain $1 energy saving.

Research Group/Approach	Ratio ($ upfront cost per $ saving)			
	Level 1	Level 2	Level 3	Level 4
EDUG + CCB	1.1	1.4	1.6	4.2

[13] Note this does not include any component of electricity usage, simply the cost to supply water.

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Research	Ratio ($ upfront cost per $ saving)			
EDUG	.80	.92	1.0	3.5
CCB	66.4	101.7	126.9	427.3

Cumulative and combined electricity and water cost benefit analysis

Combining the electricity and water savings over the project life delivers the cumulative, combined cost benefit analysis. Under the level 3 scenario CCB costs $127 to deliver a $1 saving. CCB + EDUG requires a $1.30 to deliver $1 of savings. EDUG approach by itself requires just $0.82 investment to save the householder $1 in water and energy costs. It should be noted that this is a simple cost benefit analysis and the forward estimates of costs do not include inflation, indexing or the time value of money

Research Group	Ratio ($ upfront cost per $ saving)			
	Level 1	Level 2	Level 3	Level 4
EDUG + CCB	.9	1.2	1.3	3.4
EDUG	.6	.7	.8	2.7
CCB	66.4	101.7	126.9	427.3

7.3.3 Additional benefits (project level)

This section lists additional benefits identified from the GBS project activities. Each benefit is discussed under its own heading.

Reduction in draughts in all households receiving in-home education and upgrades (for EDUG and EDUG+CCB households)

Home energy upgrades included draught proofing on doors and windows. This is a vital component of providing thermal comfort in a home and in reducing the amount of money and electricity used to heat the house.

Table 7-17: Evidence of reduction in draughts

LIEEP Benefits	GBS Benefits	Evidence
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	Improved health, social welfare and livelihood. Increased thermal comfort.	After the intervention, there was an increase in the number of people that stated their homes were not draughty (44.8% of participants said their homes were not draughty in 2015 in comparison to 2014) (see the Bulk Study). An air blower test indicated a 23% reduction in air exchange after the implementation of basic draft proofing measures (participant GBS716 test conducted April 2015).

Improvement in warmth in winter

Householder perceptions of thermal comfort in winter were included in the survey of Bulk Study participants and time spent in the comfort zone was identified in the Detailed Study. **Error! Reference source not found.** shows bulk and detail answers demonstrated an improvement in warmth in winter.

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Table 7-18: Evidence of improvement in warmth in winter

LIEEP Benefits	GBS Benefits	Evidence
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	Improved health, social welfare and livelihood. Increased thermal comfort.	The home energy upgrade intervention group were more likely to report increased thermal comfort in winter when compared to the representative group (see The Bulk Study findings). Comparative analysis in The Detailed Study showed an overall improvement in time spent in the comfort zone for the EDUG + CCB group (see Detailed Study synthesis and discussion). The EDUG+CCB group noted an improvement in heating efficiency of 0.24 °C hrs /kWh /day. This resulted in this group spending 4% more time in the thermal comfort zone (Detailed Study analysis). Due to CCB activities in the CCB approach and the EDUG+CCB approach, the GBS project was able to connect with households who were harder to reach in the communities through locals and because of an overall local presence (Organisational report section 8.9.2).

Reduction in moisture on windows

Risk of mould spores in households increases with higher moisture levels inside homes and with surface condensation, especially as a consequence of moisture forming on cold window surfaces. Mould spores can reduce the health of household occupants, compromising immune health and increasing respiratory problems such as asthma[14]. Flow on impacts from reduced health and wellbeing caused by moist homes can include loss of income and educational opportunities. **Error! Reference source not found.** evidence statistically demonstrates a reduction of moisture on windows.

Table 7-19: Evidence of a reduction in moisture on windows

LIEEP Benefits	GBS Benefits	Evidence
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	Improved health, social welfare and livelihood.	Households that received a home energy upgrade were less likely to report moisture on windows in 2015, compared to the representative group. (see The Bulk Study 5.4.4).

[14] The WHO cites water on the surface of materials (eg windows) as the most important trigger for microorganism growth (http://www.euro.who.int/__data/assets/pdf_file/0017/43325/E92645.pdf)

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Increasing the capacity to be more energy efficient

Low-income householders were given the opportunity to increase their understanding of energy efficiency.

Table 7-20: Evidence of increasing capacity for energy efficiency

LIEEP Benefits	GBS Benefits	Evidence
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	Greater capacity for low income householders to be more energy efficient (knowledge, skills and motivation).	After the intervention, 65% of GBS participants in the Bulk Study agreed or strongly agreed with the statement that they knew where to get information to improve their energy efficiency. Bulk study participants were more likely to rate themselves as using less energy in 2015 compared to 2014, when compared to the representative group. (see The Bulk Study findings

Improving Community Connectivity

Community capacity building activities employing local champions helped build community connectivity.

Table 7-21 Evidence of improving community connectivity

LIEEP Benefits	GBS Benefits	Evidence
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	Greater capacity for low income householders to be more energy efficient (knowledge, skills and motivation).	After GBS activities, 65% of GBS participants in the Bulk Study agreed or strongly agreed with the statement that they knew where to get information to improve their energy efficiency (compared with 36.9% before) (Bulk Study section 5.4.8). Bulk study participants were more likely to rate themselves as using less energy in 2015 compared to 2014, when compared to the representative group (Bulk Study section 5.4.7). Participants reported improved information flows by using community connections in CVR to share information about energy use and management and comfort management (Detailed Study section 5.2.3). Participants demonstrated raised awareness and brought topics into conversation, thought and turned them into priorities in households – particularly energy use and efficiency, heater management, shower behaviour and tariff management/understanding (Detailed Study various sections).

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Providing incentives that support a healthy livelihood

GBS provided Woolworths *Groceries Only* gift cards to participants at various stages of the project in exchange for household energy data and/or as incentives to return data promptly. Providing these cards to low income householders so that they could spend money on groceries benefited hundreds of households in the Greater Hobart area. This had an added benefit of supporting local shopping centres.

Table 7-22: Evidence of supporting healthy livelihood

LIEEP Benefits	GBS Benefits	Evidence
Assist low-income households to implement sustainable energy efficiency practices to help manage the impacts of increasing energy prices and improve the health, social welfare and livelihood of low-income households.	Access to grocery vouchers.	GBS provided $47,375 worth of grocery vouchers to low income households in the Greater Hobart area.

Building the energy efficiency industry

The GBS project provided an opportunity to employ local energy efficiency specialists. High-tech energy monitoring equipment was also installed. Both of these activities brought benefits to the energy efficiency industry in alignment with the intended LIEEP benefits.

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Table 7-23: Evidence of supporting energy efficiency industry

LIEEP Benefits	GBS Benefits	Evidence
Build capacity of Australia's energy efficiency technology and equipment companies by maximising the opportunities for Australian industries to participate in the projects.	Provide employment, training and commercial opportunities for local residents and businesses.	GBS directly purchased $64,013 worth of energy efficiency materials for home energy upgrades (Finance Report). Subcontracted the installation of an additional $90,955 of energy efficiency upgrades (Ibid.). GBS employed10 energy auditors to conduct home upgrades and spent $89,488 on wages (Ibid.). GBS spent $100,458 employing energy data analysts (7 people at various levels of employment) (Ibid.). GBS purchased technical data logging equipment to the value of $126,761 from 4 companies (Ibid). Commissioned product development to allow "Power tracker" (an energy efficiency services company) to develop large scale multi-site data collection . Helping to build their business and ability to service new market segments(Ibid.).

7.3.4 Benefits outside of the LIEEP scope

LIEEP and GBS provided benefits to the energy efficiency industry as stated in **Error! Reference source not found.**, however there were also economic benefits for supporting local Tasmanian and other Australian businesses through the rollout of the project. **Error! Reference source not found.** provides a list of additional benefits that the GBS project provided.

Table 7-24: Evidence of additional GBS benefits

Additional GBS benefits	Evidence
Supporting local businesses	GBS spent over $277,487 at Tasmanian businesses (this does not include wages for SLT or UTAS employees) GBS spent $132,793 on Australian businesses not supplying specific energy efficiency services (eg, computer support and postage).

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Additional GBS benefits	Evidence
Educating the broader public about energy efficiency projects available to help low income earners.	The State and potentially national reach of media coverage (exact numbers unknown) about GBS through ABC radio, local newspapers and State television stations. Public outreach of findings will also occur on completion of the final report. Presentations will occur in Clarendon Vale, Hobart, Adelaide and New Zealand. Papers are also being produced for international journals on completion of the Final Report.
Building relationships between community centres and NGO's.	Presentations at Greater Hobart community and neighbourhood centres introduced citizens to the work of local NGO's such as Sustainable Living Tasmania and Mission Australia.
Contributing to energy efficiency, comfort explorations with low income household groups. Developing specialist understanding of encouraging energy efficiency in Australia.	Consortium members were actively exploring this area over the duration of the GBS project (and will continue to do so after the completion of the project). Specialist research was conducted by UTAS and RED consultants throughout GBS. Understandings from this, including sophisticated methodological approaches, will inform future energy efficiency and energy use work.
Contributing to future energy efficiency research and policy development through connections made between governments, NGOs and universities around Australia, including through GEEAR.	The GBS team have attended LIEEP forums and will be attending further conferences to discuss LIEEP and GBS. A GBS UTAS representative has been directly involved in the development of the Group of Energy Efficiency Academic Researchers (GEEAR) group that has emerged from LIEEP. GEEAR has a conference in February 2017 and a UTAS representative is speaking about LIEEP at the Energy Cultures Conference in NZ. There have been numerous spontaneous communications between LIEEP projects and discussions will continue through GEEAR.

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Sealasash - a successful energy efficiency business

Sealasash is a Tasmanian small business that is now expanding interstate. They specialise in high quality draft proofing for wooden sash windows. Sealasash also has a wide knowledge of the manufacturing industry and alternative products that are available. They could see an opportunity for introducing a better alternative for low-income households.

Three years ago they met with SLT to introduce their high quality draft proofing products. The "brush strip" they supply is used to draft proof wooden framed doors and windows. It is a durable product that is quick to install. SLT has ordered and installed their "brush strip" door seals on thousands of houses through the Get Bill Smart Project and State Government funded programs. Government energy efficiency programs provide the security for small companies to invest in innovative products, grow their business and create employment opportunities.

7.4 Discussion

Each of the approaches taken in the Get Bill Smart project resulted in lower energy use than the representative (control) group. The cost effectiveness and cost-benefit ratios varied considerably between these approaches.

7.4.1 Energy Efficiency

Community capacity building (CCB) was a novel approach to energy efficiency and thermal comfort and was trialled and developed over the course of the GBS project. As a result, it is not unexpected that in its current form, CCB was highly inefficient in terms of the financial costs required to achieve energy savings. Based on electricity savings for 1 year the project delivered a simple payback of 254 years (Level 3 analysis). The cumulative energy and water savings over the service life of the works will yield $1 of household savings for every $127 invested

While financially the CCB approach appears inefficient, there were many other benefits to the CCB approach. Such benefits included improved physical and mental health for participant householders and, thanks to the localised knowledge of the ECs, the CCB approach was able to access some of the most difficult to reach and isolated individuals within the community. A great deal was learned from the CCB approach that can be applied to the development of future programs. Evidence from the Detailed Study and the Project Processes and Organisational analysis demonstrates there are benefits for community building and information sharing from the community capacity building approach.

The in-home education and upgrades (EDUG) approach, which SLT has been developing over several years, was the most cost effective approach. Based on electricity savings for 1 year the project delivered a simple payback

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of 10.3 years (Level 3 analysis). When electricity and water savings where combined over the useful life of the upgrade items, it was calculated that an $0.82 investment delivered $1 of savings. Like the CCB approach there were also intangible benefits from program participation linked to improved mental and physical health. Key to the success of the EDUG approach were the excellent people skills of those involved in program implementation. The intangible benefits of this significantly enhanced the ability of the EDUG approach to make financial savings.

Delivering the community capacity building in conjunction with in-home education and upgrades (EDUG + CCB) achieved a similar result (in terms of cost benefits) to the in-home education and upgrades (EDUG) approach, although slightly improved. With a 1 year simple payback the EDUG+CCB approach had a payback of 9.7 years (Level 3 analysis). However, the cumulative energy and water savings were not as favourable with $1.30 required to deliver $1 of savings. The poorer performance of this approach is largely due to a predicted decay in the effectiveness of the "education" and "capacity building" relative to fixed physical works. Further research could help determine if this assumption is correct.

Both the cost effectiveness and cost benefit analyses are dependent upon the electricity savings and the cost of delivering programs/approaches. As can be seen in the Bulk Study, the change in energy use is dependent on the original energy use. In fact, households that used less than 10 kWh/day on average increased their average energy usage regardless of which energy efficiency activities were undertaken with them. Across the project, 66% of households used less than 30kWh/day (approximately the Tasmanian household average). One policy response to this finding could be to target energy efficiency projects at higher energy users. Applying this approach to the EDUG+CCB group shows a 4.2 kWh/day saving. This improves the 1 year, cost-benefit ratio from 9.7 to 6.5 (at cost level 3). However, this is a cost based suggestion and would ignore the significant challenges that lower energy users have with both energy use and comfort.

Another potential approach (when focussing on cost-based data) is to focus on hot water energy use only (HWEU). We estimated the payback for such an approach would be 6.1 years. If focussing on hot water energy only *and* high energy users only, the payback period could be reduced even further - our analysis indicated as low as 2.7 years. However, the sample size for this analysis is too small to use this number confidently.

7.4.2 Comfort and health

Achieving thermal comfort improves health outcomes

The Get Bill Smart project significantly improved thermal comfort. This included reductions in window condensation, draughts and improvement of time spent in the thermal comfort zone. Households also increased their knowledge and ability to manage their homes effectively (**Error! Reference source not found.**).

In physiologically uncomfortable situations (such as we commonly saw in GBS participant houses), improvements to thermal comfort can support improvements to health. Indeed, health impacts of thermal comfort improvements may outweigh the energy and water savings discussed above by orders of magnitude.

The health gains from improved thermal comfort can be significant. Studies from New Zealand have linked energy efficiency programs (such as installing insulation) with savings to the health system. A NZ study that observed the effects of installing ceiling insulation in 1350 households, concluded

"Insulating existing houses led to a significantly warmer, drier indoor environment and resulted in improved self rated health, self reported wheezing, days off school and work, and visits to general practitioners as well as a trend for fewer hospital admissions for respiratory conditions." Howden-Chapman, P., A. Matheson, et al. (2007)

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This connection is strong and the health benefits tend to overwhelm the energy benefits by several magnitudes. In a review of the NZ "Heat Smart" Program the health benefits are attributed to be 99% of the project benefits. These health benefits include reduced: mortality, hospitalisations and pharmaceutical use. Based on these findings, for every $8 of energy saving their was $608 in health benefits[15] (Grimes, A, , Howden Chapman, Pet al 2011).

It is argued that thermal comfort changes are a significant component of the program and the impacts of these should not be discounted relative to changes in energy use. Australian cost benefit analysis cannot fully represent health cost reductions due to energy efficiency support in households as we have not developed our health cost impact understanding in the way that New Zealand has.

Cold homes result in increased death

Recent research by the Lancet (Gasparrini et a,l 2015) finds that 6.5% of Australian deaths are attributable to the cold. The research indicates that cold conditions raise peoples blood pressure and aggravates pre-existing conditions such as cardiovascular and respiratory disease. Countries with cold climates experience lower rates of mortality, due largely to better performing homes (Sweden 3.69% and Canada 4.46% of deaths). Population wide 6.5% of deaths equates to over 1000 lives lost in Australia every year due partially to poor thermal resistance (insulation) and poor construction.

Reducing condensation will reduce mould occurrence and subsequent health problems

The World Health Organisations Guidelines for Indoor Air Quality's volume on "Dampness and Mould" (WHO, 2009)concludes that

"sufficient epidemiological evidence exists…to show that occupants of damp and mouldy buildings … are at increased risk of respiratory symptoms, respiratory infections and exacerbation of asthma" (pp xiii)

They continue with policy advice that:

"Dampness and mould may be particularly prevalent in poorly maintained housing for low-income people. Remediation of the conditions that lead to adverse exposure should be given priority to prevent an additional contribution to poor health in populations who are already living with an increased burden of disease." (pp xv)

GBS demonstrated that energy efficiency support to householders can help to ameliorate mould and damp issues and therefore can assist to provide another opportunity for health improvements.

7.5 Conclusion

This trial approach explored novel community capacity building approaches. On its own the CCB approach was not cost effective, but when combined with in-home education and upgrades (EDUG+CCB) had the best simple payback period. Community capacity building activities are still in their infancy and, if further developed with the learnings from this project, could prove to be more cost effective.

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[15] Low scenario, Table 30, pp 26 http://www.healthyhousing.org.nz/wp-content/uploads/2012/05/NZIF_CBA_report-Final-Revised-0612.pdf

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The in-home education and upgrades approach (EDUG) had a similar simple payback as EDUG + CCB at around 10 years. However when all energy and water savings are combined over the useful life of the installed equipment the in-home education and upgrades approach (EDUG) delivers the best savings with $0.82 investment returning $1 in savings, compared to community capacity building and in-home education and upgrades (EDUG+CCB) requiring $1.32.. Research also indicates that targeting high energy users and Hot Water and shower upgrades could also deliver highly favourable cost benefit returns .

Other evidence from the project shows that it has improved the warmth and comfort of participants. Quantification of the relationship between these improvements and health and wellbeing outcomes in Tasmania is required before the benefits can be financially quantified. Studies conducted in New Zealand indicate improvements to thermal comfort result in ongoing health and wellbeing benefits that are likely to be several times more financially valuable than the energy savings achieved.

Other co-benefits to Tasmanian and Australian business have included strong support for the innovative energy efficiency industry.

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8 Project processes and organisational analysis

8.1 Executive Summary

The Get Bill Smart (GBS) organisational report looks at Get Bill Smart project activities from an organisational perspective. The report examines: capacity and constraint issues experienced by participating organisations; key successes and challenges associated with implementation; impacts on project implementation from participating in a national trial evaluation; and key lessons for future low income energy efficiency projects.

This report describes the project, consortium members, GBS project staff roles and responsibilities, methods used to evaluate organisational processes, and the evaluations of various approaches used in GBS. Evaluation is made of in home education and upgrade (EDUG) visits and the community capacity building (CCB) processes. CCB processes required firstly recruiting and preparing local Energy Champions (EC) and then working with the ECs in their community to roll out community capacity building activities. The two stages of activities are reported here as phase one: building capacity of the ECs and phase two: building capacity of local community.

Evaluation in this report was based on data collected through: consultation with project staff, including ECs, via written correspondence, interviews, and evaluation feedback, observation of GBS community activities; review of GBS community plans and promotional materials. The report also drew on insights gained during other GBS data collection

Through this review learnings were identified that would help in the roll out of future home energy efficiency programs. The review found that in home education and upgrade visits were well received by community members thanks to positive and non-judgemental interactions with Home Energy Helpers. The smooth implementation of this approach was assisted by SLT's previous experience in similar program delivery. Limiting the efficiency of delivery and the capacity of staff was the large administrative load of the project as a result of participation in the broader LIEEP program.

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Community capacity building programs (CCB) were also well received by the community. A strong Community Engagement Officer was key to the success of this program in managing a diverse group of Energy Champions with a range of capacities. Short time frames created serious challenges in terms of staff recruitment and time to imbed the program within the community. Community members appeared to prefer one-on-one style encounters (some group community activities worked and others did not), group community activities did however provide a symbolic identity for the program which provided legitimacy and visibility within the CVR area.

To achieve greater efficiency in future programs such as these, the following factors need to be considered:

- Considerable time needs to be given to recruiting and preparing Energy Champions and this needs to be coupled with a strong and capable Community Engagement Officer.
- Training of local staff (Energy Champions) needs to be ongoing and iterative. As staff begin work in the community, a return to key messages in the form of refresher courses would help to consolidate learning and ensure confidence.
- Energy Champions who are imbedded socially and culturally within the community are vital for legitimacy of the project and help to translate energy efficiency and thermal comfort messages.
- In a low income setting, local Energy Champions are not necessarily work ready – many are on disability pensions, look after families, have health problems and/or other limitations on capacity. However these are the people who understand the community best. It is important to understand the value of working with people with this limited capacity and to provide the required support, training and management.

8.2 Introduction

8.2.1 Purpose of report

This report describes and assesses the Get Bill Smart (GBS) project from an organisational perspective. We ask four key questions:

1. What were the capacity and constraint issues experienced by participating organisations?
2. What were the key successes and challenges associated with implementing the GBS project?
3. What impact did participating in a national trial evaluation have on project implementation?

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4. What were the key lessons for future low income energy efficiency projects?

8.2.2 Project Benefits

The GBS project trialled three approaches that aimed to improve energy efficiency in households with low incomes: direct engagement with households through In-home education and an upgrade (EDUG); community capacity building (CCB); and a combination of both (EDUG + CCB).

The cost-benefit and cost-effectiveness of each of these approaches were tested against a representative group (see Cost Benefit Study). The GBS trial evaluation was based on:

- bulk survey data collected before and after GBS approach,
- interviews with participants before and after GBS approach,
- monitoring of energy bills before and after GBS approach, and
- monitoring of indoor temperature, humidity and energy use before and (through to) after GBS intervention activities.

Table 8-1: Number of participants completing the pre and post GBS activity survey

		Community Capacity Building Approach	
		Off (Greater Hobart)	On (Clarendon Vale / Rokeby)
In-home education and upgrades approach	Off	144	65
	On	143	56

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Table 8-2 Number of participants who participated in pre and post GBS activity interviews and monitoring of indoor temperature, humidity and energy use

		Community Engagement Approach	
		Off (Greater Hobart)	On (Clarendon Vale / Rokeby)
Home Upgrade/Education Approach	Off	12	14
	On	12	13

8.2.3 Approach one: In-home Education and Upgrade (EDUG)

Approach one, In-Home Education and Upgrade (EDUG), involved direct engagement with households through a home visit. Each EDUG was conducted by two trained Home Energy Helpers (HEH). At the visit, the HEHs provided the participant with information about home energy efficiency and thermal comfort. Householders had basic energy efficiency and thermal comfort principles and tips explained to them and they received a copy of Sustainable Living Tasmania's (SLT) Your Guide to Staying Warm and Saving Money booklet (See Appendix 1). The HEHs then conducted an audit of the home with the intention of identifying what measures would improve the thermal comfort of the house and in turn reduce energy costs. The HEHs then installed relevant measures that could potentially reduce energy costs and improve comfort. Participants also received a Power Savings Plan specific to their energy use.

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Standard Home Upgrade

All participants in approach one received a Standard Home Upgrade (SHU). The types of measures undertaken as part of an SHU varied according to the individual household's needs. Participants involved in the GBS project who received an SHU were [originally] eligible to receive:

- draught proofing on the front and back door
- door snakes
- draught proofing on windows
- fridge/freezer seal check/replacement
- eco-switch
- thermometer
- energy efficient light bulbs
- flow restrictors
- water efficient showerhead
- shower timer
- insulation on the hot water tank (cylinder)
- insulation on the hot water tank pipes
- insulation in the ceiling
- curtains.

Not all upgrades were conducted in each house. HEHs would assess what was needed house by house.

The types of advice that householders were given regarding behaviours to improve energy efficiency and thermal comfort included the following suggestions:

- shorter shower times
- running appliances (such as washing machines) during cheap energy periods
- ensuring that the fridge/freezer is mostly full for maximum efficiency
- opening and closing curtains depending on sunlight and outdoor temperatures
- turning heaters off when no one is home
- hanging blankets or curtains in doorways where there are no existing doors
- using door sausages

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High Needs Upgrade

At the EDUG visit, the HEH determined whether the household was eligible to receive additional energy efficiency measures. A household was eligible for a High Needs Upgrade (HNU) based on a rating system (see Table 8-3)

Table 8-3Questions to assess high needs

High needs questions	A
Questions of Household: How would you describe your level of health over the past 12 months? From 1 to 5 with 1 being good and 5 very poor health	
Questions of Household: Do you feel that being cold in your house has effected your health? From 1 to 5 (1 = not at all, 5 very significantly)	
ASSESSOR High Needs Health ranking (1=OK health to 5 =high health needs)	
WOULD "High Needs" upgrades improve health conditions 1= marginal improvement to 5 = significant improvement	
MULTIPLY the two numbers above, if >15 high needs	
RECOMMENDED AS HIGH NEEDS (Y/N)	
Why Assessor recommends as high needs (free text)	

Initially, the HEH was required to rate the household in terms of

- the susceptibility of occupants to ill-health due to cold, and
- the likelihood that the household would experience a substantial thermal improvement from additional measures.

As the project progressed, these criteria were adjusted to also include recommendations based on:

- other occupant health concerns, and
- vulnerability to financial hardship.

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The types of upgrades that were available for people described as high needs included:

- roof and floor insulation
- curtains and pelmets
- additional draught proofing
- rugs and carpets
- sealing exhaust vents where appropriate
- retro fit double glazing
- replacement seals on fridges or freezers.

8.2.4 Approach two: Community Capacity Building (CCB)

The second approach, Community Capacity Building (CCB), involved two distinct phases. Phase one involved building the capacity of local Energy Champions. Phase two involved building the capacity of the neighbouring Clarendon Vale and Rokeby (CVR) communities.

Phase one of CCB: Building capacity of Energy Champions

The first phase of CBB entailed employing a Community Engagement Officer (EO) (0.4 FTE from Oct 2013 to Dec 2014) and 12 community representatives as Energy Champions (ECs) (paid on casual basis from Nov 2013 to Nov 2014). The role of the CEO was to recruit the ECs and to support them to develop a community engagement program and raise awareness about GBS and energy efficiency.

On joining the GBS project, the ECs received training in energy efficiency and communication from experts in these fields. As part of this training, the ECs were involved in some practical exercises in order to develop their knowledge and skills. The EO also facilitated a number of workshops that familiarised the ECs with what community capacity building entails and how to run a community engagement strategy.

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In order to extend their understanding of home energy saving, all ECs received a standard home upgrade in their own homes – some also received a High Needs Upgrade. This increased the ECs' understanding of the GBS project and objectives, practical measures to reduce energy use and improve thermal comfort, and the effectiveness of energy efficiency measures.

Phase two of CCB: Building capacity in the local community

The CEO and the ECs met regularly during early 2014 (March – June) to develop a Community Engagement Strategy. During this stage the ECs were supported to make a video about the GBS project and their role in the project. A professional artist also drew cartoon images of the ECs to be used in individual case study promotion. The ECs also worked with the CEO to develop a calendar of home energy community events and activities.

The CEO then supported the ECs to run community events and to raise awareness about GBS in the Clarendon Vale/Rokeby community over a six month period (Jun – Dec 2014).

Activities the ECs were involved with included:

- recruiting people into the GBS study
- distributing the Stay Warm booklet to householders
- developing a calendar of community events
- hosting BBQs and information sessions at neighbourhood centres and the community shed
- staffing stalls at community events, the community centres and other public locations within the CVR area
- organising and running sewing workshops
- organising hardware shopping tours
- organising and staffing a quiz night
- door-knocking homes in the local area to raise awareness of the GBS project, support the research component of the project, and to engage with householders
- organising and running home energy efficiency parties (modelled on the Tupperware approach).

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8.2.5 Approach three: Home Education and Upgrade & Community Capacity Building (EDUG + CCB)

This approach is a combination of the first two approaches described above and occurred in the Clarendon Vale and Rokeby suburbs as the community activities were being run there.

8.3 Consortium members and responsibilities

8.3.1 Mission Australia

Mission Australia was responsible for the overall project governance. Key responsibilities were to conduct review and quality assurance of project reports, convene the project steering committee, disperse funds, liaise with the Federal Government and undertake overall contract management.

8.3.2 Sustainable Living Tasmania

Sustainable Living Tasmania (SLT) was responsible for the delivery of the GBS project. Key responsibilities were to develop the project plan, compliance plan and risk management, prepare project financial reports, undertake energy efficiency education and upgrades, coordinate the community capacity building program, including providing training, draft and finalise reports on project progress, draft and finalise final reports and collate and analyse billing data.

8.3.3 University of Tasmania

The University of Tasmania (UTAS) was responsible for the evaluation of the GBS project. Key responsibilities were to develop the research plan, ensure compliance with participant confidentiality and privacy issues, obtain ethics approval, undertake primary data collection, including surveys, interviews and participant observation, collate and analyse billing, household and energy efficiency data, draft and finalise final reports, and archive datasets.

8.4 Roles and responsibilities of GBS project staff

8.4.1 Project management and administration

In order to manage and implement the GBS project, a project manager was employed by SLT throughout the duration of the three year project (1 June 2013 to March 2016). The project manager was responsible for project governance and liaison between consortium members, project management, recruitment and management of GBS staff, including the project officer (see below), EO and HEHs, liaison with government and LIEEP stakeholders, media engagement, electricity billing data collection, risk management, compliance and reporting.

A GBS project officer was also employed by SLT from 1 August 2013 to March 2016. The GBS project officer was responsible for the day to day management of the project promotion and media engagement, training the ECs, recruitment of and communication with GBS project participants, coordination of home visits, liaison with the research staff and evaluation program and reporting.

The complexity and scale of the GBS trial meant that there was a significant amount of administrative work associated with project implementation. A database was used to record participant details and track their progress through the project. SLT employed casual staff to design and manage the database, manage mail outs, field project inquiries, book appointments and communicate with project participants.

SLT with assistance from the consortium, developed a risk management plan. The plan included risks under the categories of: program governance, project management, workplace safety, project set up, approvals, recruitment and community engagement, participant retention, landlord permissions, data management, data logging, data analysis. SLT closely managed risks and reported potential problems to the rest of the consortium. On occasions where the strategy was needed, it was implemented effectively and challenges were safely addressed.

8.4.2 Home Energy Upgrade approach

To implement the in-home education and upgrades, Home Energy Helpers (HEH) were employed by SLT on a casual basis to provide in-home energy efficiency education and upgrades to GBS project participants. A range of

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contractors were engaged to supply and install insulation, lighting, curtains and extractor vent covers in eligible houses. Some participants also received maintenance services as part of the High Needs Upgrade.

8.4.3 Community Capacity Building approach

A Community Engagement Officer (EO) was employed (from 1 Oct 2013 to 1 Dec 2014) to coordinate and implement the CCB approach in Clarendon Vale and Rokeby. The EO was responsible for project promotion in CVR, recruiting ECs, supporting the ECs to undertake energy efficiency and communication training, and supporting the ECs to develop and implement a community engagement strategy.

Community representatives were employed by SLT on a casual basis as ECs within the CVR community for the GBS project. ECs were required to undertake energy efficiency and communication training, contribute to the development of a community engagement strategy, deliver community activities (centred on energy efficiency and thermal comfort), raise awareness of the GBS project in the community, and assist with recruitment of participants to the GBS project.

HEHs were also employed by SLT on a casual basis to deliver energy efficiency training to the ECs as a part of the CCB approach.

8.4.4 Evaluation

Evaluation of the GBS project was conducted by UTAS researchers. The team included a research Supervisor (employed from 1 June 2013 to March 2016), a Research Fellow (o.5 FTE employed from 1 June 2013 to March 2016) and a secondary Research Fellow (0.4 FTE employed from 1 April 2014 to March 2016). The research team were responsible for evaluation design, managing CSIRO data requirements, conducting BEFORE and AFTER surveys with all project participants and BEFORE and AFTER interviews with detailed study participants and ECs, observing community events, liaising with research stakeholders, data analysis and reporting.

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A key part of the GBS evaluation involved monitoring energy use, temperature and humidity in a group of participant homes (in what is titled the detailed group). RED Sustainability Consultants worked in conjunction with UTAS for this component of the research. RED were responsible for installation of temperature and humidity loggers in homes, collection and analysis of logger data. A qualified electrician was employed for the installation and removal of the loggers.

Table 8-4 Summary of GBS project staff

Key staff	Organisation	Employment status	Duration (months)	Area of responsibility
Project manager	SLT	Part-time	34	Project management
Project officer	SLT	Part-time	24	Project management
Administrative Officer	SLT	Casual	34	Administration
HEH	SLT	Casual	14	EDUG
CEO	SLT	Part-time	18	CCB
EC	SLT	Casual	14	CCB
Research Supervisor	UTAS	Part-time (0.1 FTE)	34	Evaluation
Research Fellow	UTAS	Part-time (0.5 FTE)	34	Evaluation
Research Fellow	UTAS	Part-time (0.4 FTE)	23	Evaluation
Sustainability Consultant	RED	Part-time	34	Evaluation
Electrician	Self-employed	Casual		Evaluation
Other contractors	Bradfords Decorama Lights & Lamps Smithy's Maintenance	Casual/contractors		EDUG

8.5 Methods for assessing organisational processes

8.5.1 Consultation with project staff

This report is primarily based on consultation with project staff involved in the implementation of the GBS project. The views of project staff were elicited through interviews, evaluation forms and/or written correspondence.

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Participants included the program manager, the project officer, the Home Energy Helpers, the Community Engagement Officer, and the Energy Champions. The format and date of feedback is detailed in the table below.

Table 8-5 Consultation with GBS staff

Role	Feedback format	Date
Project manager	Written correspondence	28 Oct 2015
Project officer	Interview	25 Feb 2015
Community engagement officer	Interview	16 Dec 2014
Home energy helpers	Written correspondence	3 Feb 2014
	Written correspondence	4 Feb 2014
	Written correspondence	5 Feb 2014
Energy champions	Workshop and training evaluation (anonymous)	18 Dec 2013
	Interview	8 Dec 2014
	Interview	8 Dec 2014
	Interview	15 Dec 2014
	Interview	15 Dec 2014
	Interview	16 Dec 2014
	Interview	17 Dec 2014
	Interview	22 Dec 2014
	Interview	21 Jan 2015
	Interview	22 Jan 2015
	Interview	27 Jan 2015

The report also draws on insights about the EDUG and CBB approaches from participant observation at home visits and community events. The activity and the dates of participation observation of the GBS project are detailed in the table below.

Table 8-6 Participation observation of GBS activities

Community event	Date
Door snake making workshop	13 Oct 2014

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Information table at child and family centre	18 Oct 2014
HEH community presentation	3 Nov 2014
Home upgrade x 2	15 Oct 2014
Home upgrade	4 Dec 2014

Where relevant, some insights are drawn from AFTER surveys and AFTER interviews conducted with GBS household participants. A description of the AFTER survey method is detailed in The Bulk Study: Bulk comparative assessment of approaches. A description of the AFTER interview method is detailed in The Detailed Study of effects of GBS approaches.

8.5.2 Evaluation framework

This report examines the GBS project from an organisational perspective. We ask four key questions:

1. What were the capacity and constraint issues experienced by participating organisations?
2. What were the key successes and challenges associated with implementing the GBS project?
3. What impact did participating in a national trial evaluation have on project implementation?
4. What were the key lessons for future low income energy efficiency projects?

The discussion of findings is organised around the following themes:

- organisational capacity
- organisational constraints
- implementation successes
- implementation challenges
- impact of research on approaches
- key lessons that have emerged from the experience of project implementation

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8.6 Evaluation of Home Education and Upgrade approach

As detailed in section 8.2.3, the EDUG approach entailed home visits which were undertaken by two qualified Home Energy Helpers (HEH). At EDUG visits participants received

- education about home energy use and thermal comfort,
- a copy of Your Guide to Staying Warm and Saving Money booklet,
- an energy audit of the house,
- a ranged of energy efficiency upgrades (see 1.2.1), and
- a Power Savings Plan specific to their energy use.

A home visit and upgrade took approximately 2 hours. While the upgrade was typically performed in one visit, in some situations additional upgrades were installed at a later date (see section 1.2.1 for a list of standard and high needs upgrades).

In 2014 and 2015, the GBS project delivered 249 Standard Home Upgrades (SHU) to low income households, 164 in Greater Hobart and 85 in Clarendon Vale and Rokeby. Ninety-eight of these households were identified by the GBS team as high needs based on the HEHs assessment of their house quality, financial situation and personal health and the potential impact of the upgrade on thermal comfort. In addition to the SHU, these households received a High Needs Upgrade (HNU), which involved higher cost energy efficiency measures than available through the SHU, such as insulation and window coverings.

8.6.1 Organisational capacity

SLT was well-placed to deliver the EDUG approach. Prior to GBS, SLT had facilitated over 4000 energy efficiency upgrade visits to households in low income areas in Tasmania. SLT staff therefore had extensive experience managing this type of approach and were able to overcome known barriers by designing specific processes into the home upgrade approach.

For GBS, SLT employed experienced HEH staff who they had worked with before. These HEHs had experience at both the home visits/upgrades aspect and also at working with low income households. SLT was also able to use

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contractors they had worked with before for some of the outsourced high need upgrades (like insulation and curtains).

Their previous home upgrade work also provided a sound understanding of what protocols were needed, what risk issues may arise, and education approaches that were likely to work during the GBS upgrade visits. For the education component of the home visits SLT updated and tailored a household education booklet they had previously developed, called Your Guide to Staying Warm and Saving Money (see Appendix 1).

Private rental tenants are traditionally challenging to engage in home upgrade activity because of split incentives tenant/landlords and other well documented issues. SLT knew about these engagement challenges because they had (also) previously worked with private rental tenants in programs. SLT therefore knew that any program aiming to engage private rental tenants had to ensure there were processes that allowed direct communication (on behalf of tenants) with landlords, especially when permission needed to be obtained for upgrade work.

8.6.2 Organisational constraints

While the scale of the upgrade delivery program was lower than previously experienced by SLT, the administrative process of delivering the HEU approach was also more complex due to substantial data collection and reporting requirements. For SLT to deliver the HEU approach as part of a major research trial required development of new systems to recruit participants into the GBS trial and track their progress through the project. SLT developed a new database and employed additional casual staff to manage this additional administrative work.

SLT did not have the capacity to undertake all the upgrade work. They were reliant on contractors to install some energy saving upgrades (e.g. ceiling and floor insulation and curtains). In order to monitor quality of contract work, SLT organised a random audit of upgrades. While SLT provided direction to contractors about the work required, the quality of contractor work varied. In addition contractors' understanding of energy efficiency varied which sometimes limited their understanding of the aim of the installations (for example that curtains were for improving thermal performance). Contractors' knowledge of energy efficiency therefore cannot be assumed and clear direction by the program is therefore very important.

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8.6.3 Implementation successes

The EDUG approach was successful, with 249 home upgrades performed. In addition home upgrades were conducted with no major incidents occurring.

Householder experiences of HEU were monitored through:

- audits of (12 of) the households who received insulation,
- random audits of a number of households by an experienced (retired) HEH,
- post GBS activity interviews with participants (25 participants), and
- post GBS activity surveys with participants (200 participants).

The independent audit results conducted by Building Evaluate[16] indicated that the insulation had been installed to an "average-good" condition. There were no safety issues noted in the audits.

The bulk survey responses and interview transcripts of households who received the EDUG highlighted a positive overall experience. For example:

I received ceiling insulation which I feel was a wonderful gift. Thank you very much for this project!! (GBS612 after survey, 2015)

The GBS project team also received unsolicited feedback from participants about the EDUG experience. Sixteen participants contacted SLT to thank them for their work and to comment on how helpful the HEHs who visited had been. For example, one participant called to say:

[16] Building Evaluate are licenced building inspectors and energy efficiency experts.

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It was lovely to have [the HEHs] here, they did such a good job. They did a marvellous job, they got me thinking of all the contractors that I've had here before and the Get Bill Smart team were so much better!

Another wrote a card to say:

Thanks so much for doing the energy upgrades to my unit. I'm really impressed.

One challenge for HEHs is developing goodwill, and trust, with householders in a short period of time at the beginning of home visits. HEHs need to achieve some repour with householders because they closely assess participants' homes, make actual upgrades, and need to gain their attention when they provide advice on how to improve energy efficiency. Having a person looking through their home and being offered advice can be unsettling for householders, particularly when they feel they are managing well and doing the best they can. It was a credit to the HEHs that the majority of comments were positive:

All good. Everything was carried out without fuss and bother to the running of house. (GBS019 after survey, 2015)

The very friendly and helpful team that came to my home. The efficient way they worked through my house. A very positive experience. (GBS482 after survey, 2015)

They were very friendly and helpful around my home. (GBS513 after survey, 2015)

One participant commented that "I didn't feel judged" (GBS135 after survey, 2015). Another noted:

Representatives were happy and cheerful – they didn't talk down to you or judge the appearance of the home. (GBS243 after survey 2015)

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However, when dealing with large numbers of households (living in a range of situations) it can be difficult to find the balance between getting the job done and ensuring that people are comfortable with all aspects of the upgrade. One participant found the advice "***a bit patronising***" (GBS593 after survey, 2015) and another, who had appreciated the upgrades, was disappointed to note that "***the lady [who] did the upgrades [was] pompous***" (GBS347 after survey, 2015).

Worth noting also are the relationships built with local Tasmanian and Australian businesses. Contractors were employed to install insulation, make and install curtains, and provide HEHs with upgrades materials.

8.6.4 Implementation challenges

Key implementation challenges are described below under four themes: the duration of home visits; the intensity of the home visits, the tension between tailored responses and maintaining consistency and fairness; and, the challenge of reversibility and choice.

Duration of home visit and upgrade

The duration of the home visit and upgrade was an issue raised by both HEHs and household participants. The HEHs observed that a 2 hour visit was not sufficient in some instances to deliver education about home energy saving and thermal comfort, as well as perform home upgrades adequately. However, the HEHs also recognised that some participants felt overloaded by the information provided in the single 2 hour session. HEHs expressed concern that scheduling visits that potentially run for over two hours might reduce program participation. One suggestion from the HEHs was to provide the participant with the Your Guide to Staying Warm & Saving Money booklet prior to the visit to enable them to absorb the information and to prepare any questions.

From the participants' perspective, the main concern was that they had not anticipated that the home visit and upgrade would take such a long time or require them to make some quick decisions. One participant, who was very pleased with her upgrades, wrote: "***A small shortcoming: From the info I read in the paper, I hadn't realised how much they were able to do, so I wasn't prepared for decisions or questions covering it all***" (GBS593 after survey, 2015). While participants were advised that the visit could take up to two hours when appointments were made,

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they were still surprised by the length of time the HEHs spent in their home and the range of measures being undertaken. In some instances, participants opted to cut short the home visit due to other commitments. SLT made a significant effort to communicate to participants in a variety of forms (over the phone, in all recruitment information etc.) that visits would take up to two hours. Given that many participants were still surprised at the length of the visit it would be worthwhile taking extra steps to explain *why* such a lengthy visit might be necessary. Any organisation running a similar activity needs to be prepared for mismatched time expectations between parties.

Intensity of the home visit and upgrade

While the HEU approach was highly valued by participating households, this approach was not suitable for all households. Some private rental tenants were unable to get permission from their landlord to participate. Others renters who were able to get permission felt limited in their capacity to make changes given they were tenants:

[I'm] frustrated that I can't make changes that would make a real difference because I don't own the house and I haven't any money for proper window coverings (GBS475 after survey, 2015).

While SLT took a lead role in contacting landlords to request permission and explain the benefits of the home visits, in some instances permission was still declined (by landlord or the tenant) due to concerns about risk and lack of interest. Other households who were keen to be involved in GBS explicitly requested that they be excluded from the EDUG group for a range of reasons: some felt unable to commit the time to a two hour visit, some had a preference for a less intensive form of involvement, some were wary of landlord reactions (such as eviction or increased rent) and some wanted to urgently access the grocery vouchers that were available to other approach groups due to personal hardship and crisis.

Tailored approach versus consistency and fairness

A strength of the EDUG approach was that HEHs could provide tailored solutions and suggestions to participants that responded to their individual housing situation. At times, however, there was some tension between providing a tailored response and consistency in program delivery. Some participants were confused that they had not received some measures when others did. This situation arose most obviously in the third approach group (EDUG + CCB) in the trial site, Clarendon Vale and Rokeby, where neighbours and friends were talking about their experiences and comparing their involvement.

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Some inconsistency also arose in EDUG visits when HEHs were not sufficiently stocked with equipment to undertake all upgrades measures, possibly due to the challenge associated with delivering a large number of upgrades in a short period (GBS099, GBS085 surveys, 2015). For example, in one instance the HEH insulated the hot water tank and pipe, but did not have a valve cosy available. The HEH was able to improvise by making use of insulating tape to cover the valve (GBS357 survey, 2015). In other situations, the household may not have received some equipment such as an eco-switch or shower-timer simply due to lack of stock.

In determining basic upgrades versus high needs upgrades there was a lack of clarity around who qualified for what. HEHs had criteria by which to judge high needs on but this was often still a very subjective process. To ensure this was fair, a more robust measure of high needs needed to be developed.

There was more consistency in the educational component of the home visit. While the consistency was useful, there were sometimes issues because the education booklet assumed a certain basic level knowledge about energy efficiency. GBS EDUG visits were aimed at households who, it was assumed, would have low energy literacy and limited capacity to use to make energy efficiency changes in their homes. In general this was a reasonable assumption. Some participants were far more knowledgeable about energy efficiency and had capabilities that could help them make change. Some participants felt that the HEHs did not take the time to find out what they knew about energy efficiency and delivered information that was already familiar to the participant.

A HEH also observed that the EDUG was delivered to a household without the direct involvement of the householder (HEH, 4 Feb 2014). The HEH felt that where there was capacity and interest from householders to be more involved in the upgrade process and that it would be valuable to involve the householder as this builds 'know-how' about the home.

Reversibility and choice

Householders expressed dissatisfaction with some of the Standard Home Upgrade measures. Some participants expressed dissatisfaction with the compact fluorescent lights (CFLs) due to the quality of the light (GBS015, 31 Jan 2015; GBS099, 06/02/2015) or the lights flickering when turned off (GBS135, 16/02/2015). The flickering CFLs created

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some anxiety for households who were concerned that this was an electrical fault (for example, GBS133 after survey, 2015). Others were dissatisfied with the installation of draught-proofing (GBS029, 30 Jan 2015) or the pressure of the water efficient showerheads (GBS100, 06/02/2015).While in some instances households contacted SLT to arrange to have measures fixed, other households went ahead and made the changes themselves (GBS015, 31/01/2015).

However, this capacity to reverse any unwelcome changes that occurred during the upgrade was hindered by the protocol of HEHs disposing of incandescent bulbs when installing the new CFLs:

Upset that the Home energy helpers threw away light globes!! (GBS021 after survey, 2015).

The guy who installed all the light bulbs put the old ones straight in the wheelie bin! Total waste. We took them out and put them back in the cupboard (GBS583 after survey, 2015).

SLT explained that ***keeping light bulbs on site totally goes against energy efficiency - they need to be removed so that the change actually is permanent*** (SLT pers. comm. March 2016). While this is a solid approach from an energy efficiency perspective, it is worth considering two things: 1) the expense that a low income person will have to go to in order to replace a dysfunctional bulb, especially if they feel unable to complain to an organisation that they either see an authority figure or one to whom they owe a favour and 2) it may be offensive for low income people to watch perfectly functional items being discarded.

From an organisational perspective dysfunctional equipment does create a risk to the success of EDUG processes as it can undermine people's confidence in energy efficiency measures and, in turn, undermine future household engagement and investment in energy efficiency.

8.6.5 Impact of research on GBS activities

The GBS research trial did have some impact on the delivery of the EDUG approach. Paperwork and early exposure to the energy efficiency questions were the main issues. Participants were required to return privacy statements,

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ethics forms and a comprehensive pre GBS activity survey before upgrades could occur. Some HEH visits were delayed due to the lengthy process involved in acquiring project paperwork from participants. This had a minor impact on the availability of HEH who anticipated that the upgrade work would be undertaken over a two month period rather than spread out over nearly 6 months.

Energy efficiency was, in some cases, brought to the fore of participant's minds when they went through the privacy forms and surveys. This awareness led to some householders saying to HEHs at the beginning of their visits that they had already gone through energy efficiency 'stuff'. This was a curious but not really surprising side effect of the research devices.

8.6.6 Key Lessons

The EDUG approach is a well-practiced approach to energy and comfort behaviour change and an approach that SLT was very comfortable delivering. The following key lessons should be understood in this light.

Previous experience with home upgrades ensured many barriers were identified and dealt with in early project design and that householders overall were happy with their interactions the HEHs at EDUG visits.
There are staffing and administrative challenges associated with delivering a large-scale energy saving program for small-scale organisations.
The intensity and duration of home visits did not suit all households, including some private rental tenants and people experiencing personal hardship and crisis.
Clearer communication of the duration of the home visit to participants is required.

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There needs to be clarification of guidelines, in order to address tension between tailoring the home visit and upgrade and ensuring consistency in program delivery.
The criteria by which high needs upgrades will be assessed needs to be clarified in detail early, prior to program delivery.
Contractors' knowledge of energy efficiency cannot be assumed and clear direction as to the intent of the upgrades should be shared with them.
Audits and quality checks were useful and allowed identification of problems and iterative improvements.
There is a need for householders to make informed choices about upgrades and for householders to be able to reverse upgrade measures if required.
A non-judgemental approach to delivering education and upgrade is valued by participants.
There is great variability in the energy literacy and capacity of participant households. The current approach does not allow participants with capacity and interest to be directly involved in installing energy saving measures. This is a missed opportunity for participants to gain energy saving "know-how".

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8.7 Evaluation of CCB approach phase one: Building capacity of Energy Champions

As discussed in Section 8.2.4, the CCB approach involved two distinct phases: building the capacity of local Energy Champions, and building the capacity of the neighbouring Clarendon Vale and Rokeby communities. In this section, we evaluate phase one and phase two of the CCB approach from an organisational perspective.

8.7.1 Overview

Phase one of the CCB approach involved:

- recruiting an Community Engagement Officer (EO) and local Energy Champions (ECs),
- training and skill development of ECs, and
- providing ECs with home upgrades (standard and high needs).
- These activities were undertaken between August 2013 and March 2014 (see Section 8.2.4).

8.7.2 Recruitment of CEO and ECs

The first phase of CBB entailed employing a Community Engagement Officer (0.4 FTE from Oct 2013 to Dec 2014). The role of the EO was to recruit 12 community representatives to be the Energy Champions and to support them to develop a community engagement program and raise awareness about GBS and energy efficiency. The ECs were paid on a casual basis from Nov 2013 to Nov 2014.

Formal recruitment began with the advertisement of community information meetings through:

- an advertisement in Clarence Plains Talking, a local community newsletter, distributed to every household in CVR (2,100 copies)
- advertisements in other community newsletters (e.g. produced by schools, neighbourhood centres)
- posters put up in shop windows
- posters put up in service provider windows
- a newly-created GBS Facebook page.

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The CEO met with a large number of community service providers (including neighbourhood houses, youth centres, local schools, local churches and real estate agents) about the project and possible recruitment activities.

8.7.3 Organisational capacity

While SLT had experience working with low income households and presenting individual workshops, they had not undertaken community capacity building work at this scale before. From previous experience SLT knew that community capacity had the potential to work at this scale, but had as yet not had a chance to trial their ideas. They employed the EO and ECs specifically for the GBS project.

8.7.4 Organisational constraint

The original intention of the GBS project was to recruit both the EO and the ECs from within the CVR population. Following delays in securing funding, the project timeframe was pushed back and as a consequence there was an unexpectedly short time frame for recruitment. This had implications for the range of candidates considered for the positions.

A key drawback for the project was that the GBS project manager was unable to recruit an EO from within the trial site. This was due to lack of interest in the relatively short period of time for which the position was advertised. The EO was, instead, selected (from outside CVR) for her experience in undertaking community engagement. Unfortunately, the EO then had limited time to embed herself in the CVR communities. As one of the ECs explained:

[The EO] was good. She's friendly but you could see she was working to an agenda and that was fine. But within that Neighbourhood House, this is a concept the Neighbourhood House should have come up with so that it actually became owned by the community long before [the EO] turned up (GBS007, 03/04/2014).

The EO was responsible for recruiting 14 ECs to the project. While the positions were advertised in local media and the EO tapped into existing service providers to identify potential recruits, only 25 applications were received. Of these, 20 progressed to selection interview stage. Eight out of the 20 interviewed where either not suitable, not

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eligible, or decided against participation. The remaining 12 were recruited. While it was anticipated that ECs would be selected based on their eagerness to be involved, level of involvement in the community, communication skills, capacity to understand energy efficiency, and the diversity they brought to the project, in practice, due to low levels of interest, the ECs were selected for their availability and interest, rather than their skill-set or community action experience. The first selection interview was held on 12 September 2013, and the last selection interview was held on 1 November 2013.

8.7.5 Implementation success

In relation to recruitment, the key success factor was that the EO was highly committed to the project and she remained in the position for the entire period that community capacity building was being conducted. She provided leadership and support to the ECs, with many stating how much they appreciated her work:

[The EO] was great! She was amazing! And she taught us everything, you know if it wasn't for her then we wouldn't have been out there (GBS002, 21/01/2015).

Among the ECs, there were varying degrees of commitment and participation. One EC moved out of area and was no longer able to participate and one EC had serious health issues which significantly limited participation.

8.7.6 Implementation challenges

Surveys of those people who became ECs suggest that the advertisements in local newspapers and community newsletters were not effective recruitment methods. Most ECs heard about the project through brochures and leaflets or via word of mouth from others involved in the project

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There were several applications from people who lived in Mission Australia housing[17]. Although advertisements included eligibility criteria (which Mission Australia residents did not meet), people were confused by the inclusion of the Mission Australia logo on the advertisements. Details of these people were not recorded. Similarly, two very keen and suitable people were living in Red Shield rental housing[18]. The EC recruitment process was started with these people until it was established that as Red Shield manages houses for Housing Tasmania, and due to government funding limitations their tenants were not eligible to participate in GBS. This artificial constraint was detrimental and sent out a problematic message to the CVR community.

Table 8-7 (below) outlines the key strengths and weakness of the various recruitment strategies and a more detailed discussion follows.

Table 8-7 Review of recruitment strategies

Recruitment strategy	Strengths	Weaknesses
Word of mouth/service providers informing people of the GBS opportunity	The most successful recruitment strategy. This worked particularly well through the Clarendon Vale Neighbourhood Centre Coordinator. This was particularly successful with the presence of the Community Engagement Officer	Recruitment low on the list of priorities for service providers without EO present. Time intensive for EO having to spend a lot of time with service providers.
Pamphlets/fliers	A useful recruitment strategy. The community meeting was advertised with a flier in the community newsletter, and resulted in the recruitment of several ECs.	The risk of getting people offside through advertising overload and 'junk mail'. The fliers were 'wordy' and may not have caught interest.
Community meetings	Community meetings on 10 Sept 2013 and resulted in the recruitment of four ECs who applied successfully.	These meetings were poorly attended (a total of nine people) as a result of insufficient EO time in the community in

[17] LIEEP funding for GBS excluded government owned housing. Mission Australia manage, and are gradually transferring ownership of government housing in the CVR area. The LIEEP requirement meant that a large number of householders who lived in government-owned (and Mission Australia managed) housing in the area could not take part in GBS. The same issues occurred with Red Shield housing in the area – the housing was still government owned. This was a significant issue for GBS and limited the community members that GBS could engage with.

[18] Housing Tasmania is a state government run welfare housing organisation in Tasmania.

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		lead up to meetings. The EO found it hard to convince people about why they might like to become ECs.
EC snowballing	Not all ECs were interviewed or offered the position at the same time, the first four to be given positions were asked to help recruit applicants and this yielded three more ECs.	Recruitment of closely related people (friends/family), rather than diverse household involvement.
Community events/festivals	Stalls at a local festival generated a lot of interest and conversation about the project and recruited three ECs.	The display was static – more opportunities for interactions might have helped increase applicant numbers.
Real estate agents	One property manager herself lived in Rokeby was interested in being an EC (this fell through but was instrumental in the recruitment of another)	All bar one real estate agency were uncooperative.
Advertisements in community newsletters/newspapers	Potential for wide coverage of local households. Some expressions of interest received however these were from people who were ineligible.	The inclusion of the Mission Australia logo created confusion as to eligibility.
Facebook	(May have been a useful approach for recruitment once the project was up and running).	Did not successfully recruit Champions as too early in the project for this.

Problematically the EC recruitment process had to be conducted in a very short time frame which was the result of contractual delays and paperwork-constraints in LIEEP paperwork. Consequently there was very little time for investment in recruitment strategies or for word about the project to spread, giving little time for potential ECs to consider the project let alone respond. This short window for recruitment was not only stressful for the GBS team (a problem in itself), but meant that people were hurriedly chosen for ECs' roles that were actually fairly long-term commitments (15 months).

It is evident from Table 4.1.2 that recruitment was most effective when those promoting the project engaged directly with potential ECs. For example recruitment through community service organisations was far more successful when the EO was present. The time that the CEO spent with the service providers when other community members were present was vital for success.

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The enthusiasm, proactive approach and professional skill of the EO was pivotal in the recruitment of ECs. It was particularly helpful that the EO had a base (an office in the Clarendon Vale Neighbourhood Centre) within the community. While the CEO's professionalism was invaluable, employing someone from within the community for this role may further strengthen this position given that the recruitment process was significantly strengthened when strong personal relationships were utilised.

8.7.7 Energy Champion profiles

This section provides some illustration of EC capacity and household attributes. The information is drawn from surveys and interviews completed by the ECs. Their ages, tenure, education levels and household occupancy varied, which meant the group was reasonably diverse.

Of the 12 ECs, eight lived in Clarendon Vale and four in Rokeby. Ten were women and two were men. Their ages ranged from 29 to 74, with the majority over 45. Tenures varied. Nine of the 12 were home owners. Three of these were owner occupiers with no mortgage, five were owner occupiers with mortgages (one of these was paid off by the end of EC preparation), and one was buying their house through a rent-purchase scheme. The other three ECs were renting their homes. The EC who paid off their mortgage during the project reported having a notably changed outlook and practices after the mortgage was paid.

The 12 ECs had a range of educational experiences with the majority (10) having finished high school to year 12 (the final year of high school in Australia). Of these ten, two had TAFE or polytechnic course qualifications and three had a tertiary diploma or degree. Two ECs finished school at year ten.

The composition of EC households changed over the first few months. To begin with, there were five single parent households with dependent children, four couples with dependent children, and three single occupant households. One of the single parent households lived in a group share house. Seven of the households had at least one person with a chronic illness or disability and one of the ECs lived with someone who was chronically ill and required full-

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time care. During 2014 one EC moved from her house and out of the area due to domestic problems. Table 8-8 (below) provides a snapshot of the EC and participating household attributes.

Table 8-8 Champion and participating household attributes

Champion and participating household attributes	No. of participants
HOUSEHOLD COMPOSITION	
Single parent with dependent children	5
Couples with dependents	4
Single occupant household	3
LEVEL OF EDUCATION OF CHAMPION	
Tertiary degree or diploma	3
TAFE/ polytechnic	2
High school to year twelve	5
High school to year ten	2
EMPLOYMENT STATUS	
Households with at least one person working full time	3
Households with at least one person working part time	3
AGE OF CHAMPION	
Age <30	1
Aged >60	2
TENURE	
Home owned outright	3
Home owned with mortgage	5 (4 by March 2014)
Home rented	3

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Home being purchased under a rent/buy scheme	1
ILLNESS OR DISABILITY	
Households with at least one person with chronic illness/disability	7
Households with at least one person with chronic illness/disability requiring full time care	1

Consistent with the diversity of the group, there was a mix in employment status amongst the households. All the households had at least one adult involved in some kind of paid work; however for some, the EC role generated the only work-related income.

It is worth noting that of the 12 ECs, ten were significantly affected by health issues. These included having chronically sick partners or children, having significant personal problems with health (mental and physical) and recovering from life threatening illness.

Some of the ECs had existing skills in energy efficiency and community engagement. One person was a community support worker, one had good technical knowledge on energy efficiency, and one had previously lived in a self-sufficient house and thus fully understood energy and water efficiency from lived experience. At a less formal level, the ECs reported high levels of control and agency when it came to the management of their own energy bills and thermal comfort. Many explained how carefully they monitored their finances and energy use while others detailed practices of household management. For example many used rolled up towels or pieces of wood as draught stoppers, or had carefully thought out plans for their modifying their homes.

8.7.8 Training and skill development of Energy Champions

On joining the project, ECs began preparations for their community engagement role. They received training in home energy efficiency and communications as well as home energy upgrades.

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The description of the EC preparation program, the ECs' experience of these preparations and assessments of the success of the preparations are described below. The information in this section is based on the data described in section 2.1 of this report.

Workshops

ECs participated in seven training workshops in November and December 2013. As part of this training, the ECs were involved in some practical exercises in order to develop their knowledge and skills. The workshops were designed to educate and inform champions about effective thermal comfort energy efficiency measures, to support the development of skills that would help them to develop an effective community capacity building strategy and to prepare them for work in the community.

The EO, employed by SLT but situated in the Clarendon Vale Community House, was responsible for running training sessions and workshops. Training workshops covered

- key concepts in community capacity building,
- project objectives including strategy development,
- community and individual strength identification,
- asset mapping,
- brainstorming community capacity building activities using mind maps,
- barriers in community projects,
- home energy efficiency (what changes to make at home and why),
- recruitment and engagement activities,
- communication styles,
- ways to motivate community members, and
- behaviour change.

Workshops provided the opportunity for champions to reflect on their own skills, the skills and capacities available in their community and the needs and requirements of their community. The outcomes of training workshops informed the development of the community capacity building strategy.

The EO guided the development of the community strategy and wrote up the final document. It was obvious that her skills in community engagement, workshopping and communication were critical to the success of this process.

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The community strategy was followed closely throughout the GBS community engagement period. However, there was a periodic review of activities and adjustments were made to planned workshops according to learning when the ECs were out in the community.

8.7.9 Implementation successes

ECs valued the workshop and information sessions for a variety of reasons, primarily the opportunity they provided to learn new things including technical knowledge, opportunities for financial savings and social and communication skills.

Overall, training was reported by both the EO and the ECs to have been a positive experience (December 2013 training evaluations; EO evaluations of training; EO communication with researcher, 28 Jan 2014). The EO reported that most aims were achieved, that the ECs considered the information to be useful and that generally there was a noticeable camaraderie. The training was seen by both the EO and some ECs as important to help bring ECs up to speed and, for some other ECs, as a way to refresh their understanding of energy efficiency.

In evaluation forms filled out by nine ECs on their training workshops in December 2013, the workshops were rated well. On a rating scale of 1 to 5 (with 1 being very poor and 5 being excellent), with only a few exceptions all workshops were rated at either a 4 or a 5.

High levels of EC enthusiasm

At the completion of the workshops and training the ECs were excited and enthusiastic about the year ahead. As reported on the anonymous workshop evaluation forms:

> ***I have learnt things I have never known before, it has always been men's territory.***
>
> ***I have enjoyed all the sessions. And I am really enjoying this, and I'm very motivated and inspired to start.***
>
> ***Looking forward to next year.***

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I have really enjoyed this group I have learned so much already and can't wait to get out there and teach others.

Love the program.

Improved confidence and capacity of Energy Champions

ECs exhibited substantial improvements in confidence after the training workshops. This was noted by the EO and the ECs themselves:

> ***I think having an income has been a really big benefit for them but also picking up on, learning new information about energy efficiency, about how to communicate, about how to be professional in working in a group. There's a couple of people who have said that it has given them a lot more confidence whereas they never had the confidence maybe to stand in front of a group of people and talk about things.*** (EO, 16/12/2014).
>
> ***Well, confidence. Big confidence. I spoke at the forum that Rokeby High School had a couple of weeks ago. [Some of us] did a session on Get Bill Smart, so I spoke about how I found Get Bill Smart for me and Jane spoke about her experience and [the EO] just did a brief talk about what Get Bill Smart was all about and how it was run and stuff, so we just spoke to a group. And I said to them before, I wouldn't hardly say a word to people, and to be able to sit in a group and actually talk is a big thing, so confidence has been a big thing. Also, looking into jobs, like careers for me, I mean I'm back at TAFE and it's good to say that I've had some employment and that I've been employed through you and it's good to actually say that I'm a mum of three and I've actually worked for Get Bill Smart and this is what we're about.*** (GBS005, 08/12/2014).
>
> ***She'd [a fellow EC] come out with a speech and we all just went, "Where did that come from, she never speaks…" And that's the confidence that's giving people, that's what giving her confidence,"*** (GBS001, 06/03/2014).
>
> ***So we've just learnt so much, and it just gives you that, you know, like the barbeques, it was that easy to go up and approach someone and say, "Hey, you know, I'm Vanessa, I'm, you know, do you want to save some money, I've got ways"*** (GBS002, 17/03/2014).

At the completion of the training program one EC reflected: "***I'm pleased to be a Power Ranger***[19]" (GBS009, 06/03/2014).

[19] 'Power Rangers' was the name that the ECs chose to identify themselves as.

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Strong and trusting relationship between EO and ECs

The EO developed a strong relationship with the ECs. The ECs recognised the value of this role and the skill of the CEO. Over time, strong levels of trust developed:

She treats us all like we're all an individual, which is a good thing as well. It's amazing. She treats us all like we're all a different personality, not just oh you all come from... She realises and recognises all our experience and potential. And she's able to bring it out in us. (GBS001, 06/03/2014).

The EO successfully managed the diversity of personalities both within the training and later in the field, recognising that certain people were not capable of working with each other. To the credit of the EO a strong sense of team developed with feedback including, "***We just seem to work so well together***" (GBS002, 17 Mar 2014), and the rallying cry of, "***Go Power Rangers, go!***" (GBS002, 17/03/ 2014).

Development of the Community Engagement Strategy

The EO and the ECs successfully developed a community engagement strategy. This strategy and the calendar of events provided a solid framework for the roll out of Get Bill Smart into the wider CVR community. The intimate knowledge of the people and culture enabled a community engagement strategy that aligned well to the wants and needs of the community (see Milestone 4). Fundamentally the ECs knew the priorities of the community and this helped in the successful development of a community engagement strategy.

Direct experience of EDUG

In order to extend their understanding of home energy saving, all ECs experienced a Standard Home Upgrade and/or a High Needs Upgrade (as described in section 1.2.2). Eight ECs received insulation, and four received new curtains; a total of eight out of the 12 received HNUs. This increased the ECs' understanding of the GBS project and objectives, practical measures to reduce energy use and improve thermal comfort and the effectiveness of energy efficiency measures.

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The EC training and the Home Energy Helper visits were designed to complement each other, enabling ECs to learn the theory of energy efficiency and experience the benefits of energy efficiency in tandem. This training and experience approach aimed to provide champions with real and detailed understanding of the advantages of suggested physical and habitual changes presented in the GBS program. With this experience it was imagined they could more honestly 'champion' ways to achieve energy efficiency and thermal comfort in the community.

The combination of the education and in home upgrades was powerful for ECs.

It strengthened any belief I had in, whether... It actually resolved any doubt I had of whether I was doing the right thing or not, and in some cases I was and in some cases I wasn't. Therefore I must have learnt quite a bit from this program. I know I have but I can't specify in words. And when I look into it and I will actually write down one day when I'm thinking about things and I'm relaxed I'll think, what exactly specifically did I learn from this program. But whether that's necessary or not I'm not sure. I think it's resolved a lot of my doubts this program. I mean I just can't say enough about it. I think of all the things I've ever done and I have done a lot in my life, I mean you just wouldn't believe what I've done. The thing is and I'm not boasting is because I like a diversity in life. But this thing I could be stuck with because it's just unending what you could do with it. GBS001 06/03/2014)

8.7.10 Implementation challenges

Training did have some challenges. The EO reported that there was a lot of information to get through in a set time. Some ECs did not understand how to conduct themselves in a meeting or workshop, and group dynamics and some difficult behaviour (of a few ECs) in meetings meant that the EO had to make efforts to carefully manage them. The EO also reported that while she thought that any more than the seven weeks of meetings in one go would have been stretching the patience of the ECs, she did believe that more training would have been useful later in the program (once they were out and about in the community).

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Timing constraints

A key obstacle to successfully building the capacity of ECs was the limited timeframe available. Some ECs thought that more time was needed for the training, while similarly others thought that there was too much information all at once. As the EO clarified, it was not that the training had been pitched too high, but rather more time was needed for the Power Rangers to be able to effectively absorb the information provided.

Diversity of skills and personalities

The ECs' assessments of the training pointed to issues with people having varied levels of knowledge and skills which meant that training sessions did not suit everyone. ECs also mentioned that some problems were encountered due to group dynamics and a couple of clashing personalities. There were variations in tempers and capacities, and one EC noted that she had difficulty learning some of the technical and mathematical aspects of energy efficiency. Another EC noted her aversion to having to undertake role play early on in the training sessions – she thought the role play would have been easier later in the training session sequence.

It appeared that the different skill bases and knowledge bases of ECs meant that information shared at training was new to most ECs but not all. The EC who noted that training was boring and was slow to get going was one of the people well acquainted with energy efficiency information (although she also said that training was good). The other few people who were fairly knowledgeable on energy efficiency in homes felt the training was a good refresher. This mix of knowledge levels was hard for the EO to cater to.

Given the diversity of the ECs the EO suggested that some people may have benefited from more personal coaching, particularly in regards to communication skills. Had there been more time and money allocated not only could training have been more tailored, but refresher training courses could have been offered throughout the course of the project. Once ECs were actively implementing the community engagement strategy and trialling their new skills, further training to consolidate learning would have been beneficial. As it was, the EO was able to provide some personalised feedback to ECs which assisted in their capacity to undertake the project.

In anonymous feedback, comments from ECs varied:

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Some workshops were rushed.

Not enough time to cram in all this info.

[The EO] is too slow for us.

Sometimes [workshops and training] seemed a bit long.

One EC provided more detail about her concerns when interviewed:

I think the feedback that you need to know about the training sessions are, they were boring. Mainly because of the structure more than the content at times. And [the EO] would have been given a set criteria to work to so it's not her responsibility for that format, but it's very boring sitting for hours. So the way it was formatted should have been where, initially, there might have been a talking session about the aims and vision, and then a hands on thing. And then a discussion about the hands on thing, followed up by a further discussion of next step down the line. Because people who go to school and do learning, learning, learning are not working in a hands on environment. It's too paper led and the role was a hands on role. (GBS007, 15/12/2014).

Complex group dynamics

The diversity of EC personalities and capacities was challenging during EC training, the development of the community engagement strategy and during community capacity building in the community. The challenge caused by this diversity in capacity was identified as a significant issue by both SLT staff and some ECs. Managing such differences in skills and capacities was challenging for the EO, who had to carefully think about who she matched with which types of work. Different personalities had to be matched against different tasks and the capacities and temperaments of the other ECs.

ECs' evaluation of training picked up group dynamics as the biggest barrier to the success of the CCB approach. In particular, evaluations mentioned meeting interruptions due to people not turning on off phones or needing to manage children they had brought along, and people talking over each other. GBS005 (08/12/2014). noted that "***people still developing skills for group appropriate behaviour".*** GBS001 (after interview 06/03/2014) said that "***group members should take training more seriously***". Another EC explained: ***I think professionally, [the EO] needs to toughen up, especially when it came to meetings. We all agreed upon the rules from day one, and yet***

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continuously there was issues with the rules not being followed; people complaining about it and it just continuing on and on and on. To the point where it did start to cause tension, even between the workers (GBS011, 15/12/2014).

The EO explained that, despite protocols having been established by the group for meeting etiquette, because of the different personalities and the inability of many in the group to conform to appropriate behaviour in the meetings (e.g. talking one at a time, not answering mobile phones etc.) some tension did develop amongst the group. Many ECs also acknowledged this tension and how difficult it was for the EO:

"We all agreed upon the rules from day one, and yet continuously there was issues with the rules not being followed; people complaining about it and it just continuing on and on and on. To the point where it did start to cause tension, even between the workers" (GBS011, 15/12/2014).

Other issues raised included uncertain and different goals and aims, a lack of focus, differences in learning styles, lack of practical training, and different base levels of knowledge and skills. Tensions also emerged between ECs over who was given what work and whether the money was actually earned. As one EC explained: ***"I think a lot of money was wasted there actually paying people for doing nothing on the face of it"*** (GBS001, 06/03/2014). Also, ECs often failed to inform the EO when they could not attend events.

At times, the EO had to be particularly stern in her approach. For example one EC continually failed to submit their pay claims on time. After providing considerable flexibility for many pay cycles, the EO had no choice but to hold off paying this EC until the next pay cycle. With this action, the EO found that pay claims were then put in on time.

There were times when the EO did not feel it was strategic to be too stern. Given the limited number of ECs (12), the EO was perhaps more cautious in asserting her authority than she would otherwise have been. She explained that she couldn't afford to get any ECs offside and lose them from the program. As it was, two of the ECs moved out of area and several others were limited in their capacity to contribute.

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Confusion around project aims

Confusion around the project aims was another implementation challenge. As previously noted, the lack of time for clearly establishing the aims of the project and the different roles of the people involved was problematic. The diversity of skills and capacity of ECs also contributed to this confusion as did the very nature of the project. The aim of the CCB component of GBS was to work with CVR community members (the ECs) to develop a tailored approach to energy efficiency and thermal comfort. As a result Champions themselves were expected to contribute to the aims and process of the program. Unfortunately at times this lead to significant confusion:

Look, in all honesty I think that there has been a very high level of confusion. And it's not just me, I think the whole group feel that we're very unsure at the end of the day of really what we're – what is it that we're trying – like, we know what we're trying to do but how are we meant to be doing it? (GBS011, 17/03/2015)

Just a lot of confusion happening at the moment, we're all getting our wires crossed…. I think it's just because it's new, the next time it'll be easier to work out because you'll be expecting certain things and it's not just going, oh no, we've got this or we've got to do that. (GBS006, 21/03/2014)

[The worst thing about the training was] understanding where the group is going: while getting a strategy organised and agreed to. [It could have been better with] more focus on the outcome and group building. (Anonymous feedback on training and workshops)

In developing this project it was understood that ECs recruited from disadvantaged communities were likely to be disadvantaged in some way themselves. The other project staff worked from this understanding and acknowledged that while many were on disability support payments, were early school leavers or were entrenched in intergenerational poverty, local champions brought invaluable insight into the cultural context of their community. When those you employ are disadvantaged it is vital to understand the impact that this will have on capacity to work to certain expectations.

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8.7.11 Organisational capacity

SLT was well-placed to deliver energy efficiency and thermal comfort projects in low income communities. Prior to GBS, SLT had worked with a number of other low income communities around Tasmania and had experience with this demographic. SLT also employed an experienced EO who had previously worked in a community development capacity with low income communities in Tasmania.

The Clarendon Vale Community Centre provided an office space for the EO. Linking in with the Clarendon Vale Community Centre increased the capacity of the GBS project in four significant ways:

- The centre provided a physical space to house project paraphernalia (timesheets, information stands, energy efficiency gadgets, paperwork, workshop materials etc.).
- The centre provided a sense of local legitimacy for the project. According to survey data many people in the area feel comfortable accessing the services at the centre and participate in existing programs there.
- The centre provided a local workplace for the ECs.
- The centre provided opportunities for incidental interactions between the EO and the community. At the same time it allowed for the EO to immerse themselves within the community and learn about the wants and need of the community.

8.7.12 Impact of research on building capacity of Energy Champions

The research component of GBS did not impact significantly on the process of building the capacity of the ECs. The small impact of the research presence was considered positive as it provided more contact points for ECs and enabled them to feel supported, valued and important. Interviews provided opportunities for ECs to find out more about the project evaluation and project objectives.

8.7.13 Key Lessons

The CCB approach is in its early stages of development. SLT had previously never delivered such an approach to energy and comfort behaviour change. The following key lessons should be understood in this light.

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Ensure there is time for the Community Engagement Officer to embed themselves within the community and for word of mouth processes to work prior to commencing Energy Champion recruitment. Flexibility of contracts would allow for this to be adapted to community needs.
Although the training was generally a success, additional refresher, revision or consolidation sessions would be helpful once work in the community had commenced.
Champion input into goals and language of community engagement strategy and implementation was vital to success.
Champions need to feel ownership of the project, but they also require close support and mentoring, clarity around the terms and expectations of employment, and regular check-ins to identify problems and frustrations. Many of the people employed were not entirely workplace ready – a number were also receiving the disability support pension or were unemployed – and the extra time needed to effectively train and manage people in this situation needs to be taken into consideration.
The EO needs to have strong interpersonal capabilities in order to deal with and manage appropriately a variety of skill-sets, capacities and personalities among the ECs.
It is better to recruit people with appropriate skills and capacity to commit than to be bound to a particular number of recruits according to a funding contract.

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8.8 Evaluation of CCB approach phase two: Building capacity of local community

Phase two of the community capacity building approach involved the implementation of the community engagement strategy as developed by the Energy Champions and Community Engagement Officer.

CCB activities were to recruit and engage households in Clarendon Vale and Rokeby, to give them the knowledge required to make their own in-home energy efficiency upgrades, and to change behaviours that result in high energy bills.

ECs and the EO worked together to develop a timetable of community events and workshops (see Figure 8-2, Figure 8-3, and Figure 8-4). In this section we briefly describe each activity and note the strengths and challenges of each approach. The varying lengths of the discussions of each are primarily due to the nature of data available. The information comes from interviews with the EO and ECs. We have also drawn on records kept by the EO and the ECs, researchers' observations of events and relevant comments from the bulk surveys and the detailed interviews. It is important to note that written records for the ECs appear to be incomplete and as such the number of events and attendees are only approximate.

Community activities and events were promoted in the following ways:

- local community newsletters
- the GBS Facebook page
- text messages to research participants
- stickers on wheelie bins
- posters around the community (shops, schools, community centres, fence posts)
- GBS newsletter
- branded clothing for Energy Champions.

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The positive and recognised brand of GBS was important for project take up. ECs were visible in the community and their ‘brand’ was important. The EO explained:

And people are able to actually know who we were by identifying who we were by looking at them. And I think that that was great, having the uniform. And I felt really, "I'm in a uniform," kind of thing, so I – yeah, no, it was good. (GBS005 08/12/2014).

The ECs also had personalised case studies explaining their experience of the project (see Appendix 3) which helped to provide them with a certain legitimacy of experience within the community. The GBS branding also included artist impressions of each of the ECs and these were posted in the Community Centre and on information fliers.

As an incentive to participate in activities and to build on the branding of the project, the ECs developed a rewards star card. People could collect a star for every event they attended. Once five stars were collected participants could collect a prize from the EO (see Figure 8-1,below).

AFTER survey responses from CVR participants indicate high levels of GBS brand awareness within the community.

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Figure 8-1 Get Bill Smart rewards Card

BBQ 12pm Wednesday 26 March	**BBQ** 12pm Monday 17 March
Information Session: HEATING – how to keep warm AND save money 10.30–11.30am Monday 31 March	**Sewing Workshop: Learn how to make curtains** 10am Tuesday 25 March
BBQ 12pm Tuesday 15 April	**BBQ** 12pm Tuesday 8 April
Community Shed Workshop: learn how to make your house warmer and how to change a shower head 9am–12pm Wednesday 16 April	**Information Session: HOT WATER – never run out again!** 10.30–11.30am Monday 14 April
BBQ 12pm Thursday 8 May	**BBQ** 12pm Thursday 15 May
Community Shed Workshop: Insulating ceiling and hot water tank/pipes 9am–12pm Wednesday 14 May	**Sewing Workshop: Make your own free door snake** 10am Tuesday 6 May
Hardware Shopping Tour Thursday 22 May (pick up at 10am)	**Hardware Shopping Tour** Thursday 22 May (pick up at 10.15am)
Information Session: No Interest Loans Scheme (NILS) 10.30–11.30am Tuesday 27 May	**Information Session: No Interest Loans Scheme (NILS)** 10.30–11.30am Monday 19 May

Figure 8-2 Community activities March and May 2014

	CLARENDON VALE NEIGHBOURHOOD CENTRE (INCLUDING SHED)	ROKEBY NEIGHBOURHOOD CENTRE
JUNE	**Information Session: HEATING – how to keep warm AND save money** 11am–12pm Thursday 5 June	**Morning Tea with the Power Rangers** 10.30–11.30am Monday 16 June
	Morning Tea with the Power Rangers 10.30–11.30am Thursday 26 June	**Sewing Workshop: Make your own free door snake/curtains** 10.30am–12pm Tuesday 2 June
	Community Shed Workshop 9am–12pm Wednesday 11 June	**The Price is Right Games Night** 7pm Friday 27 June (Rokeby High School Auditorium)
JULY	**Morning Tea with the Power Rangers** 10.30–11.30am Tuesday 8 July (Child and Family Centre)	**Morning Tea with the Power Rangers** 10.30–11.30am Friday 25 July
	Sewing Workshop: Make your own free door snake 10.30am–12pm Thursday 3 July	**Sewing Workshop: Make your own free door snake/curtains** 10.30am–12pm Tuesday 1 July
	Community Shed Workshop 9am–12pm Wednesday 16 July	**How to use a Home Energy Audit Toolkit** 11am–12pm Monday 28 July
	Hardware Shopping Tour 10am Thursday 24 July	**Hardware Shopping Tour** 10.15am Thursday 24 July
AUGUST	**Morning Tea with the Power Rangers** 10.30–11.30am Friday 1 August	**Sewing Workshop: Make your own free door snake/curtains** 10.30am–12pm Tuesday 5 August
	Community Shed Workshop 9am–12pm Wednesday 20 August	**Information Session: HEATING – how to keep warm AND save money** 1.30–2.30pm Thursday 21 August
	Information Session: No Interest Loans Scheme (NILS) 10.30-11.30am Tuesday 26 August	**Information Session: No Interest Loans Scheme (NILS)** 10.30-11.30am Friday 15 August

Figure 8-3 Community activities June, July, August 2014

SEPTEMBER	**Information Table with the Power Rangers**	Rokeby Neighbourhood Centre	Wednesday 3rd	11am–1pm
	Information Table with the Power Rangers (at community soccer)	Rokeby High School	Saturday 6th	10am–12pm
	Information Table at Chat and Chew (if you want to have lunch as well, it will cost $5. Please contact the school on 6247 7800 before 5th September)	Rokeby High School	Thursday 11th	1–2pm
	Information Session with a professional Home Energy Helper: *How to cut your power use*	Clarendon Vale Neighbourhood Centre	Monday 15th	11am–12pm
	Sewing (Door Snake/Curtains)	Rokeby Neighbourhood Centre	Tuesday 23rd	10.30am–12pm
	Information Table with the Power Rangers	Child and Family Centre	Monday 29th	11.30am–1.30pm
OCTOBER	**Information Table with the Power Rangers**	Child and Family Centre	Friday 10th	12pm–2pm
	Sewing (Door Snake/Curtains)	Clarendon Vale Neighbourhood Centre	Monday 13th	10.30am–12pm
	Information Session with a professional Home Energy Helper: *How to cut your power use*	Rokeby Neighbourhood Centre	Thursday 16th	1.30pm–2.30pm
	Information Table with the Power Rangers (at the Clarence Plains Festival)	Rokeby High School	Saturday 18th	11am–2pm
	Information Table with the Power Rangers	Clarence Plains Health Centre	Monday 27th	11am–12pm
	Information Table with the Power Rangers	Clarendon Vale Neighbourhood Centre	Wednesday 29th	12pm–1pm

Figure 8-4 Community activities available in the Winter Spring 2014 GBS newsletter

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NOV	How to stay warm AND save money	Clarendon Vale Neighbourhood Centre	Monday 3rd	1.30pm-2.30pm
	Information Table with the Power Rangers	Child and Family Centre	Tuesday 18th	11am-1pm
	How to stay warm AND save money	Rokeby Neighbourhood Centre	Wednesday 26th	1pm-2pm
DEC	Your Power Bill: Questions and Answers	Rokeby Neighbourhood Centre	Thursday 11th	11am-1pm
	Get Bill Smart Christmas Party & BBQ	Clarendon Vale Neighbourhood Centre	Monday 15th	5pm-6.30pm

Figure 8-5 GBS community activities Nov Dec 2014

8.8.1 Description of community engagement activities

Information tables

Information tables were run by the ECs at the following events and locations:

- the Rokeby IGA (1)
- the Rokeby Neighbourhood Centre (7)
- Clarendon Vale Neighbourhood Centre (7)
- unknown location (4)
- Rokeby soccer ground (6)
- Rokeby High School (6)

Each stall consisted of a GBS banner, information fliers on how to save energy and stay warm in the home, information on how to join the GBS project and some demonstration equipment (such as shower heads, shower timers etc.).

As the project progressed and recruitment for the research component became pressing, ECs also held recruitment/information stalls at:

- Clarence Plains Online Access Centre (8)

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- Knopwood shops (4)
- the local Zumba class
- Rokeby Primary School Fair
- Rokeby IGA
- Clarence Plains Community Festival
- various other events and locations throughout CVR that were not recorded by ECs.

Successes

The ECs spoke with hundreds of people at these stalls and events. The stalls outside the Rokeby IGA were particularly well located and rough records show that approximately 20-50 people were engaged each time.

Challenges

While there were a couple of ECs unwilling to actively grab the attention of people passing by stalls and tables, most felt concerned about doing this. UTAS researchers observed stalls (one at the Clarendon Vale Neighbourhood Centre and one at the Clarence Plains Community Festival) where there were times when ECs sat back and did not engage with the community.

Because GBS was unable to formally include residents of government or community housing in the project many community members were excluded. ECs may have informed these people that they were not eligible to participate in the formal evaluation of the project without making it clear that they were still able to access the community events and information.

During the recruiting phase of GBS ECs focussed their efforts on recruiting people to the GBS project. At this time discussion of ECs was diverted away from energy saving measures and instead was focussed on clarifying project requirements, potential upgrades and grocery vouchers incentives.

Expert information sessions

Free expert energy efficiency and thermal comfort information sessions were held at the Clarendon Vale Neighbourhood Centre and the Rokeby Neighbourhood Centre. The experts present were SLT-trained Home Energy Helpers, the CEO, SLT staff or community service providers. The different sessions were:

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- Heating: How to keep warm and save money (5)
- Hot water: Never run out again! (1)
- NILS (No Interest Loans Scheme) information (4)
- How to use a Home Energy Audit Toolkit (1)
- Session with professional Home Energy Helper: How to cut your power use (2)
- Your power bill: Questions and answers (1)

The sessions were usually scheduled for one hour and the space was set up and facilitated by either an EC or the EO.

Successes

According to EC notes, a total of 13 people attended the 14 information sessions.

Challenges

There did not seem to be much community interest for these sessions and many events had to be cancelled due to lack of attendance.

Visits to schools

ECs and the EO made five school visits:

- door snake making workshop with Clarendon Vale Primary School grades three and four
- door snake making, shower timer demonstrations and papier mache globe making with Clarendon Vale Primary School students
- energy efficiency technology demonstration with high school students from Emmanuel Christian School
- participation in textiles class (making door snakes) with Rokeby High School students.

With the exception of the participation in the textiles class, these visits were run by the ECs who provided hands on experience for the children and discussed what sorts of changes could be made in the home.

Successes

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The feedback from teachers and children indicates that the school visits were successful. As one EC said, "***The schools with the door snake making, that was huge, the kids loved it. They knew what they were for, like we explained about keeping warm and keep the draught out***" (GBS006, 17/12/2014).

Anonymous written feedback from high school students in response to the question 'What was the MOST interesting thing you learnt about today's session?' included statements such as:

Learning the different amounts of power used by different appliances you can find in your home.

Finding out how to use the meter and working out the cost for different appliances. And measuring the heat from the floor to the ceiling.

Seeing how little those [fluffy electric] blankets cost. Seriously. I'm finding mine.

Some students said that they would change their energy use behaviours:

Yes I will unplug my devices more often so not as much standby power is used.

Yes I will do more things to save power such as, short showers and turning off power points when I'm finished.

Demonstrating energy efficiency technologies, high school students were taught how to measure energy use of various appliances. One activity was to boil a kettle and record energy use and cost. Students then used the hot water to make hot chocolate. Linking the activity to a task that was relevant to the students was very successful. Several students made positive reference to this activity:

Getting to make milo from the kettle and finding out how to use a power measurer.

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Making milo and reading the prices.

Students clearly enjoyed the sessions with other comments including *"**it was really fun**"* and *"**thank you for coming to our school**"*. There were no negative comments on the feedback.

Challenges

Some schools were not interested or only interested if the ECs developed a program clearly within the curriculum. However, ECs' reports do not provide enough feedback about this to be able to provide more meaningful discussion of this challenge.

Community barbeques

ECs ran six free barbeque events for the local community (three at Clarendon Vale Neighbourhood Centre and three at Rokeby Neighbourhood Centre). These barbeques were an opportunity for the ECs to introduce themselves and the project to the community in an informal setting.

Successes

A total of 36 people attended the barbeques at the Clarendon Vale Neighbourhood Centre and a total of 25 people attended the barbeques at the Rokeby Neighbourhood Centre. Given that some people attended more than one barbeque, these figures do not give an accurate view of the number of individuals reached.

While the BBQs did not provide a useful forum for discussions of energy efficiency and thermal comfort they did promote the project and create brand visibility and goodwill. For those who did attend, the social element of the gathering was valued:

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I went to barbeques and things, and it was wonderful. I mean that's a social event as well as learning something. Yeah they were great (GBS045, 08/09/2015).

Challenges

Barbeques did not attract a large number of people and there was very little discussion around energy efficiency and thermal comfort at these events. However, ECs' reports do not provide enough feedback about this to be able to provide more meaningful discussion of this challenge.

Morning tea with the Power Rangers[20]

ECs ran six morning events for the local community (three at Clarendon Vale Neighbourhood Centre and three at Rokeby Neighbourhood Centre). These morning teas were an opportunity for the ECs to introduce themselves and the project to the community in an informal setting.

Success

A total of 32 people attended the morning teas, nine at the Rokeby Neighbourhood Centre, 17 at the Clarendon Vale Neighbourhood Centre (for the remaining five, location was not recorded).

Challenges

Similar to the barbeques, the morning teas did not attract a huge number of people. Those they did attract were either repeat attendees or already friends with the ECs.

[20] Power Rangers is the name the ECs chose to call themselves for CCB work in their community.

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Hardware store bus tour

ECs arranged for a mini-bus to take residents on a tour of the local hardware store. This was promoted as an opportunity to learn about the different products that could be cheaply bought for energy efficiency and thermal comfort gains.

Challenges

The hardware bus tour was not popular. Despite advertising for two events only one person was interested and the tours were cancelled.

Community shed workshop

ECs facilitated four community shed workshops. These workshops were to demonstrate how to install ceiling and hot water tank/pipe insulation. Workshops were run by volunteers from the community shed with help from ECs and the EO.

Successes

Community shed workshops were a way for people other than the ECs to take a leadership role in the CVR community. One man from the community shed felt he had played a significant role in the training of the ECs.

Challenges

Only five people attended the community shed workshops. There was some informal feedback suggesting some personality clashes and some rudeness. One EC also noted that people turned up to the workshop not to learn anything but to receive their stars for project participation.

Door snake workshops

Champions ran seven sewing workshops to teach people how to make draught-stopping door snakes. At some of the workshops advice was also given about how to make curtains.

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Successes

Eighteen people attended the seven sewing workshops. Feedback from community members was that these were enjoyable and sociable events.

Challenges

As with many of the events, attendance at these workshops was low. There were some challenges with advertising; on one occasion the text message advertising the event included an incorrect time.

The Rokeby Neighbourhood Centre only had one functional sewing machine and did not have enough material supplies for some of the workshops.

Initially some people were keen to make their own curtains, but could not afford to purchase the fabric themselves. This meant curtain workshops did not run.

Some of the ECs who had agreed to run these sessions pulled out at the last minute and two SLT staff members had to step in at late notice.

Energy Champion attendance at community groups

ECs were invited to attend the Clarendon Vale Child and Family Centre playgroup. ECs gave out information booklets and shower timers and spoke with some of the parents.

ECs also attended a meeting of the Eating with Friends group at the Lindisfarne Motor Yacht Club.

Successes

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Generally EC attendance at these community events helped to promote the GBS project and improve brand awareness and program visibility.

Challenges

ECs' reports do not provide enough feedback about these events to be able to provide meaningful discussion of any challenges.

GBS "party"

Some ECs ran GBS parties for residents. Based on the Tupperware party plan idea, ECs would visit houses and demonstrate energy efficient products and provide tips on how to improve thermal comfort and energy efficiency in the home. At least four parties were held; however some parties occurred informally and were not recorded by ECs.

Successes

ECs' reports do not provide enough feedback about these events to be able to provide meaningful discussion of any successes. GBS researchers did hear about GBS party events from other participants - they related the events in a positive light.

Challenges

ECs' reports do not provide enough feedback about these events to be able to provide meaningful discussion of any challenges.

'Price is Right' games night

With the help of the EO and SLT, the ECs ran a community games night. This event was very well advertised around the community with posters at major intersections, in shops and community centres.

Successes

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Those who attended the event appeared to have a good time. The advertising for the event increased brand awareness.

Challenges

There was very poor turn out to the event. Twenty people attended and the majority of participants were extended family members of ECs.

Individual house visits

ECs arranged personal visits with members of the CVR community to give energy efficiency and thermal comfort advice. At one visit ECs installed draught proofing around windows and door frames with foam tape. At another house the EC sat with the householder and worked out the financial value of the upgrades she had received as a part of the upgrades component of the GBS project.

While ECs officially recorded only four home visits, it is suspected that they conducted several more. Some home visits would also have been spontaneously conducted as a part of the doorknocking activity – see below – or as a part of unrelated social visits.

Successes

Individual contact with community members was one of the most successful EC activities. Feedback on surveys made positive reference to the home visits by ECs and included comments such as "***I did appreciate the ideas from Power Ranger but still unable to afford major changes. I appreciated the info***" (GBS549, 2015), "***I would like to thank the Power Rangers for their kind help***" (GBS622, 2015) and, "***[the best thing about GBS] was talking to the girls who came to visit about things. In general for upkeep of home and things you can do (money is a problem to do these)*** (GBS461, 2015)".

The CEO also recognised the value of these home visits and the headway they made in engaging people with project aims.

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Sort of take the cue from the householder. So knock on the day, say, "Hi I'm a Power Ranger, you haven't been coming to visit, we've got this information for you, we'd really love to leave it for you". Most people have been inviting them in so they've been engaging and getting some really good – having some really good conversations with people *(EO, 16/12/2014)*

Challenges

Champions did not always have the correct information or access to many of the materials. In one instance the UTAS researcher had explain to one of the ECs that the advice they were giving was incorrect (GBS009, 08/12/2014).

Doorknocking

Door knocking was originally discarded as community engagement approach as the ECs felt uncomfortable with the idea, not wanting to force themselves on neighbours.

Over time however ECs began to adopt doorknocking as a community engagement strategy due to as very low attendance at community events meant that new strategies were needed.

ECs door-knocked over 50 houses in the area and offered on the spot home energy and thermal comfort advice similar to the individual house visits above.

Successes

It is worth briefly noting here that the research requirements forced some particular behaviours in program roll out. While this report is not intended to articulate how to run an energy efficiency and thermal comfort *research* project, at times the two components of the program became inextricably linked. It is important to recognise these links and to understand the function performed by the different elements of the project.

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Doorknocking was a successful community engagement strategy. One on one contact with residents was an effective way to engage householders in the GBS project and with information about energy efficiency and thermal comfort. The process enabled people to access information without having to attend public events – particularly valuable for a population with high levels of physical and mental ill health. As one of the ECs explained, doorknocking enabled them to reach otherwise socially isolated residents:

Another person we found had agoraphobia and she found that she virtually couldn't come out at all. But we had quite a good conversation with her and she actually was interested in a lot of these things. Wanted to know how to do this and how to do that and things like that, but because she had agoraphobia she was a little bit hesitant about coming out and going to meetings where there were a lot of people around, that type of thing. (GBS012, 22/12/2014)

Another EC had a similar perspective, explaining, in conversation with a UTAS researcher:

EC I cannot stress how important I really do feel this program is to lower economic family households, but I do think that we really need to open up the doors of people that are socially confined. Or are unable to get this information under normal circumstances, like seeing a flyer at a local shop.

UTAS So that's what you were saying about some seniors and some people with disabilities, that they can't get out of their homes.

EC Or people with mental health problems. That have social phobias or have deep depression and they don't leave their homes. There's just so many different people and we're all so diverse. (GBS011, 15/12/2014).

Champions were aware that most of the activities they ran for the community attracted very little attention and interest, while the one on one contact was important:

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I think we got more when we actually went and knocked on people's doors and actually spoke to people at home… They don't like to get out and about or you know they don't feel comfortable going to things, I don't know. We got through to them well in their homes (GBS002 21/01/2015).

I think the actual going into people's homes. Once you were invited and they were willing, it was really good. (GBS006, 17/12/2014).

The more one-on-one you can provide, I think the more interest there seems to be. (GBS011, 15/12/2014).

To be honest I didn't want to do door knocking at first, because I was a bit, like going to people's houses, a bit nervous because I felt it was quite confronting, but after I'd done it I quite enjoy it, because you're getting that initial contact and they're more comfortable in their own home. (GBS009, 08/12/2014).

At least when you're down there, you're at the front door and some people just stood at the front door and talked, which was fine. Because they had a little bit of information but other people would invite them in, say can you come and have a look at this for us and things like that…Oh yeah, yeah, so I found that the most effective way of dealing with it and I would be encouraging any future project, to go down that avenue. (GBS012, 22/12/2014).

The CEO also thought the doorknocking was a successful approach to engaging people with energy efficiency and thermal comfort: "***got the Power Rangers to do some doorknocking and that has been really positive***" (CEO, 16/12/2014).

Doorknocking was also a successful part of the community engagement strategy as it played to the strengths of the ECs. One EC explained that:

I think the easiest, well I found it easiest to go to people's homes and chat to people. And when we had stalls I found that easy. Umm, the men's shed and stuff like that was harder. Because you know you had to demonstrate everything to everyone. But no I really enjoyed going to people's homes, face to face. (GBS002, 21/01/2015).

We've really got some really good results from [doorknocking]. People are really appreciative of the visit. They're actually inviting the Power Rangers to come in so the idea was just the Power Rangers… But that wasn't one of the ones that was in the strategy. So that doorknocking was never part of the strategy. It was… And these are probably things that maybe they would never have even thought about ever if no-one – if a community member hadn't knocked on their door and told them about it. They may never have even realised that they could do something about cutting their power bills. (CEO, 16/12/2014).

Appointments with the community

As part of the recruitment process and as a way to engage with the community, some ECs arranged to meet residents at their homes to help them to complete the survey and to talk to them about changes they could make to their homes. This process is distinct from the doorknocking and home visits, although often appointments were set up as a result of doorknocking.

Successes

As above, one on one interaction with community residents was very successful.

Challenges

While this was generally considered to be an effective and positive process, one of the ECs noted how frustrating it was when people cancelled appointments, failed to turn up or were running late.

You've got to come back and then go back out, which also takes time and things like that which is you know, a little bit awkward. So making appointments it was, I guess one of the most difficult and frustrating parts of the project, to get that to work smoothly. (GBS012, 22/12/2014).

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8.8.2 Community engagement successes

In general the community engagement activities run by the EO and the ECs can be considered successful. While attendance at events was low, the very existence of such activities meant high levels of brand recognition and trust. Of those surveyed in CVR, 87% said they wanted more programs on energy efficiency and thermal comfort run in their community. Whether or not people attended events or had upgrades, the general feeling in the community was the GBS program was very positive and having the program continue in the area was supported.

It is important that the limited turn out to events is not seen as a complete failure of the program as it laid the groundwork for the doorknocking and one on one engagement that came later by providing identity for GBS and legitimacy when ECs went doorknocking.

What follows below is summary of the successes and challenges of the CCB approach as whole.

Strong CEO

The developed a strong relationship with ECs, and the ECs s recognised the value of the EO role and the EO's skills. Over time, high levels of trust developed:

She treats us all like we're all an individual, which is a good thing as well. It's amazing. She treats us all like we're all a different personality, not just oh you all come from... She realises and recognises all our experience and potential. And she's able to bring it out in us. (GBS001, 06/03/2014).

The strength and skill of the EO was vital to the successful roll out of the community engagement strategy. She successfully managed the diversity of personalities both within the training sessions and later in the field, recognising that certain people were not capable of working with each other. To her credit a strong sense of team developed:

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"I think most people within the Power Rangers[21] worked very, very effectively. I've worked with quite a few different Power Rangers at various times. I mean it's okay it's been Jane lately, but I've worked with Georgia, I've worked with Ursula, I've worked with Zac, I've worked with others and things like that. We're all committed to getting that same message across. Some would do it one way, some would do it slightly differently and most of the time we would complement one another." (GBS012, 22/12/2014).

Strong and trusting relationships between CEO, ECs and CVR community

One of the risks of using local residents to champion external projects is that if the project is poorly managed this may reflect badly on the local champions and their positions within the community. However, the GBS CEO had the capacity to successfully support the ECs, and they reported that she quickly and effectively dealt with issues that arose.

For example, one EC explained how a man had called her on the GBS phone, angry and upset about monitoring equipment in his house and frustrated that no one had talked to him about vouchers. The EC immediately rang the EO:

I rang [the EO] straight up, "I've got a very upset man about his monitor and he wants his vouchers". Yeah, so pretty much he thought that he had it in, got his vouchers and then you took it away within a few – I think he got a little bit jumbled up. I think he thought he only had it in for a few weeks or something, and I don't think he understood – but I know that the EO did ring and he was fine. I think it was just him understanding. (GBS005 08/12/2014)

It was clearly understood by the ECs that without the EO, this part of the project would have failed:

I'd highly recommend [the EO] if she ever had to do anything like this again or even anyone that had to take on a role like this. I think you need that person there. I mean because she had to type everything on the computer then

[21] The ECs decided to brand themselves as Power Rangers in the community.

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she'd let us know who the people that we needed to still get hold of that we'd track down paperwork from and then she'd tell us the people that wanted information posted out... (GBS005, 8 Dec 2014).

Yes – I think so. Because she is the one that sets things up and covered what not being done by [ECs]. *(GBS010, 16/12/2014).*

She kept it all flowing and on track. *(GBS006 17/12/2014).*

Strong connection with the Clarendon Vale Neighbourhood Centre

A strong relationship existed between the ECs and the Clarendon Vale Neighbourhood Centre where their office was based and where many workshops and events held. As one EC explained:

The positive thing that came out of it [the training] was the regular meetings at Clarendon Vale that it became a thing we were accepted as part of the community. The office at the end [of the corridor] probably never would've been occupied apart from [the EO] using it. The office people, the volunteers that work in the office became quite accustomed to our ways, accepted us as part of and I think we're going to leave an empty spot in the Clarendon Vale Community Centre. (GBS001, 06/03/2014)

The above observation seems particularly important when you consider that several of the team were new to the community. Some ECs used their relationship with the Neighbourhood Centre to give the project local credibility. For example an EC explained that when she was doorknocking houses, ***"A lot of people would see you and they'd think 'No! Go away you're not selling me anything' and I'd go 'Hey! I'm from your local community centre actually!'"*** (GBS002, 21/01/2015).

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Not only did association with the Centre position ECs as a part of the community, but it also helped in practical ways. As ECs explained:

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The neighbourhood centres were really good. They were really good with giving us somewhere to go and setting up the tables and everything, because that's where a lot of people come to, [long pause] because a lot of people just go to the neighbourhood centres anyway for information or whatever it is that they might need if they need help with anything. So letting them know that we were sometimes there or we were based out of mainly Clarendon Vale one was a good thing too. To let them know that we were there (GBS009, 08/12/2014).

There's definitely going to be an empty spot there because it's a shame that when, as I say, there should be something carrying on after that. Even if it was just somebody in the office who was educated, something should be left behind it shouldn't just go and leave. (GBS001, 08/12/2014).

Having an office at the Neighbourhood Centre successfully helped to facilitate connections between local residents and the ECs. In particular it was vital that the ECs were embedded in the community and visible for incidental interactions.

Energy Champion community networks and integration in community

ECs had an intimate knowledge of the culture of the CVR community that significantly contributed to the success of GBS in three key ways: ECs understood the community and the needs and challenges they faced, they were trusted by the community as genuine locals and many of them had extensive social networks within which to disseminate information and generate interest.

Community needs and project goals were well aligned. Having local people develop the engagement strategy was important. As one EC explained, "***I think all of our backgrounds and different personalities and different views, all helped to get the message out…"***(GBS011, 15/12/2014).

The ECs had lived experience of what it was like to live with poverty and the implications this has not only for community capacity but in order to feel safe participating in programs offered by outside organisations.

That poverty thing is something you can't explain unless you live it. And when people say, this business about people on the dole not spending their money on cigarettes, they've just got no idea how poverty and social

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isolation impact on people's abilities to even be normal. And that was another thing in the group, where there was quite a number of people like myself that are on their own with physical or financial disabilities, that the program was good in giving them a bit of extra money but also that involvement in an empowerment model. And for those people that come along they are the ones that should be continually getting supported because when an opportunity comes they will be trained up enough to step into a role of some description. (GBS005, 15/12/2014).

ECs had their own experience of home upgrades written up into case studies (see appendix 3). These case studies were quick guides to the changes and savings made by ECs and helped to make accessible the shift towards more energy efficient behaviour and greater thermal comfort. The EO explained how these case studies worked:

Yeah so Natalie would sort of say since I've been using a timer it means that we don't run out of hot water anymore which has been great so the last person to hop in the shower is now not having a cold shower. So that's been really great. We've had Georgia who says that her winter power bill has been halved and that was from doing A, B and C, doing simple things. I think… (EO, 16/12/2014).

Conversations about power saving, energy efficiency and thermal comfort became much more legitimate thanks to the role modelling done by ECs:

It's opening up a very different conversation. I don't really ever recall ever hearing people talking about their power bills to one another over the fence ever before, whereas I'm feeling that that's now what is starting to be created from this program. People are saying "Well geez, I got a power bill that was $900 this last bill" and that other neighbour being able to say "Hey look, I've just found out all this information" and it hopefully could snowball. (GBS011 15/12/2014).

ECs were also able to reassure residents that the program was genuinely about improving energy efficiency and thermal comfort and that there were no strings attached. According to the EO:

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[The ECs could approach people and say] "I'm a community member just like you, I have done things… This is my story. It's easy. There are no strings attached", because I think that's been a really big thing whereas people think there are strings attached. Having that reassurance of a community member actually telling them that I think they felt… (EO , 16/12/2014).

The ECs themselves had a similar perspective:

Because like and the thing that we explained to a lot of people too was, we were just ordinary people that live in Clarendon Vale. I said, "We're no different to you", and I think when they realised too that we live in the area. What we're talking about, we're not someone that's come out of the area. Into the area and saying, do this or learn that. They know that we live in the area, and we know what they put up with or whatever… Because they relate better to us then, when they know that we are from this area. I just say to them: "No I'm not special. Just ordinary people like you". (GBS009, 08/12/2014).

Having local residents in the EC role was also important in order to really connect with not only the needs of the community but the local culture. The significance of this was explained by one of the ECs who was new to the area. This EC had a strong work ethic and at times resented the less professional approaches of the others. As she explains, while she was more professional, the others often had more luck in connecting with the community.

I also felt a bit disappointed that some didn't seem to take it as seriously perhaps as others, and it was not just with disrespecting the rules, but it was also in their approach to themselves and the way that they presented themselves to not only us – the group – but also the community. I mean, I'm not here to judge anybody, but I just felt that if you're rocking up to work where you're going to be paid to go out and help people in the community, you don't rock up to work in a pair of old tracky pants and a tank top, swearing your head off, on your phone all the time, kids running all around running amok; and that's where it's difficult because this is a community program, and who am I to say what's the dress code…. But on saying that, those two in particular that always seemed to have this standard dress code, and this is also what they wore when they were volunteering at the community centre, so it's not like it was out of their character, this is their norm. They were very, very effective. They were really good workers, because they know so many people. Their kids are at the schools and they just

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seemed to know the community really well, so it was so beneficial to have them on board and like I said, who am I to judge? (GBS011, 15/12/2014).

Many ECs were well connected into the community as they had grown up in the area and still had large networks of family and friends there. Many of them were good at putting these connections to use and were unafraid of actively recruiting people into the project.

So it was quite funny because I'd find myself at my family's or even at friends' and I'd be like, "That power point over there, I want to switch [it] off," and I did, at people's houses that I know wouldn't mind and that would just have a joke. I did. I did switch stuff off. And I'd say, "That can save you money doing that," and they'd come back with the little smart, "Go Power Ranger Natalie". (GBS005, 08/12/2014).

ECs were able to translate energy efficiency measures into a language that the community could understand. While this was mostly a successful element of the project, there were some instances where the message became too simplified or was lost in translation and thus the ECs simply acted as part of a giant game of Chinese whispers. There were occasions when the ECs presented energy savings measurers that lacked detail and the EO noted that more training was required to ensure that the ECs were *"**singing from the same song sheet**"* (EO, 19/11/2014).

Building capacity within the community

As intended the project built capacity in the CVR community. That ECs are visibly present in the community means that their knowledge and expertise is easily accessible to others in the area. ECs saw themselves as an ongoing community resource. One EC reflected that: *"**Best thing about the program was the development of people as a community resource. The long term skills that will stay in the community have been the biggest benefit**"* (GBS004, 27/01/2015), while another explained: *"**I found it a very, very worthwhile exercise. Both for myself personally and we've learnt a lot, and also obviously for trying to pass the information on to I guess the wider community**"* (GBS012, 22/12/2014).

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The CEO also recognised the value of building energy efficiency and thermal comfort knowledge within the community. She said: "***The projects got a face so they know someone in their community who knows something about energy efficiency, if they've got further questions they've got someone to go back to***." (EO, 16/12/2014).

Positive experience and skill development for Energy Champions

Feedback from the ECs was overwhelmingly positive in regards to their own skill development. Comments from ECs included reflections on the skills and knowledge they had gained, their potential to seek new work, their improved self-confidence and their pride in making a difference.

The most for me was knowing how to work the heat pump for one, I was always told to leave it on, so that was a $1200 bill we ended up that time….. I think also with the ones that were interested and willing to learn, sharing our knowledge with them. So that was really cool. (GBS006, 17/12/2014).

I enjoyed being a power ranger… I just really enjoyed what I was doing. You know even now people call me up and say "oh you're a Power Ranger..." and they ask me certain questions and it's like… it makes you feel proud that you've achieved something. (GBS002, 21/21/2015).

Oh, we enjoy it. We have met so many nice people. It's just been wonderful just to go back and check on them and see them again. (GBS009, 08/12/2014).

I found the job very, very interesting and very fulfilling. (GBS002, 08/12/2014).

I met a lot of new people. I got out and about in the community, it was enjoyable, I enjoyed it. (GBS002, 21 Jan 2015).

No, apart from missing it. Like I said I will miss it. (GBS010, 16/12/2014).

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Flexibility

The EO and ECs were flexible in their implementation of the community engagement strategy – this was vital. For example they had extremely low attendance at the community shed events and so stopped running these events. That the ECs and the EO felt able to do this reflects a strong sense of ownership and control over the process.

We found that for example the community shed workshops weren't well attended so we stopped doing those. There were things that we tried to do different things to see if we could increase participation. And it did seem that probably towards the end of winter, so say around about maybe September, August/September it seemed like the numbers were increasing a little. (CEO, 16/12/2014)

8.8.3 Community engagement challenges

There were some significant challenges faced in the rollout of the community engagement activities in CVR. Primarily these challenges related to limited time frames and the diversity of personalities, skills and capacities of the Energy Champions.

Limited time frame

Supporting people to take the difficult journey of moving from a local resident to an energy champion to a recognised leader in the community takes considerably longer than the 15 month time period available in the project. It was only by the end of the process that the EO had a clear understanding the EC's strengths and weaknesses and was in a position to conduct an audit of skill and capacity gaps in the group. This was the point at which the EO was keen to address these gaps through further support and training. Previous work on community capacity building in health promotion has highlighted the central role of incidental and informal training that may occur between program managers, coordinators and participants and the need for a flexible, iterative approach to capacity building (Hawe et al 2000). . A longer time frame would have assisted to properly implement such an approach. Understanding the need for multiple avenues for education and training and capacity building is critical to effective community capacity building. In relation to GBS, this would have entailed providing a longer time frame in which to the conduct the project.

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The short timeframe was particularly problematic given that SLT had no prior community development project management experience. SLT had few pre-existing contacts and networks in the CVR area. This was a significant challenge for recruiting a local EO and the recruitment of the ECs. Through GBS, SLT attempted to develop networks with other organisations within the community, but this proved challenging as many of the local schools were not interested and in one case the local council climate change officer failed to attend an event.

The EO commented that there were very few strong networks between existing service providers who tended to work in isolated silos. She suggested that perhaps greater collaboration between organisations might have been helpful. Having more of a physical presence in the community (the EO was only part time and thus not at the office every day) would have helped to join the dots between the organisations.

Insular nature of some EC networks

For some CVR residents there was a definite preference to engage with those ECs who were deeply entrenched in the community. While this was often an advantage, at times the more recently arrived ECs struggled to engage with the community. This was often disheartening.

There are people also in our team who had known each other for years, they'd grown up together. I was disadvantaged from the start because I was a newcomer. These people have got grandparents on the team, parents, grandparents, sisters, brothers, you name it.

Two doors up there's a lady there she's got these four houses involved with her house there. She's got a partner who lives in another house, she's got another person who lives in another house, a sister who lives in another, that's the kind of society thing we are.

Four generations of people and unfortunately, as I say, they grew used to each other and preferred to work with each other. That was a natural outcome of living and growing up together (GBS001, 08/12/2014).

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Limited capacity of ECs

As discussed above in section 4.1, the varying abilities and capacities of ECs proved challenging. From the EO's perspective, ECs were often unreliable, failing to turn up to events they had signed up to run. At times the EO and other SLT staff had to step on at the last minute to run events. Similarly ECs would sometimes attend events but fail to take responsibility for their designated work. An example of this was observed by researchers when one EC who was supposed to be running a stall at a fair spent most of the time helping someone at a different stall.

ECs also had limited capacity to commit time to GBS, often due to young children, injuries, mental health problems or existing commitments to other projects.

[I am looking forward to the community activities but] the only thing that knocks me about is if I haven't slept well and my hip is hurting and I've got to go out somewhere then I dread it. But it's not so much the Power Rangers, it could just be anything that I'm committed to where, wow, I can barely walk today, do I actually have to go. (GBS003, 19/032014)

There was a couple [of ECs] that kind of couldn't commit themselves to it due to personal reasons. A few of them were, you know, so that was all right. I mean anyone could say, "Yes, I'd love to do it," and then two weeks later they find out they can't because of health issues or personal reasons or something. (GBS005, 08/12/2014).

Because of my illnesses. I had to withdraw a lot. (GBS011, 15/12/2014).

Some ECs were expressed frustration that other members of the team failed to meet their commitments.

Contracts should be made that they should do at least so many hours per se, I don't know, so many hours per month. People shouldn't be taking on a job that they just can't do, they're committed to too many other things. (GBS001, 08/12/2014.

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Due to different capacities there was a discrepancy in the hours worked by each of the ECs. The CEO explained: "***I was trying to be fair to everyone but definitely there's quite a range in the hours that people did so there were people who did 180 hours in total and then you've got people who did 14 hours. It's quite a big range***." (CEO, 16/12/2014).

For some ECs these discrepancies were problematic.

I felt that I wasn't fairly getting the same amount of hours as what was being offered to others; that I did not hear this from [the EO] and I did not verify it, but I did hear from two other power rangers that one power ranger in particular was being paid an astronomical amount for a certain week because she racked up something like 12 hours of work on Facebook alone, and it was like "What?!" and yet there was two or three of us that had absolutely no work. We had not a time sheet to put in. (GBS011, 15/12/2014)

Yeah. And that was pretty much consistent right from the word go. There was discrepancies in hours and one person might be racking up three to six hours and I'd be lucky if I'd pick up one hour.... Well we were all really sold the idea that the hours would be distributed as evenly as possible so that we were all on the same page. Obviously you know, there were one or two that perhaps that might not want the same amount of hours as the rest of us, they might only want one or two for the week, but for the rest of us, we were pretty much all under the understanding that it would be as evenly as possible. (GBS011, 15 Dec 2014).

Poor attendance at many community events

As can be seen above, community events were very poorly attended. ECs were often disheartened by the lack of obvious enthusiasm amongst local householders.

There wasn't as much interest as what we thought there'd be. We thought there'd be people jumping for it. But the ones that were interested were yeah, it looks cool. The barbecues, they were a failure pretty much, the sale classes were a failure as well. *(GBS006, 17/12/2014).*

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I was really disappointed in. Not from our perspective on what we were doing or weren't doing, just the lack of community that… just didn't show. Most barbeques and some of the other activities that I did participate in, you would very rarely get more than a handful of people and out of that handful of people, maybe one might have been interested in signing up. I felt unfortunately with the barbeques in particular, most of the participants were people that were already utilising the neighbourhood centre for other programs, so they were just coming out to get a free sausage or vegie burger and have a chat. *(GBS011, 15/12/2014).*

Some ECs thought that people were simply attending to receive a star on their rewards card.

And I felt like at the end some people would just come in because every time a person came to an event we were giving out a star on their reward and then at the end of it they would get a little present off [the EO]. And I felt like that at the end some people were maybe not – yeah, taking advantage a little bit. Not really coming for the right reasons. They would just come in, "Where's my star? I've got to go," kind of thing. That's how I felt at the end of it. And then we didn't have as many people coming. Where at the start of it I felt like people are really coming wanting to know, loving the information. You know, you'd get the box of goodies out. I call it the goodies. And you show them the light globes and the door strip and stuff and they'd ask you questions and it was really involved, but then at the end I just felt people were just lacking off a bit and then coming and, "Where's my star?" kind of thing. *(GBS005, 08/12/2014).*

The EO worked with the ECs to attempt to overcome barriers to participation. Anecdotally people were not attending due to lack of childcare and transport, but even when these were made available attendance remained low.

Formal participants in the GBS program were also texted prior to events, however often the lead time for this was too short.

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Generally they come after one o'clock in the afternoon, usually around four for an activity that starts at ten or ten thirty the next day. On one occasion the text came around nine o'clock in the morning for something that was starting that afternoon, which is a little bit short notice and a bit easy on the information. Now I do have a recollection of there being a flyer or a notice sent out that said some of these things are coming up but at the time I looked at it and thought I've got no idea what that's about and didn't pay a lot of attention to it.

…

It would be good to know a little bit in advance yes. And certainly to have a phone number on that text so if you want a bit more information or a contact name, who's organising that particular event to find out about it. (Gbs135 before interview 12/6/14)

While engaging with the community was difficult, it is worth noting that other service providers in the area had similar troubles and this may not have been specific to GBS.

It is also worth noting that while attendance at specific events was low, as noted above many survey respondents from the area valued the existence of the program and wanted more activities. It is likely that over time these may have become more popular. It is also likely that the very existence of activities, even if poorly attended, sparked energy efficiency and thermal comfort related conversations within the community.

Impact of research on the roll out of each approach

The research component of GBS significantly impacted on the roll out of the various approaches. Details of this are outside the scope of this report however a basic summary is provided below. The research impacted in the following key ways:

- a large administrative load (both for consortium and for project participants)
- EC time and resources directed to program recruitment rather than to community education
- grocery vouchers were often more of an incentive than the upgrades
- liaising with the government took a large amount of time

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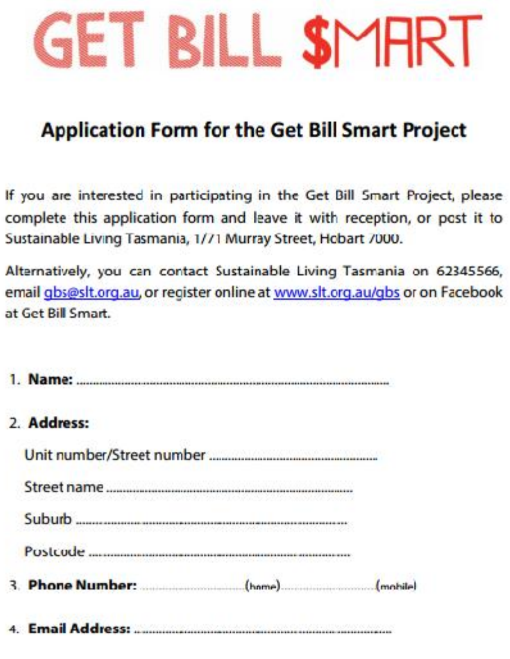
- CSIRO requirements took time away from working on project
- excluding social housing households from an inclusive community-based research project reduced buy-in to project and caused friction within the community.

Large administrative load

Organisationally some of the biggest challenges faced by GBS were related to the administration load. The paperwork and administrative processes generated as a result of the different reporting requirements of the various organisations involved significantly complicated the project.

Recruitment process

Recruiting participants into the research component of the project was administratively intensive. Potential participants were introduced to the project in a variety of different ways (See section 4.4 of Overview report)). Those people interested in the project were then asked to fill out a brief form and return it to SLT as an expression of interest **(**see Figure 8-6 below). If applicants were suitable they were then sent a package of forms to be returned. This pack included the UTAS Human Ethics Information Sheet, the UTAS Human Ethics Consent Form, the Federal Government Privacy Form, Landlord Consent Form, Billing Data Form and Permission to Use Photos Form. Once these forms had been returned, participants were then formally accepted into the program and allocated into the different groups as listed above in Figure 1.2.1. Detailed study participants were contacted by UTAS and researchers arranged to visit the home, install the data loggers, conduct the interview and, if the survey had not been returned, make sure it was done. Those who were part of the bulk group were sent a survey and asked to return this via a postage paid envelope to SLT.


GET BILL $MART

Application Form for the Get Bill Smart Project

If you are interested in participating in the Get Bill Smart Project, please complete this application form and leave it with reception, or post it to Sustainable Living Tasmania, 1/71 Murray Street, Hobart 7000.

Alternatively, you can contact Sustainable Living Tasmania on 62345566, email gbs@slt.org.au, or register online at www.slt.org.au/gbs or on Facebook at Get Bill Smart.

1. Name: ....

2. Address:
   Unit number/Street number ....
   Street name ....
   Suburb ....
   Postcode ....

3. Phone Number: ....(home)............(mobile)

4. Email Address: ....

Figure 8-6 GBS Expression of Interest form

Surveys were collected by SLT and then forwarded to UTAS where they were entered electronically and processed; some participants were posted out grocery vouchers while others waited to be contacted by SLT for their home education and upgrades. During this time, those in Clarendon Vale and Rokeby were able to attend, or not, the community engagement activities run by the Energy Champions.

The administrative load of this part of the project was far greater than anticipated. UTAS employed an additional staff member at two days per week to manage the influx of surveys, to dispatch the required vouchers and to spend hours on the phone undertaking surveys with participants or reminding them that it needed to be returned before they received either their vouchers or the upgrades.

It is important to note that before SLT could arrange for home upgrades, surveys had to be received. As recruitment deadlines crept closer, staff at both SLT and UTAS spent many hours on the phone chasing research participants, reminding them to return surveys or offering to do the surveys with them over the phone. Participants had been given the option of doing the survey online however it was later discovered that in an attempt to reduce the paperwork this notice had not gone out in the initial mail outs. Participants were given the opportunity to do the AFTER survey online however this only reduced paper surveys by a very small amount as many participants either lack computer literacy or access.

Problems with recruitment process

There were several significant problems with the process as outlined above.

First, the large load of paperwork was often overwhelming for participants. Many people involved in this project have low literacy levels and to be asked to sign so many formal documents was problematic particularly as many were uncertain and suspicious about the possibility that there were hidden costs. Secondly, participants were likely to lose forms or forget to return them. Thus the two tiered mail out (forms first, then survey) meant that there were two choke points in terms of getting people fully on board with the project. The combination of research project and multiple different approaches significantly added to the administrative load. These problems were articulated and identified by the GBS program manager, the EO and the EC. As the project manager explained:

Yeah, administration was like nothing I've ever experienced before, it was massive. And yeah, we felt the bulk of that because everything was being sent from here, everything returned to here. Every day at five to five I bolted out of the office with a bag of mail, every single day I was here and it really did my head in. And then you know,

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waiting to get stuff in the mail every day and then sometimes you'd get nothing and it's like, "Oh dear, we really need people to return their stuff" *(SLT25/02/2015).*

The impact of this was that SLT had to employ a further part time staff member to deal with many administrative elements.

The EO (16/12/2014) had less trouble with the extreme amount of paperwork:

Look I think the forms weren't so much an issue because we had the Power Rangers and me were going around and doing it face to face so we were helping people. We could sort of say "Look I'm sorry there are so many forms it's because it's a research project and blah, blah, blah." If we'd known at the beginning what I would have done differently is I would have been recruiting people that way right from the beginning. Rather than giving them a pack and leaving it with them...

Some of the administrative work by SLT was also compounded by the complexity of the project and the need to keep track of so many different people, undergoing four different intervention approaches in a variety of locations at various points in the recruitment phase. For example a large number of people were only just being recruited, while in the same period others were already receiving upgrades. A participant database developed by SLT (previously used for other SLT projects) assisted in this and according to the program manager was an essential tool for keeping track of participants.

The database, I think that the database needed to be the way it was because of the structure of the project. Like it was set up so that once the forms got sent out, you knew they were sent on what date. You had to wait for them to come back for you to progress through to the next stage. So I think without that database it would have been really hard to keep track of everything that was coming in and out. So even through sometimes we couldn't operate it how we wanted to at that time, for the bulk amount of participants it was essential otherwise we wouldn't have been able to roll out the project. So yeah, that was good. But yeah, just the volume of paperwork that came in and the scanning and having everything saved, you know, typical administration work but that all fell onto myself and then to Catherine because I just couldn't deal with it all. (SLT 16/12/2014)

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Recruitment challenges

Recruitment proved to be extremely difficult in both Greater Hobart and in CVR. In the latter area, this was partly due to the fact that the funding body (the Federal Government) would not allow the project to include people from Mission Australia housing (a state-funded community housing provider). This was despite the project having been designed with these households in mind and Mission Australia being a part of the successful consortium of organisations applying for funding.

Ultimately this proved to be hugely problematic as 495 households where in households managed by Mission Australia and a further73 by Housing Tasmania. Form a total community of 1645 households some 35% of residents were ineligible for participation. Confusion was also caused by the inclusion of the Mission Australian logo on all GBS promotional material. Furthermore Mission Australia was geared to support work within their housing community, but not set up with connections outside this group. As it was, we achieved a participation rate of 16% from eligible households in CVR. This was not as high as initially hoped for, but still represented a significant portion of the community.

The other thing that made recruitment very difficult was not being able to include Mission Australia households and that was just an absolute shock and down fall because poor Mission Australia are supporting this project that can't give them any other benefit really. And they made up a massive proportion of households in Clarendon Vale and Rokeby and to not be able to include them in this project was a real shame because they're the people in those homes, they're a massive part of the community and we had to say "No sorry" and they're like "But you've got Mission Australia written all over your material, I'm from a Mission Australia household, why can't I be there?" So that was really unfortunate. (GBS project manager, 28/10/2015).

Because recruitment was slower than expected, the program manager spent a lot of time travelling to different community organisations, putting up fliers and talking to community groups. Given the lower than expected participation rates in CVR, the Programs Manager became responsible for more than 50% of the recruitment.

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The model for recruiting in greater Hobart was utilised in community centres in low income areas. So that was quite time intensive for me because it was driving or cycling to all these places out and around Hobart, attending lunches, attending meetings etc., putting up posters. So it was a very time intensive way to recruit but I think that that's a key target for future projects. It turned out the recruitment in Clarendon Vale and Rokeby at the beginning seemed to be going really well. So I can remember meetings where [the EO] came in and she's like "We've got 100 people already" and it was amazing, we couldn't believe it. And then it was "We've got 150!" and then suddenly we realised that by joining people up to the project, they'd said they were interested and we maybe had an initial expression of interest from them but we hadn't received all of their initial paperwork and we hadn't received a survey. So that was a major issue in the project was the way that we rolled it out. (GBS project manager, 28/10/2015)

Energy Champion time and energy directed to recruitment rather than community programs

As mentioned in section 4.2.1 a significant amount of EC time was spent on recruiting community members to the research component of the project rather than engaging them in activates and discussions around energy efficiency and thermal comfort.

This was problematic, although it also proved a useful way for ECs to engage with community, especially when incentives such as grocery vouchers were offered. People seemed more receptive to energy efficiency information as it not only came with a financial incentive but also from a trusted source within the local community.

Grocery vouchers as more of an incentive than home education

The grocery vouchers were a huge participation incentive and, despite imposing a significant administrative load on the project, substantially assisted recruitment.

Problematically, however, ECs were encouraging community members to ask to be put in the voucher group. This showed that many residents exist in a state of ongoing financial crisis and participation was a good way to access

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financial resources. For participants who were tenants it is not hard to understand why they might have preferred the guaranteed grocery vouchers over upgrades to their home that they did not necessarily trust and that would ultimately benefit the landlord. Data from the BEFORE survey showed that 56% per cent of people participated for the vouchers.

Government liaison requirements

Reporting and communication to the funding body required significant administrative attention from both SLT and UTAS. It was primarily the responsibility of SLT to liaise with the Federal Government regarding changes to reporting requirements and timelines. The need to change project timelines due to recruitment challenges meant SLT/government liaison was a frequent activity.

We were in communication [with the Department] relatively often, milestone changes was a big thing that I underestimated with them and that was essential otherwise the project would have essentially failed. So I think it was a big achievement for the project to be able to get those changed and for them to be understanding. But it took a lot of work and especially because the project, when explained to someone, is quite complex and there's so many different numbers of people in different groups that that was part of the problem was they needed to understand the project first before they could change it. So that was slow but eventually we did get a response before the milestone was due which is good. Saying that, I've been waiting five weeks for a response from the Department on another contractual issue and we just found out the reason I haven't been getting a response is four people in the Department have gone. So I think this is the fourth or the fifth project manager we've had at LIEEP. And now someone else is going to come on board... (SLT 16/12/2014)

Communication challenges were exacerbated by this constant change in Department personnel. Significant time was wasted re-explaining the considerable complexities of the project.

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CSIRO reporting requirements

Although there were good reasons for the requirement that LIEEP projects data be uploaded for examination, significant problems were created by the CSIRO data schema, and these affected the UTAS research team's capacity to meet other project requirements.

Some of the most significant issues experienced by UTAS with the schema were:

- the requirement for the various LIEEP projects to submit data in a common format being imposed after project design had been completed;
- the increase in the amount of data required to be submitted beyond that specified in the contract, with ramifications for project budgets developed on the basis of more limited data submission expectations;
- the CSIRO the development of the schema after the design of the research instruments had been completed, necessitating considerable successive adjustments to the instruments in order to align with CSIRO requirements and descriptors;
- the data the design of the schema itself, which requires data in a format which is incompatible with that generated by the GBS research design, necessitating considerable additional effort to extract, clean and reinterpret data to match schema descriptors and tabulations and resulting in some compromise over the analytical utility of what is provided;
- with the CSIRO in relation to the problems with the schema, exacerbated by additional and unexpected time pressures imposed by the Government on LIEEP projects;

Exclusion of those in government housing

A significant challenge to widespread engagement with GBS activities in CVR was the exclusion of those in any government owned housing. While GBS branding included the Mission Australia logo, those living in Mission Australia housing were ineligible to participate in the research component of the project. Not only did this create a sense of division and exclusion within the community it also meant that those in government housing were likely to be uncertain about their eligibility to participate in the free activities.

For a project aiming to build community capacity and cohesion, the exclusion of a significantly disadvantaged section of the community was problematic.

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Technological problems

There were some minor issues associated with the installation of data loggers in peoples' homes to enable the GBS team to monitor indoor temperature, humidity and energy use. For example, one participant's daughter (GBS014, 29 Jan 2015) was bothered by a light flashing on a logger installed in her bedroom and so the participant moved the logger to the spare room. In other instances where people were bothered by the logger light (GBS036, 30 Jan 2015; GBS022, 31 Jan 2015), the GBS team were able to place tape over it.

One participant (GBS021, 30 Nov 2015) was unhappy with the way the electrician had installed the data loggers in the meter board. Following the installation she was unable to close the meter board door. Her nephew installed a bracket to hold the cords away from the door.

8.8.4 Key Lessons

The CCB approach is in its early stages of development. SLT had previously never delivered such an approach to energy and comfort behaviour change. The following key lessons should be understood in this light.

The limited timeframe for EC training and subsequent project implementation impacted on the capacity of ECs to consolidate knowledge and practice.
Working with local people who understand disadvantage (and are themselves on various forms of government benefits) is important for gaining community trust and buy in, however different expectations about capacity are required.
Vouchers were important incentives for the GBS project but at times overshadowed the energy efficiency and thermal comfort messages.
The knowledge, skills and capacity of the Community Engagement Officer, particularly with respect to building the capacity of the Energy Champions and managing their ongoing

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contribution.
The visibility and legitimacy of the GBS brand within the Clarendon Vale and Rokeby communities, enhanced by the office space made available to the project at the Clarendon Vale Neighbourhood Centre.
Lengthy and time consuming interactions with the funding body and CSIRO added a considerable administrative and project management load, exacerbated by the many changes to the contract.
Much longer timeframes are required to maximise the effectiveness of Energy Champion recruitment, community engagement and participant recruitment strategies.
Low turn-out at community events should not be interpreted as meaning that events should not be run. Local residents place considerable symbolic value on these activities even if they do not personally attend. These activities support the legitimacy of the program when the ECs visit homes.
The matched goals between the CVR community and the GBS project (improving residents' thermal comfort within their homes and providing them with strategies through which they could reduce their expenditure on energy bills).

8.9 Conclusion

Organisationally the Get Bill Smart project can be considered a success.

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Sustainable Living Tasmania successfully delivered in home education and upgrades (EDUG) to 249 households. This was a tried and true approach to improving energy efficiency and thermal comfort in low income households. SLT and their HEHs were confident in their approach and program participants primarily responded with positive feedback. Key lessons from this part of the project were:

- Ensuring that people did not feel judged for their lack of knowledge or capacity was essential in implementing a program in low-income areas
- Previous SLT experience delivering EDUG contributed significantly to smooth and successful deliver of education and upgrades

- Differing expectations of the length and intensity of the in home education and upgrades created some concern from participants, clear communication of time expectations is essential.
- The lack of reversibility for some infrastructure upgrades was problematic when the new equipment failed – loss of goodwill and a frustration with energy efficiency is a risk.
- Lack of clarity around who is eligible for high needs upgrades can lead to dissatisfaction amongst participants and stress on those judging high needs.

- A large administrative load meant upgrades were slow to be approved and Home Energy Helpers found their workload spread over a longer period of time

By comparison, Sustainable Living Tasmania had limited experience delivering the community capacity building approach (CCB), indeed this approach more generally is in its infancy. Key lessons from this part of the project were:

- A strong and skilled Community Engagement Officer is vital for managing the diversity of skills and personalities of the Energy Champions
- Energy Champions who are imbedded socially and culturally within the community are vital for legitimacy of the project and help to translate energy efficiency and thermal comfort messages.
- In a low income setting, local Energy Champions are not necessarily work ready – many are on disability pensions, look after families, have health problems and/or other limitations on capacity. However these are the people who understand the community best. It is important to understand the value of working with people with this limited capacity and to provide the required support, training and management.
- Successful and positive branding of GBS improved community receptivity to the program
- One on one interactions were vital for increasing program participation and the activities of the ECs were integral in this regard.

- More time is needed to imbed the Community Engagement Officer within the community and to recruit the Energy Champions in order to achieve a strong team.

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- The exclusion of a particular group of people from project involvement creates divisions and reduced the capacity of Get Bill Smart to really imbed the project (and key concepts) into the community. No community building activity should be exclusive.

There were some key lessons that were relevant to the Get Bill Smart processes more generally:

- The strong communication established between the consortium members (and the further strengthening and development of these relationships), allowed problems to be worked through and resolved as they arose and key learnings to be shared.
- The tight timeframes, which compromised the recruitment process for key project staff, including the CEO and the ECs.
- The high administrative load related to the larger Get Bill Smart project meant that much of the message was about project participant rather than energy efficiency and thermal comfort and diverted significant resources to project management.
- The grocery vouchers as program incentives were vital to ensuring participation rates however in some cases this moved the focus from the main messages of energy efficiency and thermal comfort
- Ongoing interactions with participants is vital for building trust, this can be effectively done through a variety of ways; face to face interaction, phone calls, text messages; and contact can be made for a variety of reasons; research, education, administration.
- The research component affected the delivery of the other elements of the project. While it imposed a considerable burden, particularly with regard to paperwork, on participants, it also offered another one-on-one contact point for participant engagement with energy efficiency and thermal comfort.
- The additional pressures and constraints produced by poorly coordinated data collection and submission requirements, which were incompatible with the data generated by the research design.
- Inflexible contractual requirements (such as the exclusion of Mission Australia housing) caused procedural problems and diminished possible outcomes.
- The most successful engagement strategy is one-on-one contact between project staff and participants and community members.

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9 Project budget

The project budget in commercial in confidence and has been supplied to the Department of Industry, Innovation and Science.

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10 Synthesis of results

The synthesis of results section draws together the results from each sub-report section and is structured according to the initial Get Bill Smart project objectives:

1. Understanding how different energy efficiency approaches can assist low income households to reduce their energy consumption,[22]
2. Understand the processes, key determinants for success, barriers, and drivers for each energy efficiency approach,
3. Understand how benefits from thermal and energy efficiency improvements are utilised by low-income households in a cool temperate climate; whether households choose reduction of energy use or increased thermal comfort; and, the impacts of these improvements on health and wellbeing,
4. Assist low-income households in Rokeby, Clarendon Vale and Greater Hobart to be more energy efficient,
5. Provide employment, training and commercial opportunities for local residents and businesses.

10.1 Understanding how different energy efficiency approaches can assist low income households to reduce their energy consumption

While the CCB approach was effective in delivering energy saving messages to vulnerable and socially isolated households, the EDUG approach was more effective in delivering actual energy and thermal comfort savings. **Notably, when these two approaches were combined, EDUG + CCB, the energy and thermal comfort savings were increased.** Key factors that may have enhanced energy and thermal comfort savings include:

- multiple opportunities to receive energy efficient and thermal comfort messages and consolidate this knowledge;
- increased capacity to follow-up on measures received through home upgrade; and
- more exposure to role models in the local community who have been able to reduce their energy use.

In this section, we outline the impact of each approach in terms of assisting low income households to reduce their energy consumption.

[22] This objective has been reworded for clarity and to assist in structuring a response.

10.1.1 Community capacity building approach (CCB)

- The CCB approach provided people with multiple exposures to energy saving conversations (both one on one and in group settings) with energy champions, home energy experts and neighbours (see Project Processes and Organisational Analysis Report).
- The CCB approach emphasised strategies and measures for staying warm, reducing energy and saving money (see Project Processes and Organisational Analysis Report).
- The CCB approach normalised energy efficiency and thermal comfort conversations and language within the community (see Detailed Report section 5.2.3 and Case Study 27 – Pam and Family).
- The CCB approach did not deliver effective energy or comfort savings.
- The results for non-energy benefits were mixed. The CCB approach did not result in the survey recording increased community connectedness nor did it increase people's awareness of local people with thermal comfort and energy efficiency expertise (see Bulk Report Section 5.4.10 Perceptions of Community). However, local efforts to engage people ensured that energy messages reached a wide range of people, including those who are vulnerable, socially isolated and typically disengaged from community activities (see Project Processes and Organisational Report section 8.8.1 and 8.8.2).
- The 1 year cost benefit ratio for electricity savings for this approach is 254 suggesting on energy savings alone this is the least effective GBS approach (see Cost Benefit Analysis section 7.4).
- The total cumulative cost benefit ratio is 127. This indicates that $127 needs to be invested to make $1 saving on electricity and water bills (see Cost Benefit Analysis section 7.4).
- It was impossible to calculate the improvement in health benefits due to improvements in energy efficiency and thermal comfort but it is likely that these figures would change the cost benefit ratio of this approach.

10.1.2 In-home education and upgrade approach (EDUG)

- The EDUG approach entailed one-off visits from experts who provided education and installed relevant upgrades (see Project Processes and Organisational Analysis Report).
- The EDUG approach emphasised strategies and measures for staying warm, reducing energy and saving money (see Project Processes and Organisational Analysis Report).
- The EDUG approach delivered effective energy and comfort savings. Energy productivity has improved in this group through reduced energy consumption and increased thermal performance/comfort (see Cost Benefit Analysis report section 7.3.3).
- The EDUG group reduced their average energy usage by 1.4 kWh per day (see Bulk Report section 5).
- The EDUG group improved thermal comfort by reducing draughts in their home, they had less moisture on their windows (see Bulk Report sections 5.4.3 and 5.4.4).
- The EDUG approach also increased people's knowledge of keeping their home thermally comfortable in winter and summer (see Bulk Report section 5.4.6).
- The results for non-energy benefits were mixed. The EDUG approach did not result in increased community connectedness. However, people who did receive a home upgrade were more likely to agree that there are people in their community with knowledge of thermal comfort than those who had not received a home upgrade (see Bulk study section 5.4.10).

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- The 1 year cost benefit ratio for electricity savings for this approach is 10, which is a 10 year simple payback based on energy savings alone (see Cost Benefit Analysis Report section 7.4).
- The total cumulative cost benefit ratio is 0.86. This indicates that $0.86 needs to be invested to make $1 saving on electricity and water bills. (see Cost Benefit Analysis report section 7.4
- Based on the cumulative cost benefit ratio EDUG is the only approach yields a positive financial cost benefit, whilst also delivering improved thermal comfort. However the health benefits were unable to be accurately measured but would have improved the performance of the other approaches.

10.1.3 Combined approach (EDUG + CCB)

- The Detail Study findings and the Bulk Study suggest that the combination of EDUG and CCB approaches together may work better than when the approaches are used alone (see Detailed Report and Cost Benefit Analysis Report section 7.4). The data points to this but we were not able to prove this statistically given information came from the qualitative in-depth data in the Detailed Report rather than a statistical analysis. The EDUG + CCB approach entailed visits from experts who provided education and installed relevant upgrades. It also provided people with multiple exposures to energy saving conversations with energy champions, home energy experts and neighbours.
- The EDUG + CCB approach emphasised strategies and measures for staying warm, reducing energy and saving money.
- The EDUG + CCB approach delivered effective energy and comfort savings. Energy productivity has improved in this group through reduced energy consumption and increased thermal performance/comfort (see Detailed Report case studies 1-11 and Section 4: Comparative Analysis Findings).
- The EDUG + CCB group had average electricity saving of 2.8 kWh per day . (bulk study, section 5.4)
- The EDUG + CCB group experienced improved thermal comfort by reducing draughts in their home, they had less moisture on their windows (see Bulk Report sections 5.4.3 and 5.4.4 and Detailed Report Section 4).
- The 1 year cost benefit ratio for electricity savings for this approach is 10, which is a 10 year simple payback based on electricity savings alone (see Cost Benefit Analysis Report, section 7.4).
- The total cumulative cost benefit ratio is 1.3. This indicates that $1.30 needs to be invested to make $1 saving on electricity and water bills. (see Cost Benefit report, section 7.4)
- It was impossible to calculate the improvement in health benefits due to improvements in energy efficiency and thermal comfort but it is likely that these figures would change the cost benefit ratio of this approach.

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10.2 Understand the processes, key determinants for success, barriers, and drivers for each energy efficiency approach

In this section, we provide a summary of the key learnings in relation to each of the approaches.

Community Capacity Building Approach

Key learnings:

- It takes a lot of time to engage a community in a project of this scale. The short time frame meant that the events promoting energy efficiency were used to recruit people to the project, instead of the recruited people attending the events and engaging in this way (see Project Processes and Organisational Analysis Report sections 8.9and 7.9.3).
- Reviewing the community engagement plan periodically proved an essential process. This allowed the CCB focus at the end of the project to move from hosting large, centralised community events that had low attendance rates, to door knocking every eligible household in the Clarendon Vale and Rokeby community to provide energy efficiency education and a Stay Warm Save Money booklet.
- Low turnout at community activities appears to reflect people's preferences for one on one interactions rather than community and group forums. Evidence of this can be found in the Project Processes and Organisational Analysis Report section 8.9.1. However, community activities, even those poorly attended, can build the project profile in the community and improve people's receptiveness towards other approaches from project staff such as door knocking.
- The use of community champions in a CCB project depends significantly on the motivation, health and capacity of the Community Energy Champions to maintain their role within the project. If these qualities are not within the Community Energy Champions, then the role of the Community Engagement Officer becomes essential in the CCB (see Project Processes and Organisational Analysis Report section 8.9).
- Restricting the number of households (due to government ownership) in a community to be involved in a project is a major barrier to its success (see Project Processes and Organisational Analysis Report section 8.8).
- Grocery vouchers are an excellent driver for action in low income community projects (see Project Processes and Organisational Analysis Report section 8.9.3).

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Whilst financial success for a “stand alone” community capacity building approach to energy efficiency has not been demonstrated in the Cost Benefit Analysis the community Capacity Building Approach combined with in-home education and upgrades almost has a financial payback based on cumulative energy and water savings. When these financial benefits are combined with thermal comfort and health co-benefits an argument could be made for delivering a project with this combination of approaches

For a Community Capacity Building approach to be successful, it needs to be:

- A long term approach (3-5 years) that provides opportunities for project staff to trial different approaches and reset project goals.
- Community led.
- Sufficiently resourced to enable training and up-skilling.
- Embedded in an organisational that can provide HR and information support.
- Accommodating of individual preferences for communication channels (e.g. community notice boards and social media).
- Accommodating of individual preferences for group forums and one on one interactions when delivering education and support.
- Have strong linkages with organisations with both community development and sustainability skillsets

In-home Education and Upgrades Approach

Key learnings:

- This approach delivers moderate energy savings (1.44 kWh/day). However it has the most favourable cost-benefit ratio of 0.8 (see Cost Benefit Analysis Report section 7.4)
- Use highly skilled staff to educate and upgrade homes to be more energy efficient and use high quality, effective upgrade materials.
- In-home energy upgrades such as those installed via GBS are successful at reducing energy bills and contributing to peoples increased thermal comfort (see Detailed Report section 4).
- Upgrades need to be climate/location specific. The particular energy saving options and education where developed for a cool temperate climate and a particular tariff structure.
- Acquiring landlord consent from private renters can prove difficult and time consuming (see Project Processes and Organisational Analysis Report section 8.8.6).
- Providing a free in-home energy upgrade is an excellent driver for action in low income communities, especially in cold winter climates like Tasmania, where heating costs make up a large portion of power bills.
- Programs need to be adaptive to the needs of residents.

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- Households with large energy usage are likely to have the most energy saving benefits (see Detailed Report).
- Households with lower original energy usage will use in-home education and upgrades to improve the thermal performance of their home without necessarily saving energy or money (see Detailed Report section 5).
- Thermal comfort benefits such as reduced draughts and moisture on windows are correlated to improved health incomes and could be a justification for programs in their own right (See Cost Benefit Analysis 7.5.2)
- Households made sophisticated decisions related to managing energy and optimising their heating options.

For an in-home energy upgrades approach to be successful, it needs to be:

- Sufficiently resourced to enable upgrades and training and up-skilling of staff.
- Run through and organisation.
- Skilled home energy helpers who can assess and tailor to householder contexts.
- Have strong linkages with organisations with both community development and sustainability skillsets
- Engaging the right staff. Ensure quality advice is provided that is tailored according to need. Householder engagement requires a very particular skillset- we recommend experts with compassion and interpersonal skills. Employ experts who are able to be empathetic (not patronising) in low income/vulnerable household settings. HEHs from GBS have the skills to achieve much of the tailoring needed with the support of systems that support their decision making related to tailoring (eg identifying high needs households, and households who need more or less education).
- Streamline administration to participants ensuring eligibility criteria are minimised. Ensure programs are open to all home ownership tenures. Reduce blockages to participation.

Overall determinants for all approaches

The GBS study has outlined key determinants for success for any approach:

- Enough time needs to be allowed for householders to think through ideas and to engage with thermal comfort and energy efficiency changes.
- Experienced NGOs, experienced home energy experts and community engagement officers are key to success.
- Time needs to be budgeted for a program to become known and trusted in a community. NGOs understand that this means a program needs to be in a community for over two years to take real effect.
- Energy efficiency support organisations running energy efficiency activities need to visit and make contact with householders a number of times (every three months or so) for best effects to be made of support given.

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- Strong community connections allow for trust of the organisation running programs and for connections to be made with householders.
- Programs need to be transparent and trustworthy.
- Various information flows need to be encouraged and information needs to be shown to be legitimate.
- Trust needs to be established between organisations and householders. GBS established trust with the Energy champions approach and SLT being in contact with householders and regular contact from researchers.
- Income levels affect householder's ability to engage with certain support and suggestions for energy and comfort changes (see Detailed Report).
- Tenure significantly affects householder ability to engage with certain support and suggestions for energy and comfort changes (see Detailed Report).
- Health of occupants affects householder ability to engage with certain support and suggestions for energy and comfort changes (see Detailed Report).
- Housing quality and age of house (especially thermal performance) always affects energy efficiency and the extent that upgrades and energy efficiency changes can help a household (see Detailed Report).
- Occupants will move house and this cannot be avoided. Low income households move more often than other household groups. Instability in housing makes it very difficult for householders to engage with making energy efficiency and comfort changes, so programs will have to take a greater role.
- Occupant numbers affect overall use and use per person - consider and incorporate per occupant numbers.
- Older and younger people and people who are unwell are often much more affected by uncomfortable houses and often require more heating to stay well.
- Occupant house use patterns affect energy use, for example a house may have day time occupants or work at home occupants, or be void of people during the day.
- Appliance, especially heater and hot water, appropriateness, quality and efficiency all affect energy efficiency support activity outcomes.
- Availability of affordable high quality fuels for heating, electricity, gas and wood affects the energy efficiency and comfort of many householders in Tasmania.
- Personal and household capacity varies greatly and may mean that there is great difference between households in what can be achieved without help.
- Payment methods for bills affects how people process energy use as it is the main form of feedback they receive about their energy use.
- Payment methods that are not suited to the household tend to adversely affect management of energy and perceptions of affordability.

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- Daily energy use practices, e.g. heater use practices are essential to understand as this affects the way technologies and practices are understood.
- Home energy use practices were observed in GBS to be persistent before and after changes in many households (see Detailed Report). Changing energy use "practices" may need a lot of effort in programs.
- Feeling safe and in control within the home is a top priority for householders, hence programs need to recognise these as priorities, always engage respectfully and take care to respond to householder requirements. In many instances this trumps both the financial savings and the comfort savings that can be made (see Detailed Report)
- Comfort means different things to different people and this affects take up of programs, practices and technologies (Gabrielle et al. 2016).
- Complexity of everyday lives of occupants is a real issue and makes it hard for householders to always prioritise a support program's activities. Ensuring real household needs are being attended to with a program assist householders to engage (see Detailed and Project Processes and Organisational Analysis Reports).

The cumulative cost benefit analysis (Table 10-1, below) demonstrates that the most financially effective approach is the in-home education and upgrades. This is followed by the same approach combined with community capacity building.

Table 10-1 Cumulative Cost benefit analysis (Level 3)

	Community Capacity building with in-home education and upgrades	In-home education and upgrades	Community Capacity Building
Total cumulative (electricity + water) savings	$1596	$1400	$11
Cost to deliver $1 of savings (cost-benefit)[23]	$1.32	$0.86	$126.93

[23] Level 3 cost benefit analysis, using cumulative electricity and water savings.

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10.3 Understand how benefits from thermal and energy efficiency improvements are utilised by low-income households in a cool temperate climate; whether households choose reduction of energy use or increased thermal comfort; and, the impacts of these improvements on health and wellbeing.

To identify benefits and how they were utilised (the trade-offs made) this section identifies measureable changes observed, overall benefits of GBS activities identified and then outlines key trades made between energy savings, thermal comfort and other home life needs and activities. Findings noted here are drawn from the detailed study unless otherwise noted.

10.3.1 Measured outcomes

Measured changes were observed in: overall electricity use, heater use, heating efficiency, hot water, change to comfort zone, moisture levels. Overall EDUG +CCB came out with the best performance (in both household and on a per occupant basis) (see Detailed Report sections 4.1.1 and 4.2.2).

The data referred to below *excludes* those detailed households who have wood or gas heating or moved house during the project (a total of 35 detailed households – see Detailed Report section 4.2.1) unless noted otherwise.

Overall electricity use

Peak cold weather electricity use increased for all four groups in the after period. EDUG + CCB increased their total electricity use by 3.79kWh/day (11.3%), REP increased by 2.78kWh/day (9.2%), CCB increased by 3.59kWh/day (6.3%) and EDUG increased by 1.53kWh/day (6.2%). When looked at on a per occupant basis EDUG + CCB actually *decreased* their energy use by 2.58kWh/day (19%), EDUG increased electricity use by 0.28kWh/day (2%), CCB increased electricity use by 1.5kWh/day (7.9%), while the REP group increased electricity use by 4.22kWh/day (20.8%).

Heater Use

When it came to heater use, EDUG + CCB increased their total heating electricity use by 4kWh/day (29.2%) (which correlated with an increased time spent in the comfort zone compared to the other groups), REP increased by 2.44kWh/day (12.7%), EDUG increased by 0.67kWh/day (7.2%) and CCB increased by 1.88kWh/day (6.2%). When looked at on a per occupant basis EDUG + CCB *decreased* their heating energy per occupant by 1.1kWh/day (16.7%).

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All other approaches increased their heater use. EDUG increased their use by 0.17kWh/day (3.1%), CCB increased their use by 0.47kWh/day (4.6%) and the REP group increased their use by 3.06kWh/day (24.2%).

Of note was that data in the detailed report showed that HEHs had success with encouraging householders to shift heating strategies. HEHs suggested that householders transfer heating to more efficient heaters that were available in the house and to heaters using a more affordable tariff; heating use went up but energy bills remained stable as energy was used more efficiently. This is also suggested by the Bulk study findings.

Heating efficiency

Excluding houses that used wood fire and gas as their main heating, the EDUG + CCB group had the most significant increase in heating efficiency (25%). The EDUG group's average efficiency increased by 7.6%, CCB's by 0.5% and the REP group's efficiency decreased. Before and after heating efficiency changes showed a clear pattern of diminishing returns from extra heating energy input into houses. As increased energy was pumped in, less came back as improvements to indoor temperatures. This pattern was related to the poor standards of thermal resistance of the building shells of the houses.

See the Detailed Report (section 4.2) for a more in-depth explanation of heating efficiency.

Hot water

On a household comparison of *all* households in the detail group, hot water increased most notably in the CCB group compared to REP group. The EDUG group's use also increased. The EDUG + CCB group's use decreased but decreased less than the REP group. On a per occupant basis compared to the REP group, the EDUG + CCB group was the only one that reduced its use. Both the CCB and the EDUG increased their use when compared to the REP group on an occupant basis.

During in home visits HEHS retrofitted water efficient shower heads, hot water tank insulation and hot water pipe insulation. These upgrades did support improvements in a range of houses (when viewing houses case by case). The bulk data also suggests that Hot Water (Tariff 41/42) usage decreased in the EDUG + CCB and EDUG groups. We could not ascertain statistical significance for this pattern.

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Comfort

When looking at all households including those with non-electric heating and comparing them with the REP group the EDUG+CCB and the CCB group improved their comfort levels. Both the CCB and the EDUG groups had slightly reduced comfort on average. When all houses with wood and gas heating as their main heating are taken out (that is the 35 houses reported in the energy use data above): the EDUG +CCB group had the most increased comfort and other groups had slight reductions of comfort levels. However, EDUG +CCB's time in the comfort zone did come with a correlating increase in heater use.

Moisture levels

Surface condensation, moisture and mould issues were reported by a range of householders from all groups. Humidity and moisture were ok in most houses but were actually borderline problems that require further investigation. Most detailed houses living in older and under-insulated houses presented with temperatures that only just stayed away from meeting dewpoint (and therefore stayed just away from serious condensation problems). Management by householders helped to limit moisture issues through practices such as installation of moisture beads, heating, wiping windows, opening windows. The temperatures in most newer (post 2003) houses stayed well away from dew point in general when graphed. The SLT upgrades did not seem to affect moisture levels adversely in general – but more investigation of the GBS data is needed on moisture levels and mould. One house with moisture and mould issues did report increased mould and moisture after an in-home education and upgrade visit, but there were other construction issue impacting this outcome.

10.3.2 Benefits identified

The different houses in the study had various successes and faced various challenges. Benefits noted from after data provided by the detailed group include:

- energy use reductions (see Detailed Report and Bulk Analysis Report),
- energy cost reductions (see Detailed Report and Bulk Analysis Report),
- increased time spent in the comfort zone (temperatures between 18°C and 24°C) (see Detailed Report),
- perceived improvement in comfort (see Detailed Report),
- health improvements (including reduction of stress) (see Detailed Report),
- heating efficiency improvements (see Detailed Report),
- increased confidence finding information on energy efficiency and comfort (see Detailed Report and Bulk Analysis Report),
- improved sense of control of energy in the home (see Detailed Report and Bulk Analysis Report),

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- improved sense of capacity to manage various aspects of the home (see Detailed Report and Bulk Analysis Report),
- improved moisture levels in the home (see Detailed Report),
- repeated exposure to energy efficiency information (see Detailed Report and Bulk Analysis Report),
- connections with energy champions (see Detailed Report and Bulk Analysis Report),
- pride in the knowledge and capacity of community (a positive association with an area that does not perpetuate stigma) (see Detailed Report and Bulk Analysis Report),
- a strong sense that people 'out there' care about 'people like us (see Detailed Report and Bulk Analysis Report)', and
- physical home upgrades (including draught proofing, water efficient shower heads, Eco switches, hot water insulation, ceiling insulation and curtains).

Improved time in comfort zone occurred for a range of households across the groups. Improvements to thermal comfort were very much needed in many cases due to low indoor temperatures that failed to support occupant health. GBS detailed study participants overall were living with an average time in the comfort zone of 37% in the after period. This was a small improvement on the before period (4%). The overall median was only 32% in the after period (also a slight increase on before). These comfort averages and medians figures are low and indicate that during winter inside temperatures in detailed study households were below World Health recommendations for substantial periods of time. While 32% may sound like a good portion of time for those who are often out during the daytime, for many in this study who were unemployed, at home with children or retired, this means being cold for a significant proportion of time at home. This problem with low indoor temperatures in Tasmania is reflected in other studies that also found Tasmanians tend to live in indoor temperatures that are colder than World Health Organisation (WHO) standards (Watson 2013).

10.3.3 Energy use reduction or improved comfort: trade-offs made

Trade-offs were made by many houses when the opportunity arose. When energy efficiency improved or energy costs went down householders used the extra 'slack' available. Householders tended to use any positive changes to energy efficiency or affordability to improve thermal comfort, particularly for wellbeing and health. We observed that in their complicated lives householders want, in general, to be healthy and functional. If their situations allowed them a chance to make a positive change for health or wellbeing, they used it. Householders traded energy and comfort against each other (see heating comparisons in Detail Report), but they also traded energy saving with other things too (including other household bills, groceries and treats for children and household performance related to moisture and mould).

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Better thermal performance in newer houses built post-energy efficiency building regulations meant less trades-offs were needed to be made by householder between comfort and health. Heat pumps[24] also assisted to make the energy versus comfort trade-offs a little less problematic. Despite heat pumps not giving out such a comforting heat they did tend to heat rooms more efficiently. Occupants with newer houses that had wired in radiant/fan heaters however, still felt they had to make a choice between comfort, health and energy costs.

Surface condensation and mould reductions or avoidance of these often had to be traded with other performance in the home. Houses were often moist or mouldy because of the house age, conditions, related thermal performance, heater effectiveness and problematic venting (or lack of it). Trade-offs were made between drying out the house and keeping warm (and keeping the moisture inside). Uncomfortable draughts likely kept houses just dry enough to stop moisture issues. So there was a trade off in the poor quality housing of ‘do we let the air through and be cold?’ or, ‘do we heat and keep the moisture in?’

Choice of the heaters used was important and also ended up being a trade-off related to energy and comfort in the home. The pros and cons had to be weighed up: plug in heating cost more per kWh but could be used when there was no wired in heating or in rooms that wouldn’t otherwise be heated; wired in heaters were often more effective but were permanently positioned in the living areas or a hallway. Trade-offs were therefore made between heater types, effectiveness, costs and locations. Heater performance was undermined by inappropriate heating for the context, poor performance in heaters and poor thermal performance of the housing. HEHs’ suggestions about transitioning to more effective heaters, better ways of using heaters and cheaper tariffs were acted on by householders and show how householders thought through and acted on important trade-offs.

Occupant micro politics, such as differences between occupant priorities, negotiations with landlords and caring for animals, all affected home comfort and energy use practices. We observed, for example, that:

- when only one householder was keen to save energy or make changes or one occupant was primarily responsible for paying energy bills, then energy saving actions were often overridden by other occupants,
- new occupants often created a jump in energy use and a loss of control over energy efficiency practices,
- tenants would put aside ideas of energy upgrades if landlords didn’t support them or if tenants thought landlords would disapprove, and

[24] Heat Pumps AKA Reverse Cycle Air Conditioners used in heating mode use around 1/3 of the energy to heat a space compared to resistive heating

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- animals and their movements and needs regularly affected energy use and were prioritised over energy efficiency practices.

Moving house for better comfort (and a better heater) was more of a drastic trade off we observed. Householders were prepared to put up with the hassle of a move because their old homes were so uncomfortable. Realistically new homes were not significantly better, but comparatively they were a big improvement.

Key influences related to all the trade-offs made included:

- Time available
- Number of times SLT was in in contact with each household
- Community connections
- Information flows and legitimacy of information
- Trust between organisations and householders
- Income level
- Tenure
- Health of occupants
- Housing quality and age of house (especially thermal performance)
- Occupant numbers and ages
- Occupant house use patterns (e.g. home during day or not)
- Appliance, especially heater and hot water, appropriateness, quality and efficiency
- Availability of affordable high quality fuels for heating, electricity, gas and wood
- Personal and household capacity
- Payment methods for bills and related feedback on electricity consumption
- Daily energy use practices, (e.g. heater use practices)
- Persistence and of daily habits after support activities
- Safety and stability within the home
- Complexity of everyday lives of occupants.

10.3.4 In summary

Overall benefits of GBS energy efficiency activities were gained in a variety of areas related to energy, heating, comfort, confidence with information, thermal and moisture performance of the house, community and personal

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connections, improved thermal conditions in the home, health and stress, and increased choices/options for energy use and comfort.

Mostly, in what are often low energy use houses, householders took opportunities to use extra energy, rather than save it. They used energy most often so they could attain thermal comfort and support related health needs. Alongside thermal comfort and health householders used extra energy for other reasons, most importantly, to support poor housing and appliance performance, because other occupants were not invested in energy efficiency or there were new occupants, for animal care, and because of a lack of investment by landlords.

Householders were often trying to stay warm enough so they could stay healthy and generally function in their lives. This priority indicates that when given a chance householders want to be well and productive.

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10.4 Assist low-income households in Rokeby, Clarendon Vale and Greater Hobart to be more energy efficient.

This project worked with 498 low income householders many of whom were unemployed and living below the poverty line (See Bulk report, demographic analysis).

The project assisted low income households in Rokeby, Clarendon Vale and Greater Hobart in the following ways:

- 272 houses received an in-home education and upgrades by participating in the EDUG and EDUG + CCB approaches.
- In total 61houses received improved insulation.
- In total 26 houses received new curtains.
- A further 15 houses who participated in the REP group received an in-home education and upgrade as a prize after the study period.
- 498 households who completed surveys received grocery vouchers.
- Approximately 340 people received a Stay Warm booklet.
- A range of minor energy efficient measures were provided to people at community forums.

The project also provided intensive assistance to twelve low income people in Rokeby and Clarendon Vale who were recruited to be local energy champions. The champions were employed casually throughout the duration of the community capacity building implementation. They received:

- Training in energy efficiency and communication.
- In-home education and upgrade.
- 4received improved insulation.
- 4 received new curtains.

The project also assisted low income households to significantly reduce their energy usage:

- EDUG group reduced their energy use by 1.4kWh per day on average ($112 PA).
- EDUG group saved a cumulative $1400 on electricity and water bills over the equipment service life.
- EDUG +CCB group reduced their energy use by 2.8kWh per day on average ($218 PA).
- EDUG + CCB group saved a cumulative $1596 on electricity and water bills over the equipment service life.

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10.5 Provide employment, training and commercial opportunities for local residents and businesses.

The Get Bill Smart Project provided 34 jobs for residents in the Greater Hobart region. 12 of these where specifically targeted at the project area in Clarendon Vale and Rokeby. The project also engaged and spent $277,000 on local Tasmanian businesses. In detail the project:

- casually employed 12 local energy champions over 15 months ($56,457).
- casually employed 10 local energy auditors over 12 months ($89,488).
- contracted energy data analysis that employed 7 people over a period of 3 years ($100,458).
- employed 2 research staff at the University of Tasmania for monitoring and evaluation (average 1 FTE).
- employed 9 project staff at SLT(various levels of commitment) over the project (average 2.5 FTE).
- purchased technical data logging equipment and commissioned product development from 4 companies ($126,761).
- purchased $64,013 worth of energy efficiency materials from Australian businesses.
- subcontracted an additional $90,955 of energy efficiency materials (mainly insulation and curtains) from Tasmanian business.
- spent in total $277,487 on Tasmanian businesses (NB excludes UTAS and SLT staff).

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11 Recommendations

11.1 A large scale residential energy productivity program

The evidence shows that a program that delivers in-home education and upgrades (EDUG) is effective for improving energy productivity. Such a program would return the Governments investment in energy and water savings alone (cumulative cost benefit ratio of 0.86). When combined with the known improvements to condensation and thermal performance and their links to health outcomes, such a program becomes compelling

A community capacity building approach when combined with in-home education and upgrades (EDUG + CCB) is also valuable as it reinforces messaging and increases the impact of the project. Whilst the cost benefit ratio is not as favourable as in-home education and upgrades (EDUG) alone it is argued that some elements of a community capacity building approach would improve project impact.

A successful program would:

- Involve in-home education and upgrade visits. Upgrades have been shown to generate tangible benefits to households (see Bulk and Detailed Reports). The upgrades suite would be similar to those undertaken under Get Bill Smart.
- Heat Pump upgrades should be considered as part of the program, given the sustained energy savings and thermal improvements they deliver (see detailed study section 5.3.3)
- Ensure multiple repeated opportunities to engage each householder. Create engagement with households prior to and post home upgrade visits to ensure householders understand the scope of works and then understand how to augment upgrades made (see Detailed and Project Processes and Organisational Analysis reports).
- Ensure quality advice is provided that is tailored according to need. Householder engagement requires a very particular skillset – we recommend experts with compassion and interpersonal skills (see Detailed and Project Processes and Organisational Analysis reports). Employ experts who are able to be empathetic (not patronising) in low income/vulnerable household settings. HEHs from GBS have the skills to achieve much of the tailoring needed with the support of systems that support their decision making related to tailoring (eg identifying high needs households, and households who need more or less education).
- Be large scale, delivering home visits in the thousands rather than the hundreds.
- Be a multiyear program (3-5 years) that creates a "learning environment" for delivery organisations so they are empowered to refine and improve approaches over time (see Project Processes and Organisational Analysis report)..
- Streamline administration to participants ensuring eligibility criteria are minimised. Ensure programs are open to all home ownership tenures (see Project Processes and Organisational Analysis report).
- Deliver CCB approach in a streamlined manner, small teams of energy champions based in community houses with support at a regional level by a community engagement officer/s (see Project Processes and Organisational Analysis report).
- If possible Energy Champions visit participants before and after the EDUG visit. This will ensure the household is ready for the visit and also assist reinforcing concepts at a later date (see Project Processes and Organisational Analysis report).
- Tailor approaches to climates – each region has its own energy efficiency typology that needs to be addressed.

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- Understand the driver for a program and tailor approaches to this. I.e. if energy savings are the only measure, focus on PAYG customers with large energy bills (see bulk study section 5.4.4). If population health is the driver, focus on older dwellings and low energy users. Multiple aims require a multi-method, multi-scaled approach (reducing energy use is easier in households that use more energy, however this risks ignoring vulnerable low energy users with poor comfort and limited capacity).
- Ensure householders are able to understand the processes of the program and choices that may be made about upgrades. Ensure communications and structures are transparent, that decisions are consistent and understandable (see Project Processes and Organisational Analysis report).
- Link energy productivity programs with health agency programs in recognition of the strong links between thermal comfort and health. Work in the area of the social determinants of health could be a basis for this (see Detailed and Cost Benefit Analysis reports).
- Partner with research organisations to longitudinally study the health impacts of the program (for example see University of Otago health and housing studies[25]).

In summary after review, the GBS team believe that EDUG coupled with a modified CCB component would offer the most potential benefits to the community.

11.1.1.1 Targeted program options

Our research indicates the following approaches would have solid energy savings. In addition, a number of these approaches would have thermal comfort improvements.

- Change all the showerheads in the country to low flow. Over the life of a showerhead it will save over $300 of water, notwithstanding significant electricity savings (see cost benefit analysis)
- Convert electric heaters to heat pumps. For example SLT recently ran a community bulk buy program for heat pumps that reduced the purchase and install price by around 20%. This program was operating successfully, until it interacted with a State government rebate for "No Interest Loans" on energy efficient appliances. 100's of applications where received within days. See http://www.slt.org.au/bulk_buy for details. Rebates and community mobilising can create energy efficiency outcomes in a market based environment.
- Insulate ceiling and floors in Tasmanian houses

11.2 Policy recommendations

Policy recommendations are listed below.

Improve the thermal performance of houses in Tasmania (and southern Australia) through:

- Phase out energy-intensive hardwired resistive heaters in cold climates as they are inefficient, expensive and ineffective.
- Subsidise heat pump purchase.

[25] http://www.otago.ac.nz/wellington/departments/publichealth/staff/otago024457.html

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- Ensure minimum rental standards include roof insulation, reasonable draught proofing, hung curtains in the living area and hot water efficiency.

Integrate community engagement and capacity building in collaboration with in-home education and upgrades by:

- Ensuring all community capacity building projects have sufficient time for recruitment and training, and to integrate key ideas, concepts and behaviours into the community (see Project Processes and Organisational Analysis report).
- Providing strong local leaders in low income areas who are physically situated within the community and with significant resourcing and support, to manage, mentor and train low capacity community members to become (and continue to be) community champions (see Project Processes and Organisational Analysis report).
- Acknowledging key priorities and drivers of behaviour within different communities and demographics (see Project Processes and Organisational Analysis report).
- Genuinely valuing the importance of respect and care for the successful engagement of people with energy efficiency and thermal comfort behaviours by ensuring appropriate time and capacity for initiating and maintaining relationships (see Project Processes and Organisational Analysis report).
- Ensuring that metrics designed to measure program success go beyond simple attendance numbers and easily measurable engagements (see Project Processes and Organisational Analysis report).
- Placing a value on difficult to measure such as the slow movement of knowledge through social networks, the small changes that happen over time as a result of exposure to ideas and norms, the motivation people give each other through good experience and the shift to different 'normal' ways of doing things (see Project Processes and Organisational Analysis report).
- Identifying ways that governments can work with community networks, being sensitive to the fact interactions with government in low-income areas are generally avoided (see Project Processes and Organisational Analysis report).
- Ensuring that existing knowledge about local culture, practices, limitations, expertise and challenges are integrated into program design and implementation (see Project Processes and Organisational Analysis report).
- Supporting capacity exchange within the community to allow existing knowledge to be shared and developed (see Project Processes and Organisational Analysis report).

Integrate health priorities with energy efficiency aims:

Trade offs in GBS and overseas evidence shows that benefits of energy efficiency upgrades in cold climates are predominantly taken as thermal gain. (see Detailed Study section 4.4.5) Energy savings are taken in this way because health and function are important to householders. Improvements to the warmth and comfort of the home are linked to improvements in health and reduction in mortality (Gasparrini et al., 2015). It is argued that this thermal gain can improve health outcomes on a broad scale reducing the drain on health systems.

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The health gains from improved thermal comfort are significant. Studies from New Zealand have linked energy efficiency programs (such as installing insulation) with savings to the health system. Grimes et al., (2011) found that for every $8 spend on energy savings there was a related $608 in health benefits[26]. This linkage is strong and the health benefits tend to overwhelm the energy benefits by several magnitudes. In a review of the NZ "Heat Smart" Program the health benefits are attributed to be 99% of the project benefits. These health benefits include reduced mortality, less hospitalisations and reduced pharmaceutical use (Grimes et al., 2011).

Similarly in a study of 1350 households that had recently installed ceiling insulation, Howden-Chapman et al., (2007) concluded that

"Insulating existing houses led to a significantly warmer, drier indoor environment and resulted in improved self rated health, self reported wheezing, days off school and work, and visits to general practitioners as well as a trend for fewer hospital admissions for respiratory conditions"

The World Health Organisation also acknowledges the importance of properly maintained houses for healthy living. In particular they provide policy advice in order to combat condensation and mould and their impact on health outcomes:

"Dampness and mould may be particularly prevalent in poorly maintained housing for low-income people. Remediation of the conditions that lead to adverse exposure should be given priority to prevent an additional contribution to poor health in populations who are already living with an increased burden of disease." (WHO, 2009, p xv[27])

We argue that thermal comfort changes are a significant component of the GBS program and the impacts of these should not be discounted relative to changes in energy use. In fact health outcomes are likely larger than energy outcomes. In order for this to be recognised at a program **level improving thermal comfort needs to be treated as a "health intervention".**

Opportunities for linking thermal comfort and energy efficiency with health programs are currently limited, especially as preventative health or so called "Social determinants of health" receive much less funding than

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[26] Low scenario, Table 30, pp 26 http://www.healthyhousing.org.nz/wp-content/uploads/2012/05/NZIF_CBA_report-Final-Revised-0612.pdf
[27] http://www.euro.who.int/__data/assets/pdf_file/0017/43325/E92645.pdf

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emergency or general practice care. A potential policy initiative could be the creation of Social Impact Bonds[28] issued at a population level to change health incomes by improving the thermal performance of households. We have not critically examined this possibility however further research into this may help to consolidate linkages and improve further policy directions.

[28] http://www.socialventures.com.au/investment/social-impact-bonds/

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12 Conclusion

Get Bill Smart successfully trialled a community capacity (CCB) approach with an in-home education and upgrade (EDUG) approach in Greater Hobart. Through monitoring this trial we now better understand (with evidence) the processes, key determinants and possible outcomes that affect energy efficiency interventions program like Get Bill Smart in the Tasmanian context.

Despite householders often living in very poor housing stock and despite working with householders with limited capacity to make energy and comfort changes, Get Bill Smart activities were still able to create various positive outcomes for householders. GBS evidence showed that in-home education and upgrade visits by Home Energy Helpers improve energy productivity by reducing energy use and increasing thermal comfort. This effect is even greater when community capacity building (with energy champions) is mixed with in-home education and upgrade visits. **A successful future program can include all aspects of the in-home energy efficiency visits and modified components of the community capacity building.** It is envisaged this approach would have a cumulative cost-benefit ratio of around 1 as well as delivering thermal comfort and health benefits. Combining the energy savings and health benefits will deliver a substantial net benefit to society.

GBS evidence has outlined key structural barriers challenging moves made for energy efficiency in the Tasmanian context. Critically poor thermal performance of the stock and persistent socio-economic challenges still undermine energy efficiency and comfort efforts by householders and NGOs. Participants live at relatively low indoor temperatures, often under World Health Organisation recommendations and on very low incomes. It cannot be emphasised enough the significant limitations that such poor housing stock places on the capacity of householders to engage in energy efficient behaviours and to be comfortable in their homes. Just achieving one of these aims is difficult in such poor housing, with such limited financial capacity, while achieving both together seems near impossible.

GBS showed that for low income householder's affordability and health needs are closely affected by home energy use and comfort and therefore also need to be engaged with in energy efficiency in housing is to be achieved.

To overcome structural barriers the GBS team suggest to following policy initiative:

- **Improve thermal performance of existing houses**
- **Develop a long term energy efficiency program based on current practice**
- **Refine and develop community engagement within a long term energy efficiency program, and**

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- **Integrate health priorities with energy efficiency aims through all policy initiatives.**

Through a long term energy efficiency program with community engagement, improvement of the housing stock, and recognition of health priorities embedded in home energy use and home comfort there is an opportunity to transition householders towards better health and better productivity.

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14 Appendices

Appendix 1 Stay Warm Save Money Educational Booklet

Appendix 2 Energy Champion Case Studies

Appendix 3 - Assumptions for cost benefit analysis

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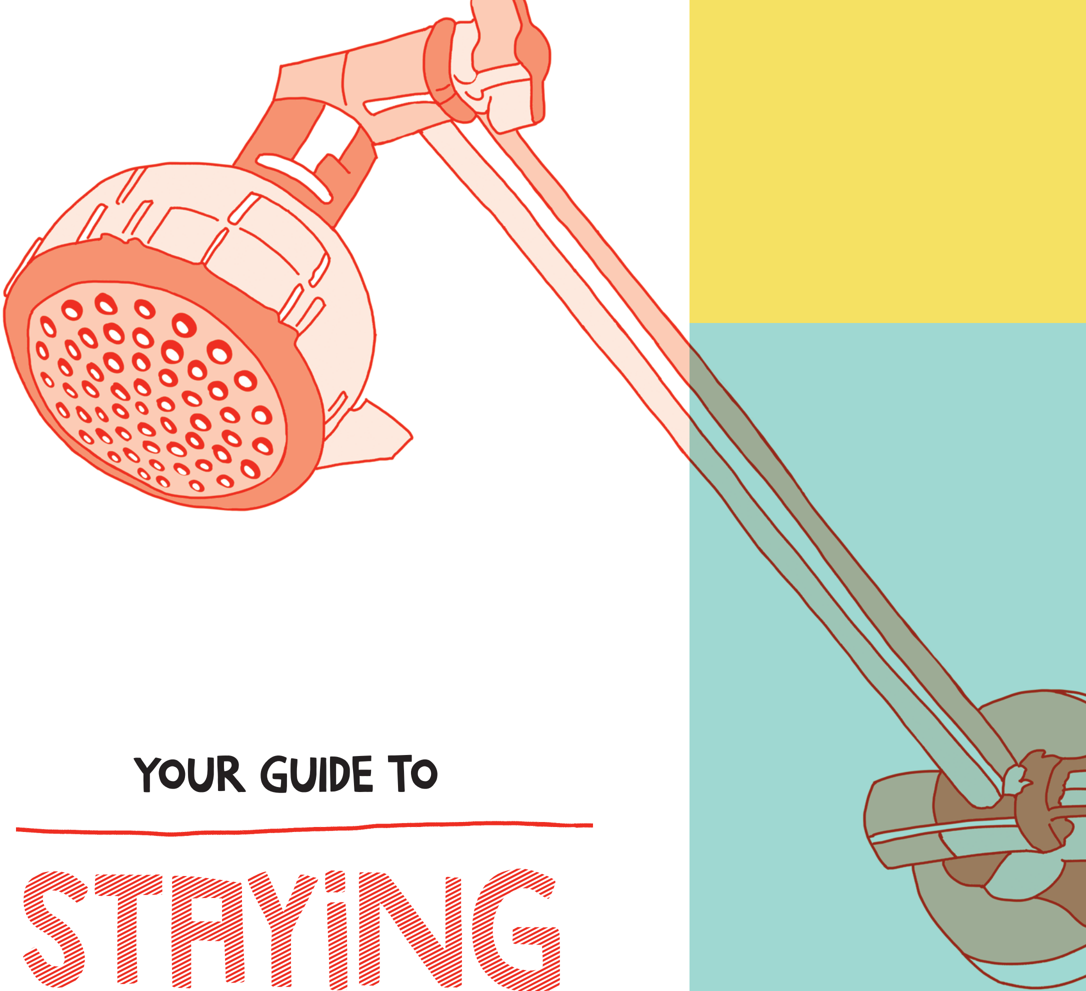
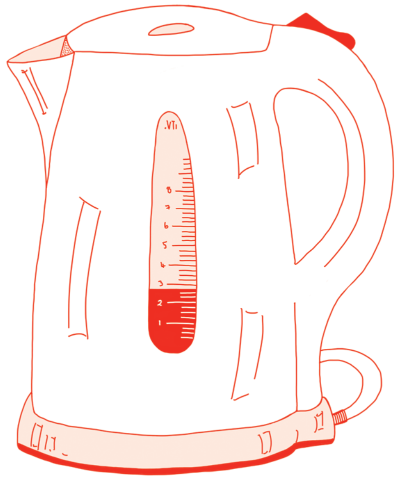
Appendix 1



YOUR GUIDE TO

STAYING WARM & SAVING MONEY



GET BILL $MART

This easy guide to cutting your power bills has been developed by **Sustainable Living Tasmania** (SLT). SLT is a not-for-profit organisation that has been spreading the word on sustainability for 40 years. We deliver programs and advice on home energy efficiency, food security and transport. We also host Tasmania's annual Sustainable Living Festival.

The development of this guide was originally sponsored by the Tasmanian Government. Rights to reproduce and alter the booklet have been granted for the purposes of this project.

The Get Bill Smart Project is assisting low income households to be more energy efficient. It is funded by the Department of Industry as part of the Low Income Energy Efficiency Program. Get Bill Smart is being delivered by a consortium of three organisations; Mission Australia, Sustainable Living Tasmania, and The University of Tasmania.

For more information visit: www.slt.org.au/gbs

Sustainable Living Tasmania: Level 1, 71 Murray St, Hobart. Ph (03)6234 5566

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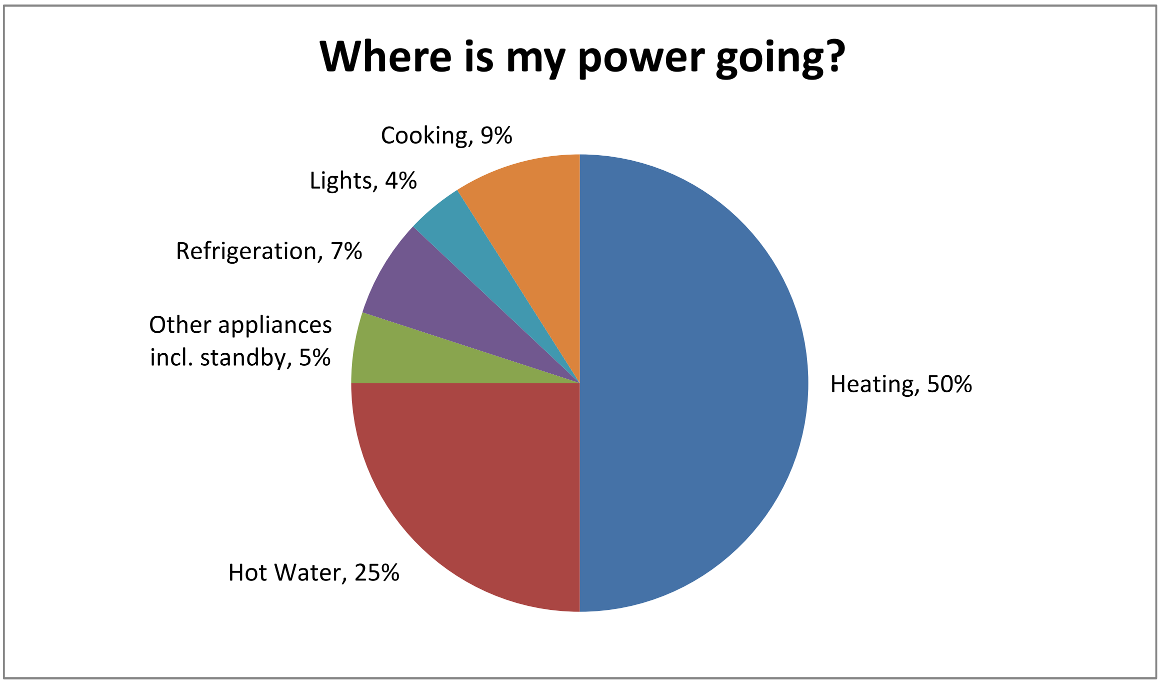
Save money & stay warm

There are lots of simple ways to reduce power costs – even if you live in a rental house. While each action is small, combined they can help save hundreds of dollars on your power bills.

This booklet can help you to decide which options will work best for you. Not all of these actions will suit each house and some require the approval of the property owner or a plumber.

Heating and hot water are the major power costs for most Tasmanians, especially in the winter months. You can also save money on lights, cooking, fridges and much more. Find out in this book what you can do.



(Information based on average Tasmanian home)

How much energy do I use?

very day the average 4 person house in Hobart uses around 42 kWh in winter and 27 kWh in summer. That's around $3100 per year in electricity bills. You can see the average and compare your bill at **www.energymadeeasy.gov.au**

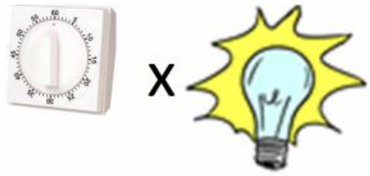
About your electricity bills

Electricity bills are measured in Kilowatt hours (**kWh)**. It is a measure of "power use" multiplied by the amount of "time" that it is used. It equals 1000 Watts for 1 hour.

1kWh =

1000 Watts for 1 hour

1 x Incandescent Light bulb for 10 hours

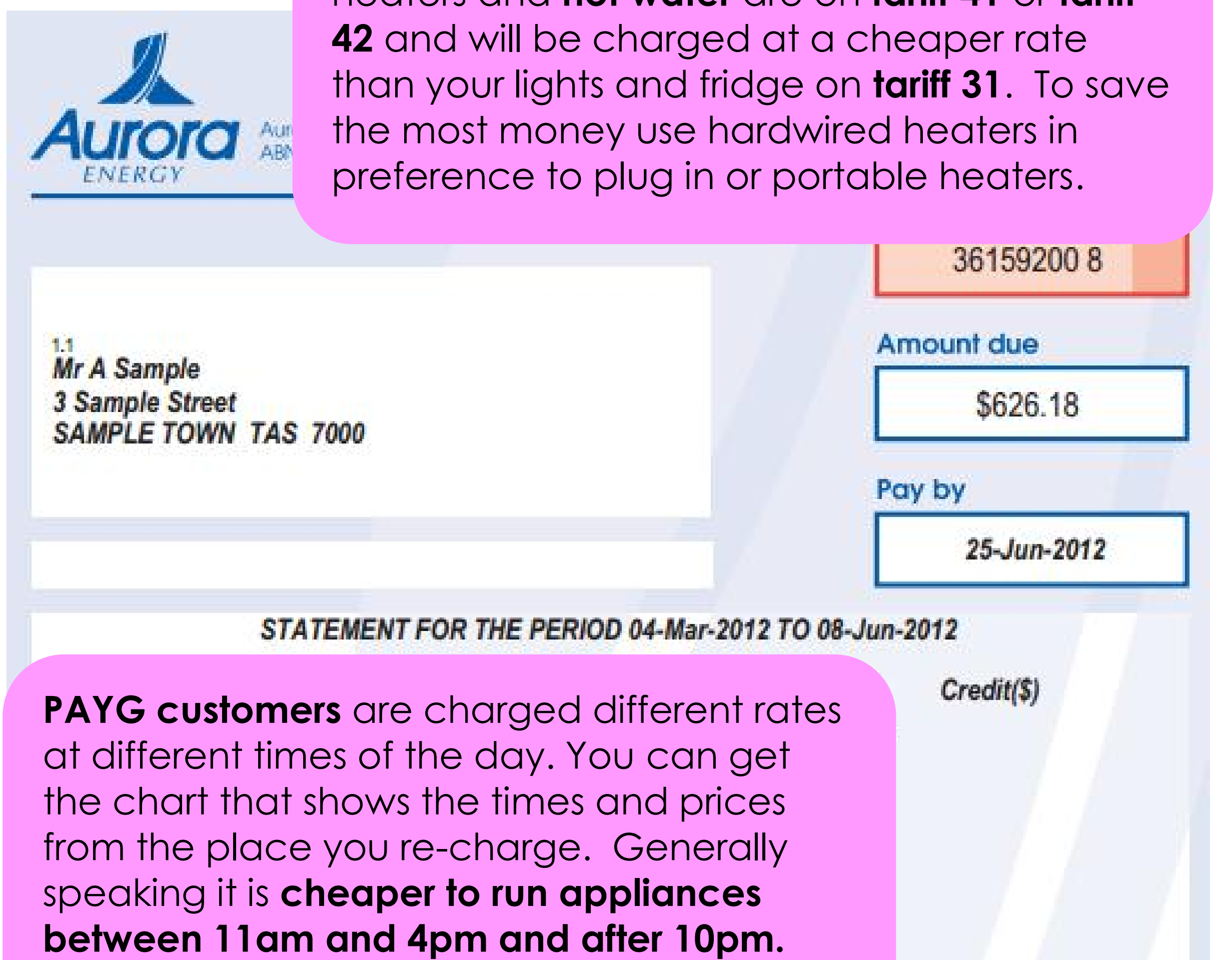


(100W x 10hour = 1kWh

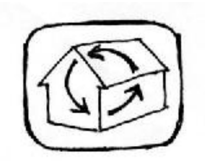
OR/ A kettle running for 25 minutes

(2400W x 25m = 1kWh)

For people on **Quarterly bills** your **"hardwired"** heaters and **hot water** are on **tariff 41** or **tariff 42** and will be charged at a cheaper rate than your lights and fridge on **tariff 31**. To save the most money use hardwired heaters in preference to plug in or portable heaters.



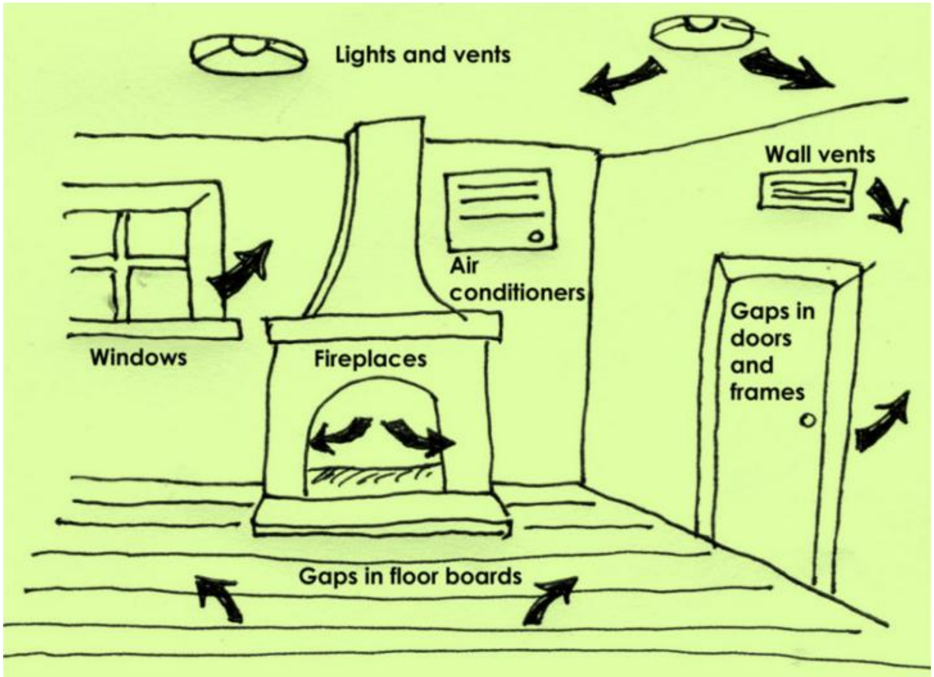
PAYG customers are charged different rates at different times of the day. You can get the chart that shows the times and prices from the place you re-charge. Generally speaking it is **cheaper to run appliances between 11am and 4pm and after 10pm.**



Keep warm

Cold air can creep into your home through gaps and cracks around doors and windows.

Seal the gaps to keep warm air in and cold air out.



Where's the draught?

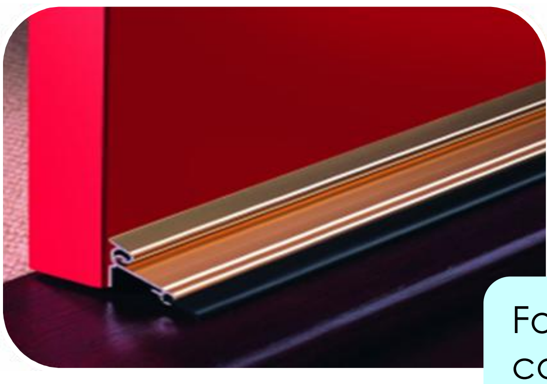
Can you feel cold air coming in? Find the draught by holding an incense stick near doors, windows and other joins. Does the air move the smoke?

Cover gaps

Block a gap at the bottom of your door with a **door snake** or rolled-up towel.

Use tape to seal around the sides of doors and windows. You can buy this at a hardware store.

If the gap is uneven, use a **weather strip**. It has a rubber seal (like on your fridge)

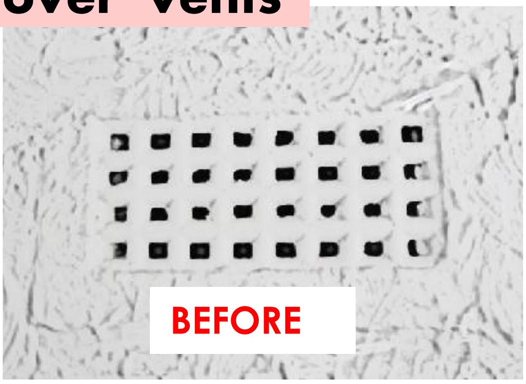


For the bottom of outside doors, you can use a **weather seal or brush strip.**

Cover your floor

Rugs or carpet help to keep floors warm.

Cover vents



Cover old vents with cloth tape or contact adhesive.
Don't try this if you already have condensation issues

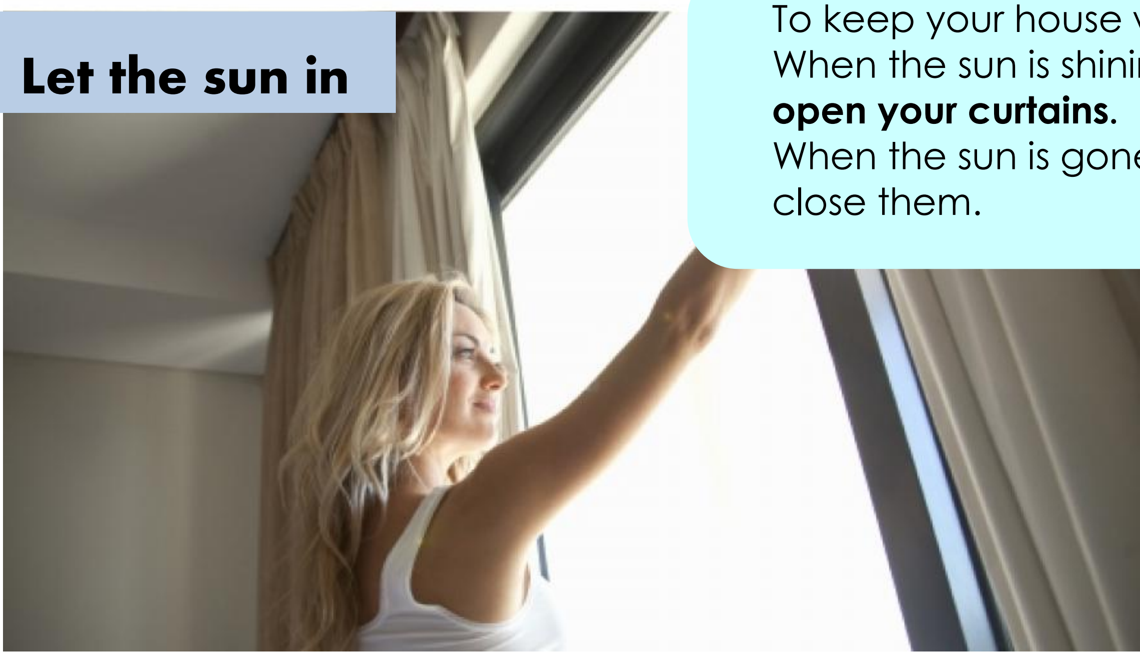
How much could I save?

Mike and Jane live in a weatherboard home. They stopped draughts from doors and windows by using door snakes, putting sealing tape on windows, and covering vents. This made a big difference to their heating costs.

TOTAL SAVINGS PER YEAR = $74
(based on standard Aurora tariff of 26.807c/kWh)

Windows

Let the sun in



To keep your house warm:
When the sun is shining, **open your curtains.**
When the sun is gone, close them.

Use thick curtains

The best curtains are **full-length** (down to the floor) thick or lined. There should be no gaps.

You can often get good curtains cheaply from op-shops.

Most **blinds** don't keep the heat in because they have large gaps

Use pelmets

Pelmets trap air between the curtains and the window. They help stop heat loss through the window.
The most common type is a **wooden box pelmet** that sits over the curtain rail.

A **ledge pelmet** sits on top of the curtain rail, out of sight.
It can be made from thick cardboard, foam, or wood – anything that blocks the space

Double glazing the easy way

Window **insulation film** can help keep warm air in. **"Clear Comfort"** is a see-through plastic which you attach to your window frame and then shrink it to fit with a hair dryer. Or try using bubble wrap for instant double glazing! Just hold it in place with velcro tabs or a light mist of water.

Another option is to **cover unused windows** with material, especially during winter.

CONDENSATION and MOULD

Condensation is formed when warm moist air touches a cold surface. To reduce condensation try to **reduce** the amount of water vapour released into the air, **vent** the house so dryer air enters and **heat** the home to make the air warmer.

To reduce dampness try the following:

- On sunny days, open up windows and doors
- Use ceiling or wall fans in bathrooms and kitchens, or open windows to let out steam
- Cover cooking pots with lids
- Wipe down wet windows
- Don't dry clothes inside the house, if using a dryer make sure a window is open
- Window insulation film (or bubble wrap) is a great way to stop moisture on windows
- Use a fan heater in damp rooms for a few minutes each day
- Wood heaters are great for drying moist air

Mould can only thrive in moist conditions. In such conditions, mould spores can grow and will continue to grow until steps are taken to both remove the mould and eliminate the source of moisture. Problem areas can be bathrooms, shower recesses, windows, under leaking roofs and near guttering and down pipes.

To clean up mould try the following:

- **Wear safety gear** such as gloves, dust mask and eye protection
- Dilute around 1 teaspoon of **tea tree oil** per cup of water and spray onto the mouldy surface.
- Clean up with **bi-carb soda** and **vinegar** mix with a cloth.

Heating

Heat yourself

Put on a jumper, thermals and woolly socks instead of turning up the heater. The more clothing you have on, the less you need to spend on heating.

Only heat the rooms you use

Why heat your whole house?

If you spend most of the day in one part of the house, just heat that area.

Close the doors to the rest of the house.

If there's no door, **hang a blanket** or curtain in the archway or hall.

How much could I save?

Narelle heats the living room and keeps doors to other rooms shut whenever possible. This has reduced her heating bill by 40%.

Warm up your bedroom with the heat from your living room **just before you go to bed**.

A **hot water bottle** warms you under the covers, where you need it most (but for safety, always use a bottle cover).

Every Degree Counts

Set your heater to the lowest comfortable temperature, this is **"1 degree above being cold"**

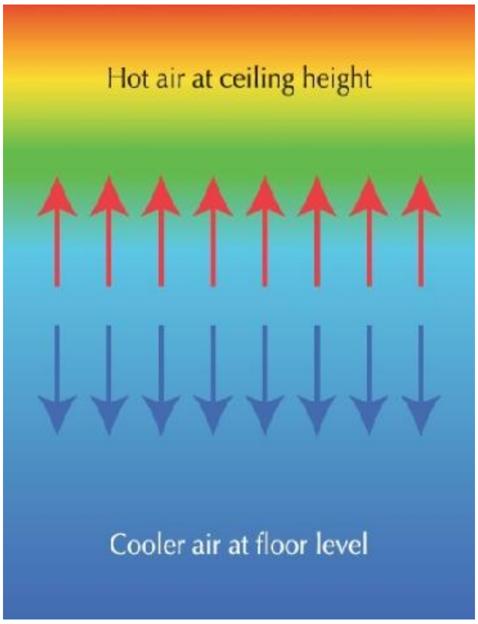
You can do this by lowering the temperature a degree and then wait 15 minutes, and lower again until it is **"just comfortable"** and set the thermostat at that temperature

Every degree adds 10% to your heating bill
If the room is "toasty warm" it should ring alarm bells

Use a timer.
Set it to switch the heater on ten minutes before you get up, or arrive home. Set it to turn off at night.

Mix the air to stay warm

A big problem when heating a room is **"Stratification".** This is where hot air rises and keeps the ceiling warm. But it also means the air near the floor is cold. Improve this by **"mixing the air"** by using heaters with fans. But don't blow the fan directly where you sit as it will make to feel cooler.



Use the right heater

Which heater is best for you? Use the best heater for your heating needs, and keep costs down. For people on quarterly bills it makes sense to use your "hard-wired" heater before using a plug-in heater

Heat Pumps

Heat pumps are the cheapest form of electric heating, but can cause draughts.

For best results:

- Turn off overnight or if you are away from the house for more than a few hours
- Turn the thermostat down to "1 degree above cold"
- Direct the air at the floor to mix the hot and cold air

"Pureheat "

"Pureheat Royal/Belmont" heaters use quite a lot of energy (6, 7 or 8kW models). If you have one of these heaters you should use it wisely to keep your power bill down. These heaters have two main settings **"Space Heat"** and **"Radiant heat"**. Each is suited for a task. You can turn both settings on, but you will use more energy!

Space Heat
If you are trying to heat the room or larger spaces turn on the "space heat". **Make sure you use the fan:** The fan only uses a little energy but helps spread the heat around.

The most efficient way to use these heaters is to have the thermostat set to **"low"** and turn the right hand switch on and off to maintain a **"just comfortable"** temperature. If this isn't hot enough, turn on the thermostat to **"high"** to engage the second element (be careful to set this to zero when you are not using the heater)

Radiant Heat
This is good if you sit near the heater for short periods of time. It feels warm and cosy but only heats people close by.

Fan Heater

Fan heaters are **"plug-in"** and warm the air quickly.
For best results, run the heater on HIGH until the room is warm. Then turn it to LOW.
These heaters dry the air so are good if there is condensation in your home.

Column heaters are "plug in" and slowly heat the air. They are one of the **most costly** ways to heat a space. **But they may be good for someone with asthma.**

For best results:

- stand the heater in the middle of the room
- use the thermostat to set on the lowest comfortable temperature
- turn it off if you're out of the room

Column Heater

Wood Heater

Wood heaters can be efficient and cheap to run if used correctly. For best results:

- Start with lots of small pieces of wood until you have a big fire. When starting a fire or adding more wood, allow the fire to burn brightly for 20 minutes before turning it down.
- Use only dry wood.
- Wood heaters work best if you don't put too much wood in.
- If the heater has a fan –use it to spread the heat around

These simple steps will help to reduce smoke and improve health in your community.

Hot Water

Set hot water at 60°C

Ask a plumber, electrician or your landlord to set your hot water temperature at **60 degrees.**

If it's lower than this, bacteria can build up.

How much could I save?

Julie and her two children have a hot water tank outside set at 76°C. The temperature was turned down to 60°C.

TOTAL SAVINGS PER YEAR = $29

(based on standard Aurora hot water tariff of 16.757c/kWh)

Cover hot water pipes

Use **foam tubing** to stop heat loss from your hot water pipes. Called lagging, this tubing fits easily over the pipes. You put it onto the pipes for a meter or so where they leave the tank. You can get it from a hardware store.

To put it on:

1. cut along the length of the lagging to open it up
2. slip it onto the pipe
3. use electrical tape or cable ties to hold it on snugly.

Wrap up your tank

Keep your **hot water tank warm** by wrapping it up. You can buy a cover for your tank or use insulation batts. ***Make sure you don't cover the pressure outlet valve! This is important for safety.***

Short showers

Shorter showers of three or four minutes mean less hot water so less cost. You can use a **timer** to keep track

Have **shallow baths**. Baths use more water than showers.

How much could I save?

Dave and Kaylene each have five minute showers each day. They replaced their old 17L/min showerhead with a water saving showerhead which uses 9L per minute.

TOTAL SAVINGS PER YEAR = $139
(based on Aurora hot water tariff 16.167c/kWh)

Water saving shower head

Use a **water-saving shower head** that uses 7-9 litres per minute. To measure your own shower flow rate, fill a bucket for 15 seconds, then multiply the litres measured by 4 to get litres per minute

Use flow restrictors on your taps

Flow restrictors for all your taps will reduce water use.

Move your mixer tap

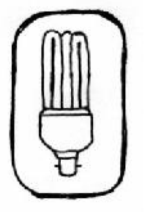
Remember to leave your **mixer tap** turned all the way to the COLD side.

If it's left in the middle it runs warm water. This costs you money.

Fix the drip

Fix **dripping** hot water taps.

A drip every 2 seconds can waste over a thousand litres of hot water every year. This is as much water as 10 baths!



Lights

Turn lights off

Use energy efficient lights

Compact fluorescent lights (CFL) use about a quarter as much power as “normal” light bulbs. (Keep away from cheap brands as some aren’t well made and won’t last)

LED lights fit most light sockets. These are energy efficient and last a long time.

Use **low-energy fluorescent tubes**. They don’t flicker, have natural light colour and use a lot less energy.

The right light for the job

Use natural light when you can.

If you’re reading, **use a lamp** with a lower-power light bulb.

How much could I save?

Tony changed his security light from a 150W Halogen to a 23W CFL. Using the light 10 hours per night the light payed for itself within 3 months.

TOTAL SAVINGS PER YEAR = $130
(based on standard Aurora tariff of 27.785c/kWh)

What to do if your energy saving light breaks

Energy saving (fluorescent) lights contain very small amounts of mercury, so it is important to clean up carefully if you break a globe. If one breaks:

1. Open windows and leave the room for 15 minutes.
2. Wearing rubber gloves, sweep up (don't vacuum) the broken material.

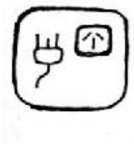
   If small pieces are in the carpet, use a damp cloth or sticky tape to pick them up.
3. Put the pieces into a sealed plastic bag. Take it to be recycled or put in outdoor rubbish bin.
4. Wash your hands and face. If you get any pieces of broken globe on your clothes, put clothing in rubbish bin or wash carefully by hand with soap and water.

The first time you vacuum the area where the bulb was broken, remove the vacuum bag afterwards. Put the bag in the outdoor rubbish bin.

Where can globes be recycled?

For a small fee, CFL lamps can be recycled at Sustainable Living Tasmania.

1/71 Murray Street, Hobart



Appliances

Buy energy efficient

Large appliances such as fridges, washing machines and dryers cost a lot up-front. But they can last 10-15 years. The energy efficiency of the model you buy will make a big difference to the running costs and power use over its lifetime.

Before you buy, ask yourself – is it energy efficient?
For **any appliance**, ask yourself: can I turn it off when I'm not using it?

Use a **laptop computer.** They use much less power than a PC.

Use a **smaller TV**. Big TVs use a lot of energy.

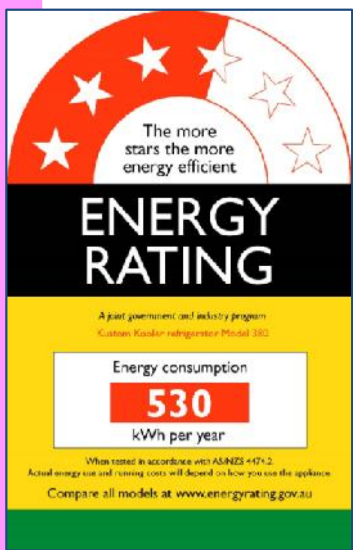
LCD and LED TVs use a lot less power than plasma TVs.

How many stars?

If you're buying white goods, check the energy label to see how many kWh (kilowatt hours) per year it uses. The lower the better A fridge (or freezer) with a 5-star energy rating uses half as much energy as one with a 1 star.

You can even calculate how much an appliance costs to run. Power costs about 25c per kW. This means that a fridge with energy rating 530kW per year will cost about $147 per year to run:

530kW by $0.2785 = $147.26

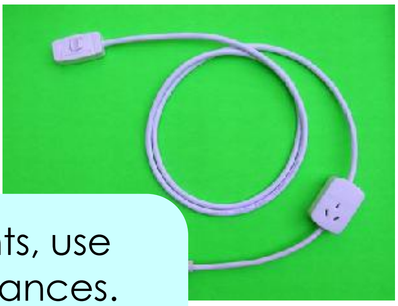


Don’t leave on standby

Standby power is the energy used by appliances when they are not in use.
Even though it’s a small amount for each appliance, it all adds up. On average, the cost is 12% of your home’s total energy use!
Switch appliances off **at the power point** when they are not being used.

It can be a pain to turn off computers because they take a long time to start up again.
Try clicking on **Hibernate.** The computer will switch off completely, but starts up quickly when you turn it back on.

Use an Ecoswitch



For hard to reach power points, use an **Ecoswitch** to turn off appliances. It’s great for TVs, and reduces fire risk from appliances on standby.

How much could I save?

Troy and Danni have a 90cm TV, set top box and DVD player that are left on standby for 16 hours per day. They can’t reach the power point behind the cupboard to turn them off. They purchased an Ecoswitch so they could turn appliances off easily.

TOTAL SAVINGS PER YEAR = $24
(based on standard Aurora tariff of 27.785c/kWh)

Fridges & freezers

What's the temperature?

Keep your fridge at around 5°C and defrost it regularly. Make sure your freezer is set at -15 to -18°C.

Seal fridge doors

Make sure fridge and freezer doors have **good seals** that do not leak cold air.

If you can easily slide a piece of paper or dollar note in your fridge door, the seals need replacing.

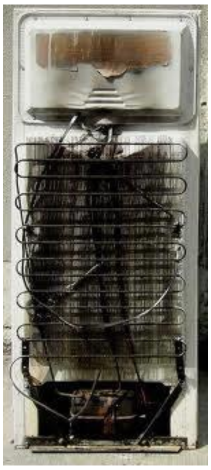
How much could I save?

Carolanne has a two door fridge and freezer unit in her kitchen that she often hears running. She checked the seals and replaced them. This made a big difference to the cost of running her fridge.

TOTAL SAVINGS PER YEAR = $27

(based on standard Aurora tariff of 26.807c/kWh)

Clean the heat sink



Keep the **heat sink** (the metal grill on the back of the fridge) clean and free from dust and lint.

This will help it to run more efficiently.

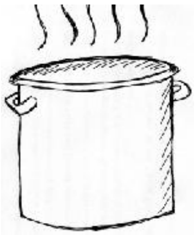
Keep ventilated and cool

Fridges and freezers are cheaper to run if placed in the coolest part of the kitchen. Allow space at the back and on top for air to circulate and keep the unit cool.

Consider locating fridges and freezers in unheated rooms.

Turn off that extra fridge

Do you really need that second fridge or freezer? Usually these are older models that don't run efficiently. Unplug it or get rid of it.



Cooking

Use lids on pots and pans

Lids keep the heat in so food doesn't take as long to cook. This saves energy.

Think before you fill

It takes a lot of energy to boil water. Fill your kettle with only the number of cups of water needed.

Use the microwave

A **microwave** can reduce cooking costs by up to 75%. Consider using the microwave instead of the oven or stove.

Thaw it

Thaw frozen food before cooking (in the fridge). This saves on cooking time.

Washing clothes

Wash with COLD water

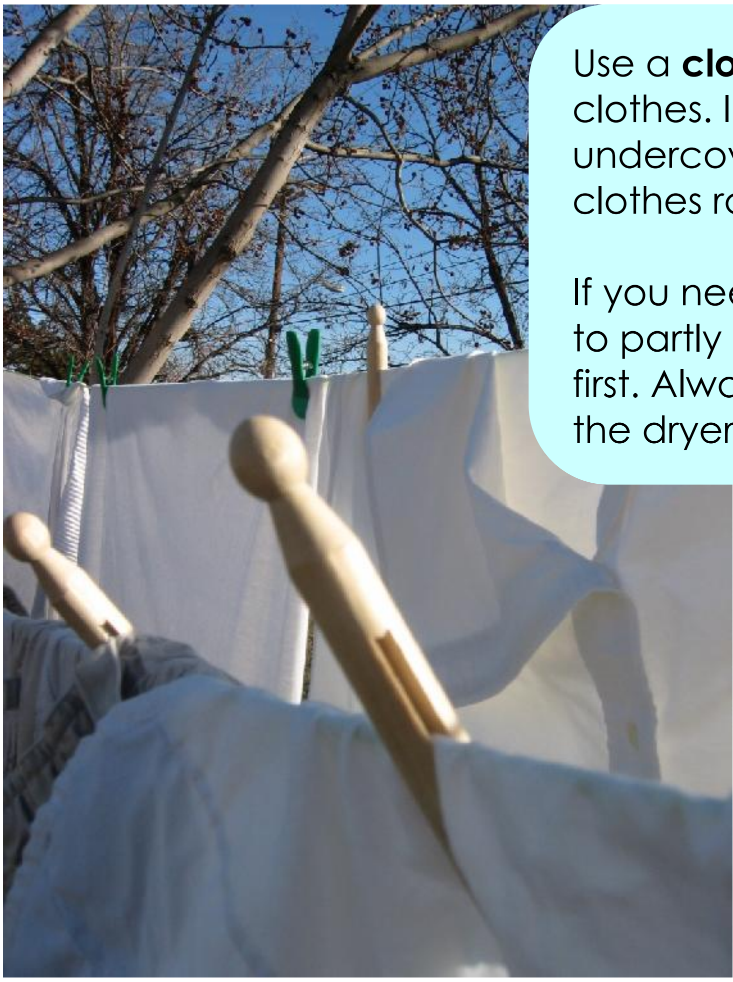
Washing with cold water gets your clothes just as clean, and will cut your power bills.

Use front loading

Front loading washing machines are usually more **energy and water efficient** than top-loading machines.

You can compare models by looking at the information on the star-rating stickers. Always check how many kilowatt-hours (kWh) the appliance uses.

Use a solar dryer



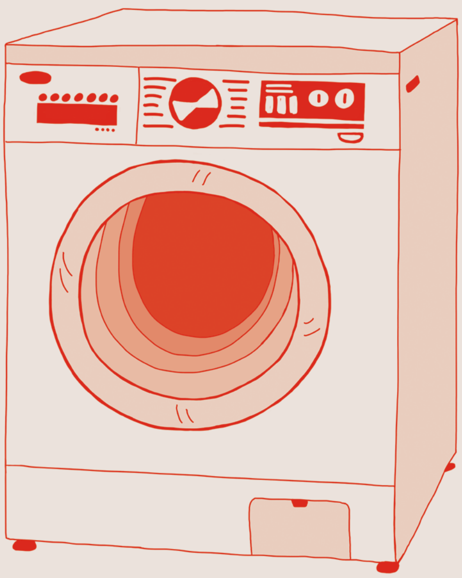
Use a **clothes line** for drying clothes. In winter, find an undercover area and set up clothes racks.

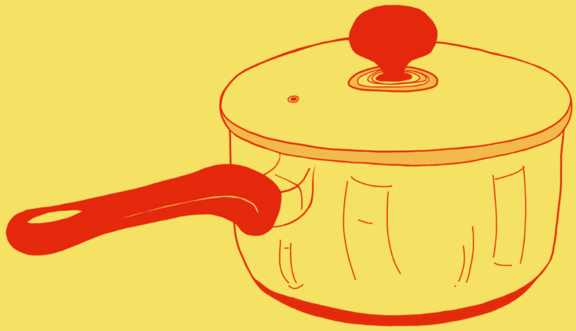
If you need to use a **dryer**, try to partly dry on a clothes line first. Always put a full load in the dryer.

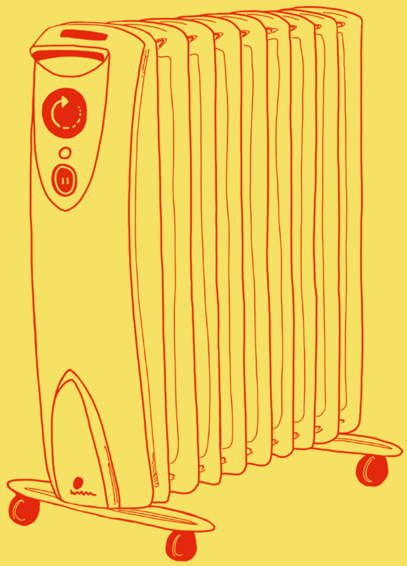
How much could I save?

Linda uses her clothes dryer for four hours every week on average. She changed to the clothes line and a portable clothes rack inside.

TOTAL SAVINGS PER YEAR = $64
(based on standard Aurora tariff of 26.807c/kWh)







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Appendix 2

THE POWER RANGERS

Bec's Case Study

Experience:

"I have noticed with the new showerhead, insulation of the hot water cylinder and thermostat reduction that I get a lot more out of my hot water.

"I've spent $130 on new kitchen and bathroom taps, which, in time, will save me thousands."

Upgrades Received:

Hot water temperature reduced
Water saving showerhead
Front door seal
Draught proofing of windows and doors
Curtains

Behaviours Changed through Education:

Close curtains when appropriate.
Only warm rooms when using them.
Close doors of rooms I am heating.
Monitor my Pay As You Go meter.
Switch off appliances at powerpoint when not in use.

Household Demographics /Statistics:

Free standing 3 bedroom home
1 six-year old child, two teenagers—13 and 14, and one adult

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THE POWER RANGERS

Debra's Case Study

Experience:

"Between the upgrades and my own actions, my bill this winter was $460 instead of last winter at $780!" (savings of $320)

"I have been very happy with all the help and advice I have received."

Upgrades Received:

Energy efficient lighting
Draught proofing
Eco-switch
Valvecosy installed
Roof insulation completed (house was only partially insulated)
Hot water tank insulated
Hot water pipes insulated
Thermostat adjusted
Curtains in lounge room

Behaviours Changed through Education:

Now turns off all power points (except phone and alarm) when not in use.
Got rid of second freezer.
Stopped using dryer so much.
Got rid of electric blankets.
Now washes in cold water and chooses appropriate water level and wash time.

Household Demographics /Statistics:

Free standing 3 bedroom brick home
Single parent with 12-year old daughter

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THE POWER RANGERS

Gill's Case Study

Experience:

"I have been surprised by the amount of power different appliances use by using our power meter."

"I have been surprised by how much more effective draught proofing our house has been on power savings."

Upgrades Received:

Energy efficient lighting
Draught proofing
Eco switch
Water heater thermostat adjusted

Behaviours Changed through Education:

Turn off power when not in use, including eco switch at night-time.
Timed showers.
Keeping lounge door shut when heat pump/air-con is in use.
Putting dryer on at economic times of the day.

Household Demographics /Statistics:

Free-standing Besser brick home
2 adults with 3 children of 14, 18, and 21 years old

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THE POWER RANGERS

Harry's Case Study

Experience:

"With the upgrades and my own actions, I have saved $210, which is 55% less than the average 2 person household for a medium house."

"I am very happy with the upgrades, help, and advice I have received."

Upgrades Received:

Energy efficient lighting
Draught proofing
Eco switch
Water heater insulated
Energy efficient showerhead

Curtains/blinds for living room/kitchen (still to be installed, looking forward to further energy savings)

Behaviours Changed through Education:

Used thermometer to set temp of fridge/freezer and heat pump for more energy efficient use.
Greater awareness of energy usage (running costs, compliance plate) when purchasing household items).
Daughter no longer uses electric blanket.

Household Demographics /Statistics:

Single parent with adult daughter

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THE POWER RANGERS

Kay's Case Study

Experience:

"The draught proofing of the front and back doors has made a big difference in warmth and comfort levels."

"The shower head changes are great with the use of a timer."

"Focusing on turning off the switches and using the eco switch will help with the next power bill."

Upgrades Received:

Energy efficient lighting
Draught proofing
Eco switch

Behaviours Changed through Education:

Closing doors, windows, and vents to keep heat in.
Timing showers.
Turning off switches when not in use and using the eco switch.
Only using heaters when in the room.

Household Demographics /Statistics:

Free-standing wooden house
Single woman and dog
Casual overnight stay of granddaughter and other relatives who have longer showers than I do!

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THE POWER RANGERS

Kylie's Case Study

Experience:

"Using a shower timer for 4 minute showers saves on hot water."

Upgrades Received:

Energy efficient lighting
Draught proofing
Eco switch
Hot water tank and pipes insulated
Curtains in lounge room

Behaviours Changed through Education:

4 minute showers.
Turn off power point when not using appliances.
Keep curtains closed when it is hot to keep the heat out in the summer.
Open curtains on sunny days to warm up rooms.

Household Demographics /Statistics:

3 bedroom brick home
2 adults and 3 children

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THE POWER RANGERS

Rosemary's Case Study

Experience:

"I have noticed that 'door draughts' are gone since the door strips were fitted."

"So far, I have been saving money on my Pay As You Go. Winter will be more interesting."

Upgrades Received:

In December 2013:
Eco switch
Draught proofing door strips
Energy saver light globes
Thermometer

Behaviours Changed through Education:

Thermometer to check fridge, freezer, and room temperature.
Use eco switch every day.
Checked how long it took to shower (5 minutes).

Household Demographics /Statistics:

3 bedroom breeze brick house with corrugated roof and non-concrete foundation

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THE POWER RANGERS

Tash's Case Study

Experience:

"With the upgrades and my family taking a few small steps, we have saved $260 compared to this time last year!"

Upgrades Received:

Energy efficient lighting
Draught proofing
Hot water pipes insulated
Water saving showerhead
Valvecosy installed

Behaviours Changed through Education:

Lights get switched off when not using room.
4 minute showers.
Power points gets turned off when not using appliances.
Heat pump turned off when not needed.
Ceiling fans used to cool instead of air-conditioning.

Household Demographics /Statistics:

3 bedroom brick home
Family of 2 adults and 2 children

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THE POWER RANGERS

Vic's Case Study

Experience:

"Have had a reduction in daily power usage."
"Learning how to calculate appliance power consumption is really helpful."
"It is empowering to know what appliances are costing."

Upgrades Received:

Draught proofing
Eco-Switch
Hot Water pipes insulated
Roof Insulation

Behaviours Changed through Education:

Using Eco-Switch to incorporate non-essential power in lounge room.
Switching off unused power points – especially chargers for phones, computers etc.
Using curtains to insulate at different times, e.g. open curtains when sun is on that area to maximise heating. Close to retain heat. Do the opposite in summer.

Household Demographics /Statistics:

Free standing 2 Storey brick veneer and weatherboard 5 bedroom home.
Married couple with 18, 17 and 12 year old children.

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Appendix 3

Appendix 3 - Get Bill Smart Cost Benefit Analysis Assumptions

		APPROACH LEVEL PROPORTIONS																				
		In-home education and upgrades					Community capacity building					In-home education and upgrades + Community capacity building					Representative group					
Item detail	Total Expenditure	**PROJECT LOAD**	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	**PROJECT**	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	**PROJECT**	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	**PROJECT**	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	SUM CHECK
Governance (in-kind)	$35,026	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Governance (LIEEP)	$35,026	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Project manager	$379,615	**34%**	0%	10%	20%	100%	**18%**	0%	10%	20%	100%	16%	0%	10%	20%	100%	**33%**				100%	100%
Community Development Officer (from MA Better Housing Futu	$44,288	**0%**				100%	**53%**	20%	30%	40%	100%	**47%**	20%	30%	40%	100%	**0%**				100%	100%
Community engagement officer	$117,164	**0%**				100%	**53%**	30%	40%	50%	100%	**47%**	30%	40%	50%	100%	**0%**				100%	100%
Community champions	$56,457	**0%**				100%	**53%**	40%	80%	90%	100%	**47%**	40%	80%	90%	100%	**0%**				100%	100%
Meter readers	$2,792	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Data collectors	$0	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Energy Program Manager	$155,428	**34%**	0%	10%	20%	100%	**18%**	0%	10%	20%	100%	16%	0%	10%	20%	100%	**33%**				100%	100%
Executive officer	$35,026	**34%**			30%	100%	**18%**			30%	100%	16%			30%	100%	**33%**				100%	100%
Finance & administration officer	$80,275	**34%**	0%	10%	20%	100%	**18%**	0%	10%	20%	100%	16%	0%	10%	20%	100%	**33%**				100%	100%
Finance & administration officer	$0	**34%**	0%	10%	20%	100%	**18%**	0%	10%	20%	100%	16%	0%	10%	20%	100%	**33%**				100%	100%
Research Fellow	$235,698	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Research Supervisor	$66,550	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Research Assistant	$51,230	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Energy Audits	$47,376	**0%**	50%	50%	50%	100%	**50%**	50%	50%	50%	100%		50%	50%	50%	100%	**50%**	50%	50%	50%	100%	100%
In-home education sessions	$44,081	**68%**	75%	75%	75%	100%	**0%**				100%	**32%**	75%	75%	75%	100%	**0%**				100%	100%
Upgrades performed by SLT Home Energy Helpers	$119,749	**68%**	75%	75%	75%	100%	**0%**				100%	**32%**	75%	75%	75%	100%	**0%**				100%	100%
Upgrades performed by subcontractors	$90,955	**68%**	100%	100%	100%	100%	**0%**				100%	**32%**	100%	100%	100%	100%	**0%**				100%	100%
Energy monitoring equipment	$126,761	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Temperature monitoring equipment	$0	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Aurora bill reporting establishment fee	$15,000	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Aurora bill processing fees	$0	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Data analysis consultant	$79,035	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Marketing & communications consultants	$21,817	**20%**	0%	30%	30%	100%	**30%**	0%	30%	30%	100%	**30%**	0%	30%	30%	100%	**20%**				100%	100%
Venue hire	$14,000	**0%**				100%	**53%**	100%	100%	100%	100%	**47%**	100%	100%	100%	100%	**0%**				100%	100%
Use of office space	$0	**0%**				100%	**53%**	100%	100%	100%	100%	**47%**	100%	100%	100%	100%	**0%**				100%	100%
Event expenses	$15,557	**0%**				100%	**53%**	100%	100%	100%	100%	**47%**	100%	100%	100%	100%	**0%**				100%	100%
Printing	$15,655	**20%**	20%	30%	30%	100%	**35%**	20%	30%	30%	100%	**35%**	20%	30%	30%	100%	**10%**	20%	30%	30%	100%	100%
Travel & accommodation	$35,076	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
Phone	$0	**34%**	0%	50%	50%	100%	**18%**	0%	50%	50%	100%	16%	0%	50%	50%	100%	**33%**				100%	100%
SMS Service	$0	**34%**	0%	50%	50%	100%	**18%**	0%	50%	50%	100%	16%	0%	50%	50%	100%	**33%**				100%	100%
Transcription services	$35,190	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
IT equipment	$11,961	**34%**				100%	**18%**				100%	16%				100%	**33%**				100%	100%
TOTAL	$1,966,916																					

Appendix 3 - Get Bill Smart Cost Benefit Analysis Assumptions

APPROACH LEVEL COSTS

	In-home education and upgrades				Community capacity building				In-home education and upgrades + Community capacity building				Representative group			
Item detail	Level 1 - direct trial	Trial componen t	Level 3- Total Business	Level 4- Total trial	Level 1 - direct trial	Trial componen t	Level 3- Total Business	Level 4- Total trial	Level 1 - direct trial	Trial componen t	Level 3- Total Business	Level 4- Total trial	Level 1 - d	Trial componen t	Level 3- Total Business	Level 4- Total trial
Governance (in-kind)	$ -	$ -	$ -	$ 11,769	$ -	$ -	$ -	$ 6,235	$ -	$ -	$ -	$ 5,464	$ -	$ -	$ -	$ 11,559
Governance (LIEEP)	$ -	$ -	$ -	$ 11,769	$ -	$ -	$ -	$ 6,235	$ -	$ -	$ -	$ 5,464	$ -	$ -	$ -	$ 11,559
Project manager	$ -	$ 12,755	$ 25,510	$127,550	$ -	$ 6,757	$ 13,514	$ 67,571	$ -	$ 5,922	$ 11,844	$ 59,220	$ -	$ -	$ -	$125,273
Community Development Officer (from MA Better Housing Futures)	$ -	$ -	$ -	$ -	$ 4,721	$ 7,081	$ 9,441	$ 23,603	$ 4,137	$ 6,206	$ 8,274	$ 20,685	$ -	$ -	$ -	$ -
Community engagement officer	$ -	$ -	$ -	$ -	$ 18,732	$ 24,976	$ 31,220	$ 62,441	$ 16,417	$ 21,889	$ 27,362	$ 54,723	$ -	$ -	$ -	$ -
Community champions	$ -	$ -	$ -	$ -	$ 12,035	$ 24,070	$ 27,079	$ 30,088	$ 10,548	$ 21,095	$ 23,732	$ 26,369	$ -	$ -	$ -	$ -
Meter readers	$ -	$ -	$ -	$ 938	$ -	$ -	$ -	$ 497	$ -	$ -	$ -	$ 436	$ -	$ -	$ -	$ 921
Data collectors	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Program Manager	$ -	$ 5,222	$ 10,445	$ 52,224	$ -	$ 2,767	$ 5,533	$ 27,666	$ -	$ 2,425	$ 4,849	$ 24,247	$ -	$ -	$ -	$ 51,291
Executive officer	$ -	$ -	$ 3,531	$ 11,769	$ -	$ -	$ 1,870	$ 6,235	$ -	$ -	$ 1,639	$ 5,464	$ -	$ -	$ -	$ 11,559
Finance & administration officer	$ -	$ 2,697	$ 5,394	$ 26,972	$ -	$ 1,429	$ 2,858	$ 14,289	$ -	$ 1,252	$ 2,505	$ 12,523	$ -	$ -	$ -	$ 26,491
Finance & administration officer	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Research Fellow	$ -	$ -	$ -	$ 79,194	$ -	$ -	$ -	$ 41,954	$ -	$ -	$ -	$ 36,769	$ -	$ -	$ -	$ 77,780
Research Supervisor	$ -	$ -	$ -	$ 22,361	$ -	$ -	$ -	$ 11,846	$ -	$ -	$ -	$ 10,382	$ -	$ -	$ -	$ 21,961
Research Assistant	$ -	$ -	$ -	$ 17,213	$ -	$ -	$ -	$ 9,119	$ -	$ -	$ -	$ 7,992	$ -	$ -	$ -	$ 16,906
Energy Audits	$ -	$ -	$ -	$ -	$ 11,844	$ 11,844	$ 11,844	$ 23,688	$ -	$ -	$ -	$ -	$ 11,844	$ 11,844	$ 11,844	$ 23,688
In-home education sessions	$ 22,578	$ 22,578	$ 22,578	$ 30,104	$ -	$ -	$ -	$ -	$ 10,483	$ 10,483	$ 10,483	$ 13,977	$ -	$ -	$ -	$ -
Upgrades performed by SLT Home Energy Helpers	$ 61,335	$ 61,335	$ 61,335	$ 81,780	$ -	$ -	$ -	$ -	$ 28,477	$ 28,477	$ 28,477	$ 37,969	$ -	$ -	$ -	$ -
Upgrades performed by subcontractors	$ 62,116	$ 62,116	$ 62,116	$ 62,116	$ -	$ -	$ -	$ -	$ 28,839	$ 28,839	$ 28,839	$ 28,839	$ -	$ -	$ -	$ -
Energy monitoring equipment	$ -	$ -	$ -	$ 42,592	$ -	$ -	$ -	$ 22,564	$ -	$ -	$ -	$ 19,775	$ -	$ -	$ -	$ 41,831
Temperature monitoring equipment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aurora bill reporting establishment fee	$ -	$ -	$ -	$ 5,040	$ -	$ -	$ -	$ 2,670	$ -	$ -	$ -	$ 2,340	$ -	$ -	$ -	$ 4,950
Aurora bill processing fees	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Data analysis consultant	$ -	$ -	$ -	$ 26,556	$ -	$ -	$ -	$ 14,068	$ -	$ -	$ -	$ 12,329	$ -	$ -	$ -	$ 26,081
Marketing & communications consultants	$ -	$ 1,309	$ 1,309	$ 4,363	$ -	$ 1,964	$ 1,964	$ 6,545	$ -	$ 1,964	$ 1,964	$ 6,545	$ -	$ -	$ -	$ 4,363
Venue hire	$ -	$ -	$ -	$ -	$ 7,461	$ 7,461	$ 7,461	$ 7,461	$ 6,539	$ 6,539	$ 6,539	$ 6,539	$ -	$ -	$ -	$ -
Use of office space	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Event expenses	$ -	$ -	$ -	$ -	$ 8,291	$ 8,291	$ 8,291	$ 8,291	$ 7,266	$ 7,266	$ 7,266	$ 7,266	$ -	$ -	$ -	$ -
Printing	$ 626	$ 939	$ 939	$ 3,131	$ 1,096	$ 1,644	$ 1,644	$ 5,479	$ 1,096	$ 1,644	$ 1,644	$ 5,479	$ 313	$ 470	$ 470	$ 1,566
Travel & accommodation	$ -	$ -	$ -	$ 11,786	$ -	$ -	$ -	$ 6,244	$ -	$ -	$ -	$ 5,472	$ -	$ -	$ -	$ 11,575
Phone	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SMS Service	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transcription services	$ -	$ -	$ -	$ 11,824	$ -	$ -	$ -	$ 6,264	$ -	$ -	$ -	$ 5,490	$ -	$ -	$ -	$ 11,613
IT equipment	$ -	$ -	$ -	$ 4,019	$ -	$ -	$ -	$ 2,129	$ -	$ -	$ -	$ 1,866	$ -	$ -	$ -	$ 3,947
TOTAL	#######	$168,952	$193,157	$645,069	$ 64,180	$ 98,283	$122,719	$413,180	$113,802	$144,001	$165,417	$423,624	$ 12,157	$ 12,314	$ 12,314	$484,914

Appendix 3 - Get Bill Smart Cost Benefit Analysis Assumptions

PARTICIPANT LEVEL COSTS

	In-home education and upgrades				Community capacity building				In-home education and upgrades + Community capacity building				Representative group			
Item detail	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	Level 1 - direct trial	Trial component	Level 3- Total Business	Level 4- Total trial	Level 1 - d	Trial component	Level 3- Total Business	Level 4- Total trial
Governance (in-kind)	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70
Governance (LIEEP)	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70
Project manager	$ -	$ 76	$ 152	$ 759	$ -	$ 76	$ 152	$ 759	$ -	$ 76	$ 152	$ 759	$ -	$ -	$ -	$ 759
Community Development Officer (from MA Better Housing Futures)	$ -	$ -	$ -	$ -	$ 53	$ 80	$ 106	$ 265	$ 53	$ 80	$ 106	$ 265	$ -	$ -	$ -	$ -
Community engagement officer	$ -	$ -	$ -	$ -	$ 210	$ 281	$ 351	$ 702	$ 210	$ 281	$ 351	$ 702	$ -	$ -	$ -	$ -
Community champions	$ -	$ -	$ -	$ -	$ 135	$ 270	$ 304	$ 338	$ 135	$ 270	$ 304	$ 338	$ -	$ -	$ -	$ -
Meter readers	$ -	$ -	$ -	$ 6	$ -	$ -	$ -	$ 6	$ -	$ -	$ -	$ 6	$ -	$ -	$ -	$ 6
Data collectors	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Program Manager	$ -	$ 31	$ 62	$ 311	$ -	$ 31	$ 62	$ 311	$ -	$ 31	$ 62	$ 311	$ -	$ -	$ -	$ 311
Executive officer	$ -	$ -	$ 21	$ 70	$ -	$ -	$ 21	$ 70	$ -	$ -	$ 21	$ 70	$ -	$ -	$ -	$ 70
Finance & administration officer	$ -	$ 16	$ 32	$ 161	$ -	$ 16	$ 32	$ 161	$ -	$ 16	$ 32	$ 161	$ -	$ -	$ -	$ 161
Finance & administration officer	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Research Fellow	$ -	$ -	$ -	$ 471	$ -	$ -	$ -	$ 471	$ -	$ -	$ -	$ 471	$ -	$ -	$ -	$ 471
Research Supervisor	$ -	$ -	$ -	$ 133	$ -	$ -	$ -	$ 133	$ -	$ -	$ -	$ 133	$ -	$ -	$ -	$ 133
Research Assistant	$ -	$ -	$ -	$ 102	$ -	$ -	$ -	$ 102	$ -	$ -	$ -	$ 102	$ -	$ -	$ -	$ 102
Energy Audits	$ -	$ -	$ -	$ -	$ 133	$ 133	$ 133	$ 266	$ -	$ -	$ -	$ -	$ 72	$ 72	$ 72	$ 144
In-home education sessions	$ 134	$ 134	$ 134	$ 179	$ -	$ -	$ -	$ -	$ 134	$ 134	$ 134	$ 179	$ -	$ -	$ -	$ -
Upgrades performed by SLT Home Energy Helpers	$ 365	$ 365	$ 365	$ 487	$ -	$ -	$ -	$ -	$ 365	$ 365	$ 365	$ 487	$ -	$ -	$ -	$ -
Upgrades performed by subcontractors	$ 370	$ 370	$ 370	$ 370	$ -	$ -	$ -	$ -	$ 370	$ 370	$ 370	$ 370	$ -	$ -	$ -	$ -
Energy monitoring equipment	$ -	$ -	$ -	$ 254	$ -	$ -	$ -	$ 254	$ -	$ -	$ -	$ 254	$ -	$ -	$ -	$ 254
Temperature monitoring equipment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aurora bill reporting establishment fee	$ -	$ -	$ -	$ 30	$ -	$ -	$ -	$ 30	$ -	$ -	$ -	$ 30	$ -	$ -	$ -	$ 30
Aurora bill processing fees	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Data analysis consultant	$ -	$ -	$ -	$ 158	$ -	$ -	$ -	$ 158	$ -	$ -	$ -	$ 158	$ -	$ -	$ -	$ 158
Marketing & communications consultants	$ -	$ 8	$ 8	$ 26	$ -	$ 22	$ 22	$ 74	$ -	$ 25	$ 25	$ 84	$ -	$ -	$ -	$ 26
Venue hire	$ -	$ -	$ -	$ -	$ 84	$ 84	$ 84	$ 84	$ 84	$ 84	$ 84	$ 84	$ -	$ -	$ -	$ -
Use of office space	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Event expenses	$ -	$ -	$ -	$ -	$ 93	$ 93	$ 93	$ 93	$ 93	$ 93	$ 93	$ 93	$ -	$ -	$ -	$ -
Printing	$ 4	$ 6	$ 6	$ 19	$ 12	$ 18	$ 18	$ 62	$ 14	$ 21	$ 21	$ 70	$ 2	$ 3	$ 3	$ 9
Travel & accommodation	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70
Phone	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SMS Service	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transcription services	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70	$ -	$ -	$ -	$ 70
IT equipment	$ -	$ -	$ -	$ 24	$ -	$ -	$ -	$ 24	$ -	$ -	$ -	$ 24	$ -	$ -	$ -	$ 24
TOTAL	$ 873	$ 1,006	$ 1,150	$ 3,840	$ 721	$ 1,104	$ 1,379	$ 4,642	$ 1,459	$ 1,846	$ 2,121	$ 5,431	$ 74	$ 75	$ 75	$ 2,939

9 GET BILL SMART – PROJECT BUDGET

9.1 Original project budget

The approved project budget was $1,956,108 in total, consisting of $1,748,717 LIEEP funding, $202,391 in-kind funding and $5,000 of consortium funding (cash). The budget detail is found below in Table 9-1.

Table 9-1 - Original Project Budget

Item	LIEEP	CASH	IN-KIND	TOTAL
Aurora bill processing fees	4,920	0	0	4,920
Aurora bill reporting establishment fee	0	5,000	0	5,000
Community Champions	45,750	0	0	45,750
Community Development Officer (from MA Better Housing Futures)	0	0	44,288	44,288
Data analysis consultant	50,000	0	0	50,000
Data Collectors	3,808	0	0	3,808
Detailed study data logging equipment & installation	258,000	0	0	258,000
Energy Audits	41,400	0	0	41,400
Engagement Officer	126,221	0	0	126,221
Event expenses	10,000	0	0	10,000
Finance & Administration Officer	34,297	0	0	34,297
Governance & supervision	97,052	0	70,053	167,105
In-home education sessions	44,100	0	0	44,100
IT equipment	6,000	0	0	6,000
Marketing & communications consultants	25,000	0	0	25,000
Meter Readers	24,980	0	0	24,980
Miscellaneous	0	0	0	0
Phone	1,000	0	0	1,000
Printing	10,000	0	0	10,000
Project Manager	351,728	0	0	351,728
Research Assistant	51,230	0	0	51,230
Research Fellow	235,698	0	0	235,698
Research Supervisor	0	0	66,550	66,550
SMS Service	1,000	0	0	1,000
Transcription services	35,190	0	0	35,190
Travel & accommodation	28,290	0	0	28,290
Upgrades performed by SLT Home Energy Helpers	71,534	0	0	71,534
Upgrades performed by subcontractors	191,520	0	0	191,520
Use of office space	0	0	17,500	17,500
Venue hire	0	0	4,000	4,000
TOTAL	**1,748,717**	**5,000**	**202,391**	**1,956,108**

This activity received funding from the Department of Industry Innovation and Science as part of the Low Income Energy Efficiency Program. The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information.

9.2 Final project budget[1]

The final project budget is shown in Table 9-2 below. $1,748,717 of LIEEP funding was expended on the project. In-kind expenditure totalled $226,391 and consortium cash expenditure was zero.

Table 9-2 - Estimated final project budget

Item	LIEEP	CASH	IN-KIND	TOTAL
Aurora bill processing fees	0	0	0	0
Aurora bill reporting establishment fee	0	0	15,000	15,000
Community Champions	56,457	0	0	56,457
Community Development Officer (from MA Better Housing Futures)	0	0	44,288	44,288
Data analysis consultant	100,458	0	0	100,458
Data Collectors	0	0	0	0
Detailed study data logging equipment & installation	132,361	0	0	132,361
Energy Audits	47,894	0	0	47,894
Engagement Officer	103,164	0	14,000	117,164
Event expenses	10,707	0	2,500	13,207
Finance & Administration Officer	81,705	0	0	81,705
Governance & supervision	160,454	0	70,053	230,507
In-home education sessions	44,050	0	0	44,050
IT equipment	11,535	0	0	11,535
Marketing & communications consultants	15,817	0	0	15,817
Meter Readers	2,792	0	0	2,792
Miscellaneous	330	0	0	330
Phone	9,270	0	0	9,270
Printing	12,711	0	0	12,711
Project Manager	391,893	0	0	391,893
Research Assistant	51,230	0	0	51,230
Research Fellow	235,698	0	0	235,698
Research Supervisor	0	0	66,550	66,550
SMS Service	0	0	0	0
Transcription services	35,190	0	0	35,190
Travel & accommodation	35,076	0	0	35,076
Upgrades performed by SLT Home Energy Helpers	118,969	0	0	118,969
Upgrades performed by subcontractors	90,955	0	0	90,955
Use of office space	0	0	0	0
Venue hire	0	0	14,000	14,000
TOTAL	**1,748,717**	**0**	**226,391**	**1,975,107**

[1] Please note final expenditure figures are currently estimates, including committed funds. Final figures will be unavailable until April 2016.

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9.3 Discussion

Overall project expenditure was slightly higher than the original budget, largely due to a greater delivery of in-kind resources. The Get Bill Smart Project expended all LIEEP funding provided by the Commonwealth Government. Cash expenditure was lower than budgeted due to electricity providers providing electricity data for free (counted as in-kind support). In-kind support was higher based on good support from agencies and groups within the community engagement area.

Overall, the project budget provided a good level of funding for delivering the project outputs. Significant savings where made in some budget line items that were absorbed in greater expenses in other areas.

Overall the key driver for shifts in project expenditure was the unknowns at the point of project proposal. Many items such as the data-logging equipment could not be specified until full research design had been completed. The modified project timelines also impacted with some items requiring additional resources to be completed in a timely manner.

9.3.1 Main areas of savings

Data-logging equipment supply and installation

The data-logging equipment was supplied under budget. Further savings were made by reusing equipment from the champion households in the remainder of the bulk study. Unfortunately the equipment supplied required significant additional work to clean data before analysis, which resulted in increased consultant costs.

Provision of upgrades by third party contractors

There were a limited number of houses eligible for these upgrades. All possible households satisfying the criteria received curtains and/or insulation. Additional items such as improved rugs for floors were offered but declined. Some installs were cancelled, for example one participant would not clear some items stored under their home and thus under floor insulation could not be installed. Savings from this line item were used on additional upgrades installed by Home Energy Helpers.

Meter readers

This line item was originally a contingency due to uncertainty about the introduction of competition to residential electricity retailing in Tasmania and how this would impact on the project accessing participants' energy billing data. In the end, data was supplied for free from both the network operator (Tas Networks) and the electricity retailer (Aurora Energy).

Engagement officer

Given that the engagement officer spent considerable amounts of time on other project areas, some of the funding for this officer was allocated to project management expenses to reflect the time required in this area.

Marketing consultant

The marketing consultant provided exceptional value for money for the work completed. They also offered a 20% community discount for working with not-for-profit organisations in disadvantaged communities.

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9.3.2 Main areas of increased spending

Project management
This project required greater staffing resources than budgeted at the beginning of the project. Areas requiring attention included project system setup, recruitment processing, database management and reporting.

Data Analysis consultants
An increase in spending on the data analyst position was a result of

a) Difficulty cleaning detailed temperature data
b) Setting up billing data analysis tools
c) Time taken to run analysis and develop the detailed report

In home education and upgrades
The original budget for in-home education and upgrades had miscalculated the wage component of the project and neglected to include travel for casual employees (a requirement for delivery). Also additional materials were installed in homes as part of the project.

Governance and financial management
Costings for audited reports had not been budgeted into the project proposal. In addition, the sheer quantity of transactions to manage staffing and equipment increased the expense of keeping financial systems in place. Some extra time was allocated to the Energy Project Manager to ensure that project governance was managed to the expectations of the department.

Champions
Additional resources were allocated to the Champions recognising the role of the champions in door knocking and recruiting.

Travel expenses
Additional unforeseen travel expenses included travel to 3x LIEEP forums in Canberra, Newcastle and Adelaide.

Miscellaneous changes
There are a number of smaller changes in the budget that are the result of the minutiae of project delivery. This includes higher phone and postage costs but savings in items such as SMS services.

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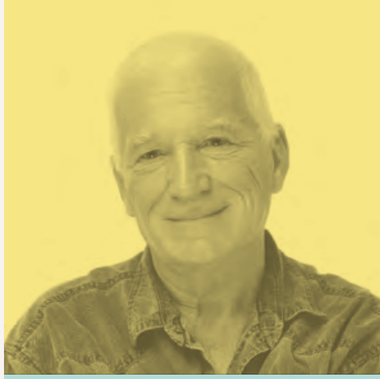

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Department of Industry, Innovation and Science

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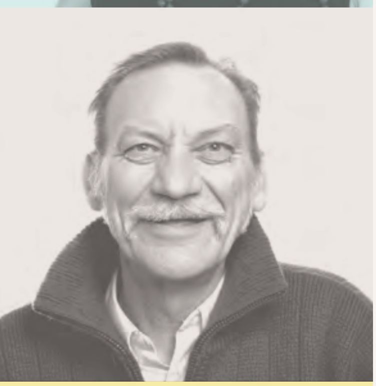


GET BILL SMART

DETAILED STUDY REPORT




SUSTAINABLE LIVING TASMANIA


UNIVERSITY of TASMANIA

GET BILL SMART

DETAILED STUDY REPORT

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(Please note: all authors contributed equally to this document)

This activity received funding from the Australian Government. The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information or advice contained herein.

Please note: There were time constraints that restricted report development. There is more we could say. If interested, please contact the authors to discuss the report and its underlying data further.

This report also uses stock photography rather than photos of actual participants.

Graphic design by Poco People, Hobart.

Contents

1. Introduction

This report, The Detailed Study, provides in-depth examination of participant households and the change that occurred for these households after Get Bill Smart (GBS) program involvement. The report presents the methods and findings from qualitative and quantitative detailed research conducted with 51 of the households involved in the broader GBS project. The aim of The Detailed Study is to gain further insight into energy efficiency and thermal comfort behaviours through more nuanced understanding of the conditions that householders experience, the changes (outcomes) that occur over the GBS study period, key influences affecting those changes, and trade-offs made between energy use and comfort.

The Detailed Study enhances understanding of:

- home energy consumption and energy efficiency change outcomes
- home thermal comfort management and performance changes
- housing conditions participants live with that influence their thermal comfort and energy consumption
- affordability related to energy use and thermal comfort
- health and wellbeing and its relationship to energy use and thermal comfort
- trade-offs participants make when there is an opportunity for comfort improvement or energy saving
- comparative effects of GBS support approaches, and
- the context of low income householders and how it affects energy use, energy efficiency and thermal comfort in the home.

This is one of four reports produced on Get Bill Smart activities and outcomes. The other three are:

1. The Bulk Study
2. Cost benefit analysis, and
3. Organisational report.

These four reports make up the majority of the final report submitted for the Get Bill Smart project. The Detailed Study contributes to the GBS objectives of: comparing outcomes of the approaches and support activities trialled; understanding how a community capacity approach can assist energy efficiency; understanding key processes and determinants that lead to energy and comfort changes; and understanding how energy and comfort outcomes are utilised by low income householders. Overall GBS is working to advance understanding of energy use and thermal performance to improve the design of support activities for application in Tasmania and Australia.

Participants in GBS are divided into four approaches:

1. In-home education and upgrades (EDUG)
2. Community capacity building (CCB)
3. In-home education and upgrades and community capacity building (EDUG+CCB)
4. Representative group (the no activity, baseline comparative group) (REP)

Essentially in these four groups GBS tested two key approaches to energy efficiency support: Community capacity building with local energy champions, and in-home education and upgrades supported by expert sustainability assessors. The 51 households who participated in this detail part of the study were drawn from all four GBS approach groups in roughly equal numbers so that differences in the approaches could be compared.

Research methods used for the Detailed Study were both qualitative and quantitative. As Foulds et al. (2013: 627) have previously observed, the use of both types of data “provides the depth required to reflect suitably on data collection, theoretical application and analysis-related issues”. Change outcomes are examined by comparing key indicators before GBS energy efficiency activities and again after the activities, and through comparisons between the GBS approach groups. The quantitative data collection involved monitoring of household’s electrical consumption and temperatures inside and outside the house, over a 15-month period. The electricity and temperature monitoring period was across two winters in order to establish ‘before’ and ‘after’ periods of cold weather. The qualitative methods involved before and after interviews with householders in addition to the surveys conducted across all GBS households. Electricity billing data, gathered for all participants in GBS, is also referred to in this report.

Detailed study findings are presented in two ways: as individual case studies and as comparative (summative) analysis. Each participant household is described in an individual case study. Each case study describes key characteristics of the participant household, the physical house conditions relevant to the energy/comfort focus, outcomes of the energy efficiency support activities; key influences that affected those outcomes; critical contextual and community considerations; and key domestic considerations within the household. The richness of information presented in this way, while not statistically significant, allows examination of varied cases and reveals critical dynamics (differences) in experiences house to house.

A case-based approach, such as we have used, has recently been applied by Gram-Hassen (2010) to understand variation in residential heat comfort practices and energy use across households. By pulling together quantitative aspects of the home with personalised dwelling experiences we are able, as Ellsworth-Krebs et al. (2015, 100) suggest, to "adopt the home (and all the baggage the term comes with) as the focus for investigation, highlighting an appreciation for the socio-technical nature of domestic energy demand".

Comparative summary analyses identify outcomes for different approach groups and outcomes according to key indicators. Comparisons are presented in tables with interpretation. These comparisons:

- illuminate influential relationships between housing/heater performance and electricity use/comfort outcomes
- present outcomes of the four different GBS approaches, and
- assist, in conjunction with case study analysis, to develop overall detail study findings.

In order to compare cases, the Detailed Study includes only the detailed participants that took part in the main study proper and were part of one of the four approaches described above. 'Energy Champion' (EC) households are not reported here. The 12 EC households took part in similar research processes to detailed participants but, due to program delays at the outset of the project, the monitoring period for the ECs was a non-winter period. Hence, quality data regarding heating could not be collected from the EC household group. The 12 EC households became a very valuable testing ground for detailed research processes. Understanding from researching champion households was fed back into the research processes for the detailed study.

In this report we present all stages of the detailed study by first outlining methods used for quantitative and qualitative data collection and combined analysis; then presenting detailed case studies and comparative analyses; and, finally, presenting a discussion of findings and conclusions.

2. Detailed data collection and analysis methods

This section outlines the methods used to collect, process and analyse data for the detailed component of the Get Bill Smart project. Both qualitative and quantitative data collection methods were used, in a mixed-method approach in order to construct more detailed understanding of: (i) home thermal and energy performance (before and after support activities in homes); (ii) the contributions to change in home thermal and energy performance outcomes; and (iii) people's knowledge and practices around managing energy and comfort in the home.

The detailed study was conducted with 51 households. The 51 households who participated in this detail part of the study were drawn from all four GBS approach groups in roughly equal numbers so that differences in the approaches could be thoroughly investigated. Over the investigation period numbers in various approaches did shift somewhat because of house moves and the length of monitoring periods for people who moved (EDUG 12 households, CCB 16 households, EDUG + CCB 11 households, and REP 12 households). These participant households were involved in the detailed research process between May 2014 and late September 2015. Data for the detailed component of the study was collected via multiple data collection tools, namely:

- semi structured longitudinal interviews with householders (one before GBS support activities and one afterwards)
- logging of household electricity use and the thermal performance of houses through sensors placed in the homes (placed in the home at the 'before' visit and removed at the 'after' visit)
- an interim check-in and sensor-swap visit
- observations of physical housing features affecting thermal performance and energy use (during 'before' visits), and
- surveys before and after GBS support activities.

The analysis is conducted using a before/after overlay so that we can ascertain one year's cold period activity with the next year's cold period activity.

2.1 Ethics and privacy guidelines

The research team obtained ethics approval for the project from the University of Tasmania's Social Science Human Research Ethics Network (Tasmania) through application H0013682. After an Expression of Interest was received from an applicant and their suitability for GBS had been established, applicants were provided with a package of forms. This pack included the GBS (UTAS Human Ethics) Information Sheet, the UTAS Human Ethics Consent Form, the Federal Government Privacy Form, Landlord Consent Form, Billing Data Form and Permission to Use Photos Form. Once these forms had been returned, participants were then formally accepted into the program and allocated into the four different research groups. SLT were often the main contact with landlords and assisted to gain landlord permissions. Detailed Study participants were contacted by UTAS and researchers arranged to visit the home, install the data loggers, conduct the interview and, if the survey had not been returned, make sure it was done.

2.2 Household data Collection timeline

UTAS researchers and data consultants (the researchers) visited each participant house three times. At initial visits (in May to July 2014) electricity and temperature logging equipment was installed, house observations were conducted and 'before' interviews were held. Interim visits (held in February 2015) provided an opportunity to check logging equipment, collect and replace temperature/humidity loggers that were full of data and helped to maintain contact with participants. At the interim visit checks were made on changes to appliances and their use; and, notes were made about relevant changes to household practices or the changes to the fabric of the house itself. At final visits (in August and September 2015) logging equipment was removed, changes to appliances and their uses were noted, 'after' interviews were conducted, participants were thanked and final vouchers were given. An electrician accompanied the researchers to the initial and final visits to houses in order to install and then remove electricity loggers in/from meter boards.

Figure 1: Timing of research activities for the Get Bill Smart Project shows the process of data collection over time.

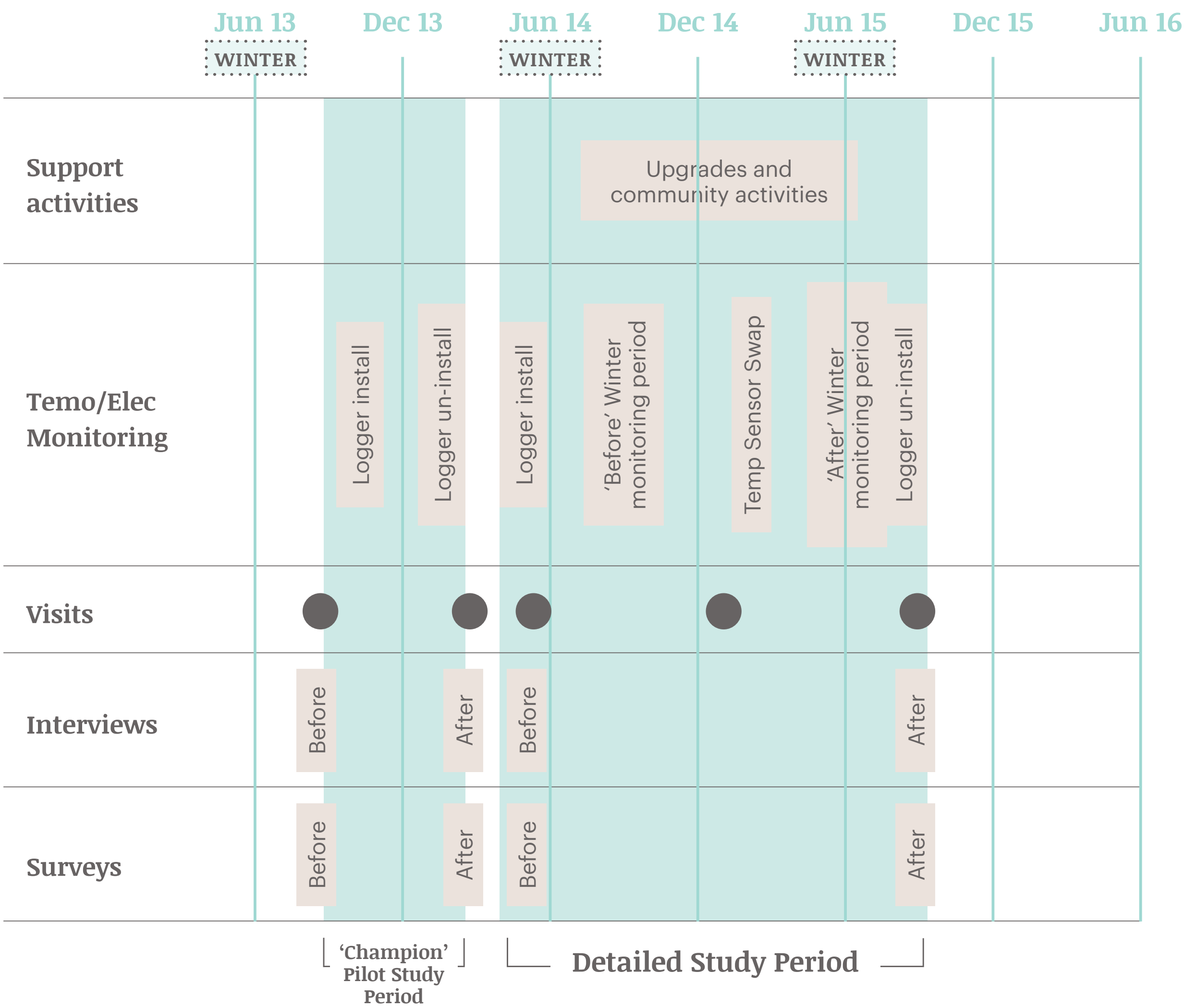

Figure 1: Timing of research activities for the Get Bill Smart Project

Standard information sheets and consent forms were provided to participants as per GBS ethics and Australian Government privacy requirements. In addition, information sheets about the logging equipment were given out at initial visits to Detailed Study participants. These sheets provided explanations of the equipment, what it was recording and contact numbers for researchers.

Grocery vouchers played an important role in the GBS project. Vouchers were given to participants as they completed key stages of the research. Extra vouchers were given to detail participants (more than were given to bulk study participants) to compensate them for the extra time involved in participation and for looking after the-home logging equipment. As with bulk participants, participants in the detailed study received different amounts of vouchers depending on the GBS approach they were part of. For further information on vouchers see the Get Bill Smart Final Report Overview.

2.3 Quantitative data logging and processing

Quantitative logging, data processing and analysis were undertaken for all households in the Detailed Study group. Quantitative data collected included temperature, humidity and electricity use, providing the opportunity for calculation of changes occurring over the life of the GBS project. Electricity billing information was also collected from the electricity power supplier.

Data logging processes were trialled in the houses of the community champions involved in GBS before roll out into detail participant houses. Problems with logging technology and processes identified during the champion logging phase were corrected before the roll out of loggers in detail households (Sustainable Living Tasmania, University of Tasmania et al. 2013). The collected temperature and electricity data allowed the research team to calculate average winter temperature changes (°C); average winter heating power consumption (kWh/day); average winter heating efficiency (°C/kWh/day); and, other significant thermal and electrical use changes in each house.

At each household, during initial consultation with the householders about logger installation, researchers were able to learn more about how each participant's home functioned – for example which rooms were coldest, whether children were likely to pull out power cords, which beds had electric blankets and which heaters were never used. This process built on insights gathered through the interviews and home observations, facilitating discussions about how the home functioned technically and socially.

Logging periods began when loggers were installed into a house and were recorded as finished when loggers were removed. This means that every house has different overall logging periods. Logging periods for electrical and temperature/humidity loggers *within* any given house were the same. Periods over which logging occurred in each house are listed in Table 1. Logging periods generally lasted for about 14 or 15 months, but some logging periods were shorter because households moved. Loggers were removed early when participants moved out of a house. Three houses who moved took part again in their new residences. Table 2 outlines the participant houses that had shorter logging periods.

Table 1: Logging periods in detail houses

House	Start logging	End Logging	House	Start logging	End Logging
GBS013	4/06/2014	31/08/2015	GBS093	10/06/2014	9/09/2015
GBS014	20/05/2014	31/08/2015	GBS094	10/06/2014	9/09/2015
GBS015	26/05/2014	7/09/2015	GBS097	19/06/2014	9/09/2015
GBS016	20/05/2014	2/09/2015	GBS098	2/06/2014	9/09/2015
GBS018	19/05/2014	31/08/2015	GBS099	28/05/2014	8/09/2015
GBS019	19/05/2014	2/09/2015	GBS100	2/06/2014	8/09/2015
GBS021	19/05/2014	1/09/2015	GBS110	2/06/2014	6/09/2015
GBS022	26/05/2014	2/09/2015	GBS113	4/07/2014	8/09/2015
GBS023	16/06/2014	1/09/2015	GBS131	12/06/2014	25/09/2015
GBS026	26/05/2014	6/10/2014	GBS135	12/06/2014	21/09/2015
GBS028	23/06/2014	7/09/2015	GBS140	16/06/2014	1/09/2015
GBS029	23/06/2014	1/09/2015	GBS144	30/05/2014	7/09/2015
GBS036	29/05/2014	1/09/2015	GBS148	4/06/2014	24/08/2015
GBS037	16/06/2014	2/09/2015	GBS156	3/06/2014	24/08/2015
GBS040	25/06/2014	8/09/2015	GBS157	10/07/2014	2/09/2015
GBS041	24/06/2014	9/09/2015	GBS159	27/05/2014	31/08/2015
GBS044	1/07/2014	3/02/2015	GBS161	23/06/2014	31/08/2015

GBS045	19/06/2014	8/09/2015	GBS166	25/06/2014	1/09/2015
GBS046	11/06/2014	8/09/2015	GBS168	18/06/2014	4/09/2015
GBS047	4/07/2014	25/06/2015	GBS172	20/06/2014	15/12/2014
GBS052	24/06/2014	8/09/2015	GBS175	30/05/2014	2/09/2015
GBS078	9/07/2014	9/09/2015	GBS268	10/07/2014	7/09/2015
GBS088	26/06/2014	24/09/2015	GBS724	22/06/2015	21/09/2015
GBS089	18/06/2014	3/02/2015	GBS725	3/06/2015	21/09/2015
GBS090	28/05/2014	4/09/2015	GBS726	17/12/2014	25/09/2015
GBS091	26/06/2014	15/12/2014			

Table 2: Shorter logging periods (participants who moved house)

GBS no	Reason for shorter logging period	Data logging	Data still viable?
GBS026	Moved interstate so no longer lived in the monitored residence.	26/5/14 – 24/9/14 approx 4 months	Yes. Was in GH, no upgrades group so can use for comparative purposes. Also made personal changes which provide good example.
GBS089	Moved house, still in area. Agreed to be involved in new house (became GBS725).	18/6/14 – 3/2/15 approx 7.5 months	Yes. Was in CVR no upgrades group so no home visit and community activity was already underway. Can use cold period of 2014 for control and comparative purposes.
GBS172	Moved out of area.	20/6/14 – 17/12/14 approx 6 months	Yes. Was in CVR no upgrades group. Can use for control and comparative purposes.
GBS044	Moved house, still in area. Agreed to be involved in new house (became GBS724).	1/7/14 – 3/2/15 approx 7 months	Yes. Reasonable length of time. After home upgrade has no winter. Useful as comparison with performance in new house.
GBS047	Participant moved out of area (as rental that was in was mouldy).	4/7/14 – 24/6/15 approx 11.5 months	Yes. Reasonable length of monitoring with cold weather measured after upgrade.
GBS091	Moved house. Still in area. Agreed to be involved in new house (became GBS726).	26/6/14 – 12/12/14 approx 5.5 months	Yes. Cold periods of time recorded. Can compare this with the data from new house.
GBS724	Moved house. Was a participant in another house (GBS044). Was offered an upgrade in this house. Moved to a more comfortable and less energy hungry house so didn't have an upgrade.	22/6/15 – 21/9/15 approx 3 months	Yes. Periods of cold data collected. Compare against performance of old house.

GBS725	Moved house. Was a participant in another house (GBS089). Went into the upgrade group (there were more short term data sets and one removal in that group).	25/6/15 – 21/9/15 approx 3 months	Yes. Have period of cold weather data logged. Compare against performance of old house.
GBS726	Moved house. Was a participant in another house (GBS091). Went into the upgrade group (there were more short term data sets and one removal in that group). Was in the upgrade group previously. House they moved into had been in the GBS study as GBS 172 with different occupant. The house had been a no upgrade group house when was GBS172.	17/12/14 – 25/9/15 approx 9 months	Yes. Have a good length of logged data. Can compare with GBS172 if needed.

2.3.1 Thermal Logging

Temperature and humidity (thermal) data were recorded using stand-alone USB Lascar USB 2+ Temperature and Humidity loggers, which recorded in situ at 30-minute intervals[1] over the full data collection period. Typically, two (sometimes three) loggers were positioned internally and one was positioned externally, in order to get a comparison of ambient temperature for each house.

Placement of thermal loggers required some consultation with the householders. Householders were shown the loggers before they were installed and their purpose(s) were explained. Householders then consulted with researchers as to the best places to position devices. Typically, one was placed in the main living area, sometimes this was a kitchen or dining area. A second logger was then placed in a bedroom. Internal loggers were positioned carefully so as to get the most reliable reading of the indoor air temperature for the room. They were positioned away from the direct effect of heating devices, away from external walls, and so they would not receive direct sunlight. An attempt was made to position loggers at the same height above the ground in all internal locations to provide consistency of readings. Loggers were fixed in position using double sided sticking foam. External thermal loggers were positioned such that they did not receive direct sunlight and were mounted in PVC piping (with both pipe ends open) for protection and to ensure more controlled and consistent readings. External loggers were mounted in various accessible positions such as under eaves, on sheds, and on top of meter boxes in porches.

The data capacity of the temperature/humidity loggers meant that they were filled with data before the end of the monitoring period and so were removed and replaced at the interim home visits. Loggers were removed (taken out of houses) at final visits. Downloading this data was reasonably straightforward. Temperature/humidity loggers were directly downloaded onto a field laptop during interim visits wherever possible, or at the first convenient chance after visits. Data viability could not be checked while logging was in process so data was checked as soon as data was downloaded. An example of the raw collected data from one of the loggers is shown in Figure 2. Most loggers installed in homes successfully recorded data. Out of all the temperature/humidity loggers used (300 or more over the study), only four loggers failed (a success rate of over 99%). In every case the failure was due to a faulty battery (despite all having fresh batteries inserted just before installation). Three of the failed loggers were in outside positions and one was internal.

1 In Milestone 3 we reported using temperature sensors at 5 minute intervals during monitoring of the champion households. Such a short interval filled the loggers' storage capacity quickly which meant downloads of the lascar usbs (and visits to the houses) had to be more frequent. Upon review, five-minute intervals did not offer any extra benefits for analysis so sensors were set to 30-minute recording intervals (the only other available setting). The 30 minute recording interval was proposed in the original GBS data plans and was therefore in line with original data clarity commitments (Sustainable Living Tasmania et al 2013).

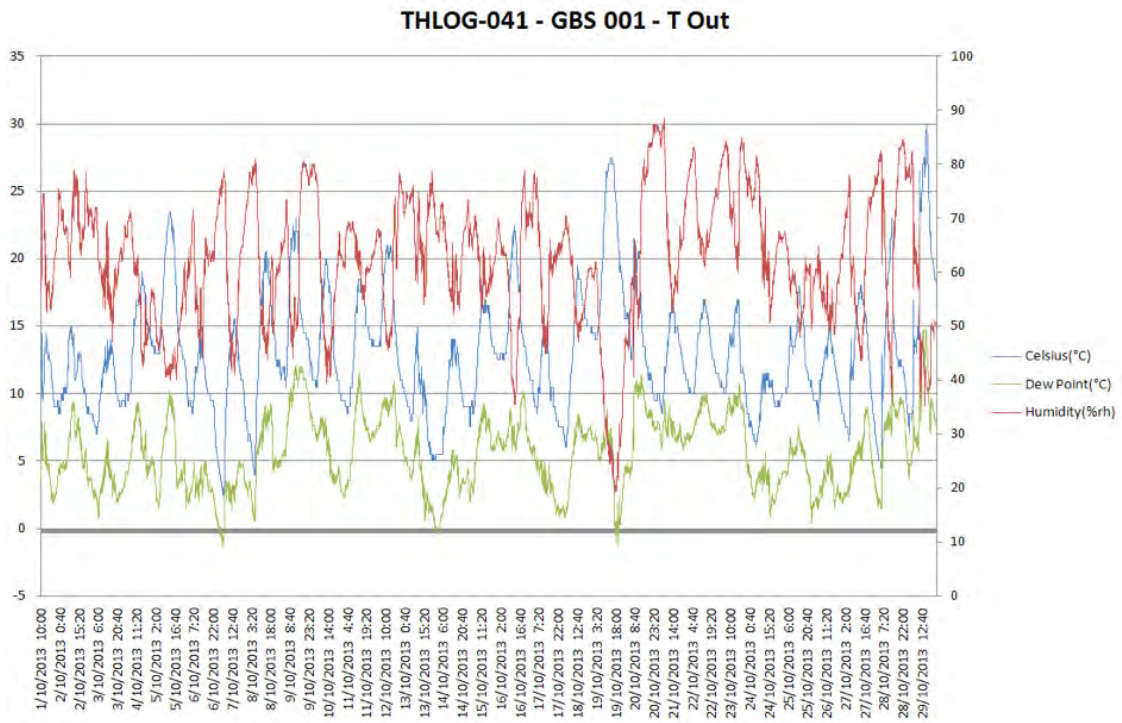

Figure 2: Example of graphed raw data from temperature/humidity data loggers

2.3.2 Electricity Logging

Electricity was logged by sensors in the house that fed data to a remote collection point via a router. Loggers were installed at the first ('before') home visit and were taken out at the final ('after'). Hardwired and plug in sensors were used to log electricity use. Hardwired circuits were monitored by installing hardwired sensors onto the circuits within the house's electrical meter board. Plug in heating appliances were monitored with the use of a sensor that was positioned (plugged-in) between the appliance and the power outlet. Both of these sensor types were wireless and sent data at approx. 5 second intervals to a centrally located router (the Billion sg6200nxl) installed in the house[2]. A 3G modem was attached to the router which uploaded the data to a web-based data collection portal. Figure 3 shows the equipment installed for electrical logging. The number of sensors installed in a house depended on the number of wired in circuits and plug-in heating devices that were in use in the household.

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2 All houses bar one in the detail group were able to have electricity sensors installed (GBS110). There were no electrical sensors installed GBS110 because there was a lack of space in the meter board for the sensors.

Figure 3: Power Tracker electrical sensing equipment (Reduction Revolution 2016)

The Power Tracker online data collection portal has a web interface through which real-time electricity use can be viewed (Reduction Revolution 2016). An example of the real-time data from the Power Tracker web portal is shown below in Figure 4. Power tracker's web portal gave the research team the opportunity to monitor the system installations in real-time. The online interface was useful to check that data being recorded, but was not used for calculating outcomes and other analysis. Logged electrical data was consequently accessed from Power Tracker in two ways. Aggregated information was accessed, using a power tracker account, from the web either as graphs or as csv files. This web information was aggregated into 10 minute intervals. More detailed, raw information was accessed via data downloads. GBS data consultants downloaded full data sets from Power Tracker once the monitoring period was complete.

The routers could be accessed remotely in order to undertake some maintenance and upgrades. Dropping out of 3G modem connections caused significant trouble with data collection, particularly with households in certain locations in the study. Processes were put in place such that the modems should have automatically re-connected if a disconnection occurred, but sometimes this reconnection did not occur. This was problematic because it meant that the routers could not be accessed remotely and data loss occurred. On the occasion where contact with the router was lost and could not be regained remotely, the research team would contact the householders and ask them to check the router. Sometimes the router had been accidentally unplugged or switched off, in which case the householders could turn it back on. In other cases, where the router was apparently working, the householders were asked to re-start the routers, which would in turn re-set the 3G modem and allow re-connection.

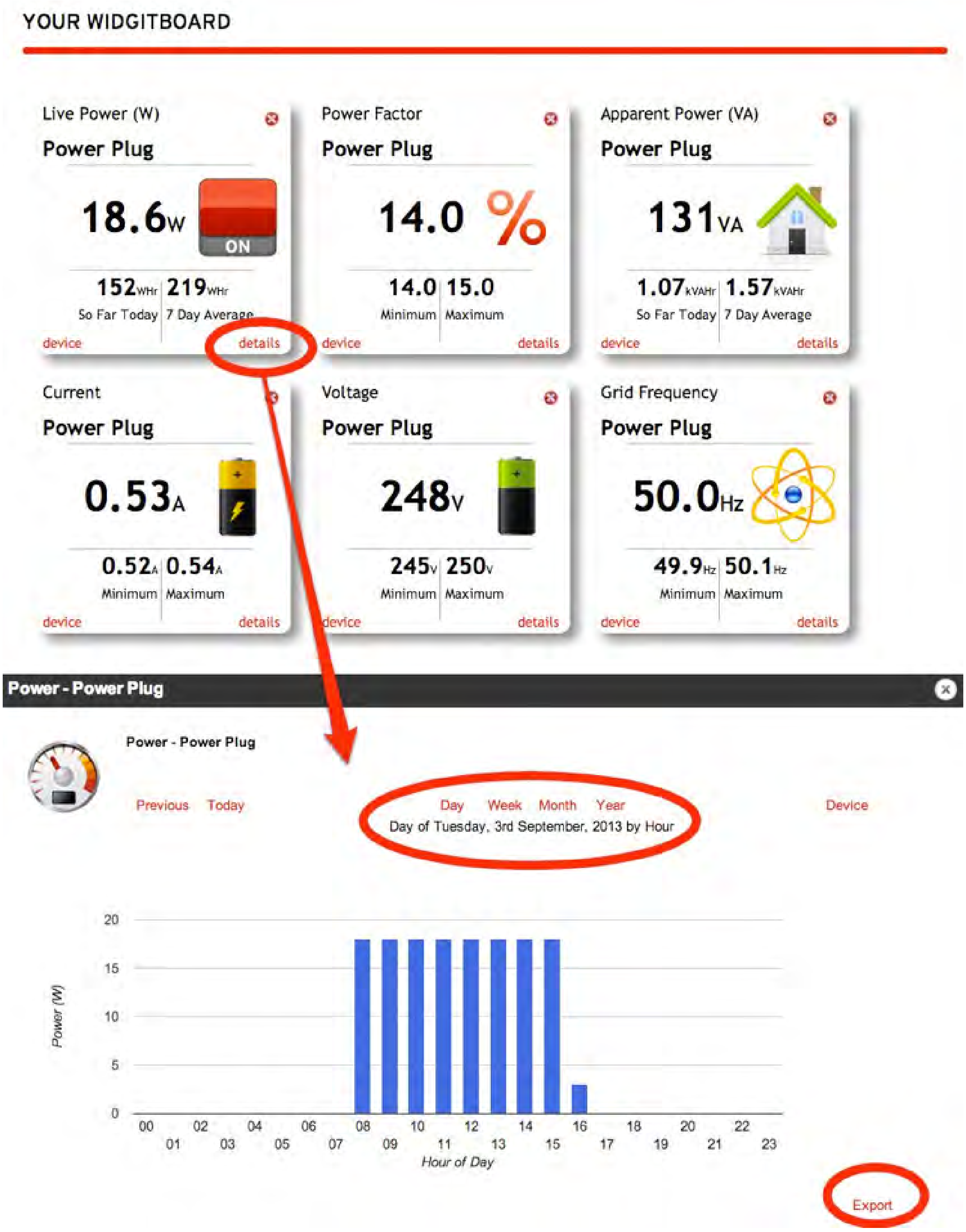


Figure 4: Example of information provided by power tracker portal (Reduction Revolution 2016

Overall electrical logging was successful in isolating key heating devices and electrical circuits. Some issues did occur, in particular:

- In a few cases hard wired heating appliances were not able to be isolated from the general light and power circuits because they were not on their own meter board circuits. For example, 'IXL Tastic' bathroom heater lights.
- Plug in heating appliances were isolated via sensors on plugs to isolate this data from general light and power. From review of the data it appears likely that some households used some heaters at times without using the sensor extension plug.
- Similarly, the use of new appliances in detail houses over the study period was not always recorded because households did not notify us when they began to use them.

2.3.3 Pre-processing logged data

After the electricity and thermal data was logged and downloaded, pre-processing was required before analysis could be conducted. Pre-processing data included downloading sequences, cleaning sequences, setting consistent time sequences and checking integrity.

Electrical data required significant pre-processing effort before it could be analysed. Early conversion of data took place at Power Tracker before it could be downloaded by the GBS team. There were numerous false starts with downloads from Power Tracker. Downloads were difficult in part because of the significant size of data sets. The GBS team liaised with the Power Tracker data mangers to download data in an appropriate format. Liaising took time – by degrees GBS received data in a cleaner format with column definitions clarified. Data files when downloaded contained 4 or 5 key parameters:

- main energy – the cumulative measure of the amount of energy that had passed through the sensor
- active power – the instantaneous power being used by the appliance or circuit
- apparent power
- power factor, and
- negative energy – for circuits that were monitoring PV systems this is the cumulative amount of energy being produced by the PV system.

After receiving correct electrical data, all individual sensor data sets for a given house were amalgamated into one data set. Data was 'padded out' to fill gaps in data. Gaps in data sequences occurred when there were interruptions in data feeds from internet failure and householders accidentally removing routers for periods of time. After padding, before and after periods were then applied to extract sample data. Electrical data was then checked for completeness in the identified before after periods.

Temperature/humidity logger downloads were reasonably straightforward. Data was downloaded directly to computer in CSV format. The length of time houses were monitored and the technology used for temperature and humidity logging meant that each particular location in each particular house had two data sets. Data from two individual loggers used for the same location were amalgamated to give a continuous measure of temperature and humidity over the logging period for that particular sensor location. All temperature/humidity logger data sets for a particular participant house were then amalgamated into one file.

All logger time periods were then cropped so that data sets only contained data logged while the loggers were sitting at participant houses and not data logged during set up, removal and transit to the house. Cropping allowed a consistent time base to be established. The same time base was also used for electrical analysis. The before and after periods were applied as per the electricity data, and then all thermal and electricity data for an individual household was combined into one file.

2.4 Quantitative Analysis methods

After data cleaning, padding, amalgamation and cropping, analysis was conducted on the quantitative data. Before and after (comparative) sampling periods were established and temperature/humidity and electrical data were analysed separately and together.

2.4.1 Identifying comparative before and after periods for quantitative analysis

Key sampling periods were identified according to the individual circumstances of each house and according to the dates GBS support activities were undertaken. Comparative before and after periods were first identified by specifying two periods of time when temperatures were below 18°C – one before interventions took place (but in the logging period) and one period after (but before the end of the overall logging period). Identifying these periods of time was achieved using Bureau of Meteorology (BOM) data from the two closest meteorological stations: Hobart airport and Hobart CBD. After identifying periods of time below 18°C (where the temperature never went over 18°C), the before and after periods were further refined based on the completeness of the electricity data for those periods (and based on start and finish dates of the logging process). Figure 5outlines the steps taken to define before and after periods. The upper temperature limit of 18°C was used because it was the bottom of the comfort zone and guaranteed a period of continuity with no hot days. An average cold(er) temperature could not have been used to define cold periods because temperatures still could have spiked above 18°C. Taking an upper limit temperature approach to defining the cold period meant that temperatures would often be much colder than the 18°C upper limit chosen.

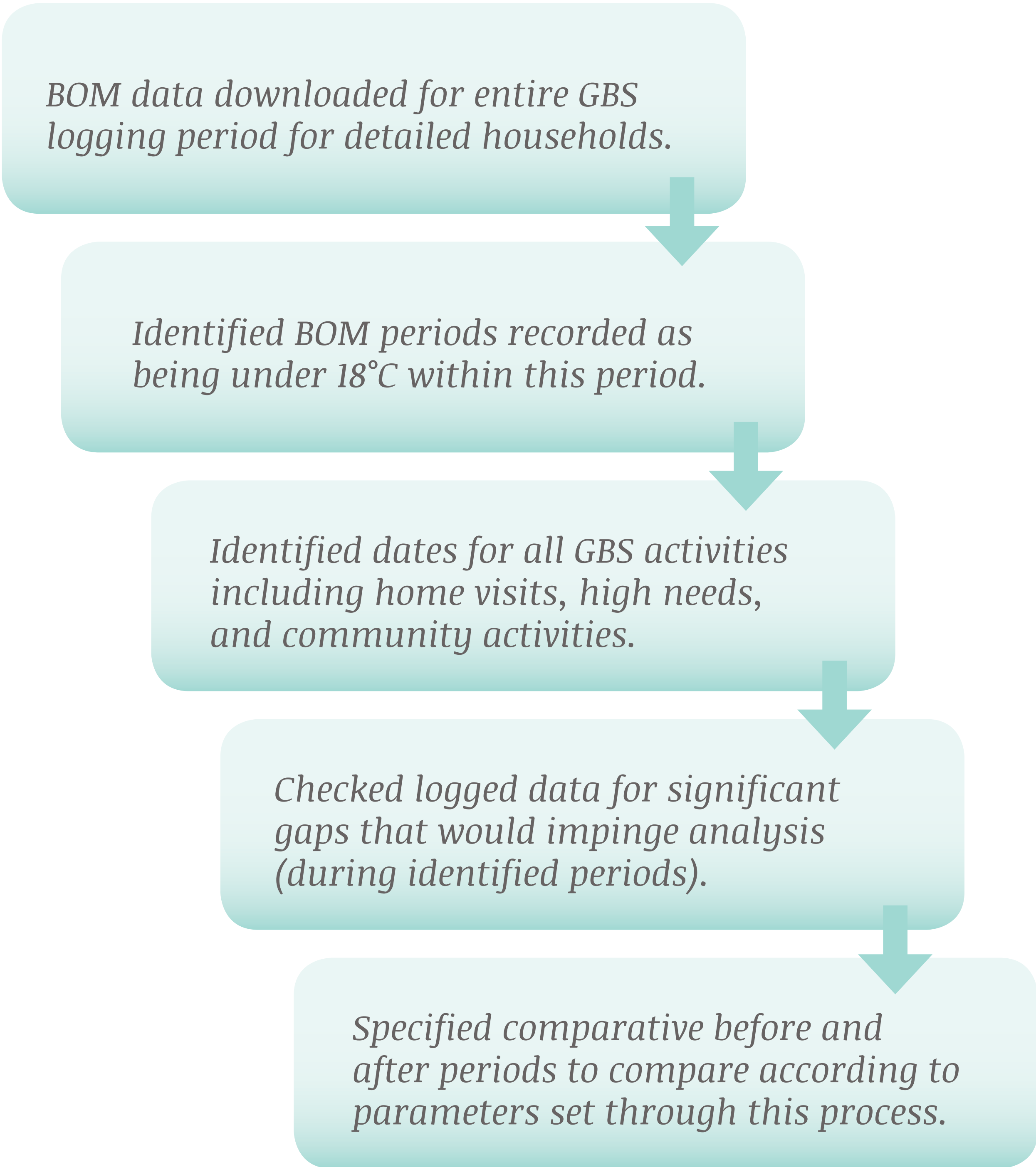


Figure 5: Steps to defining before and after periods.

Table 3 lists the specific before and after periods applied to each participant house.

Table 3: Before and after periods used for analysis

House	Before Period		After period		After Period 2	
	Start date of period	End date of period	Start date of period	End date of period	Start date of period	End date of period
GBS013	5/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS014	21/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS015	27/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS016	21/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS018	20/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS019	20/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS021	20/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS022	27/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS023	17/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS026	27/05/2014	26/08/2014				
GBS028	24/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS029	24/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS036	30/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS037	17/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS040	26/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS041	25/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS044	2/07/2014	26/08/2014				
GBS045	20/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS046	12/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS047	5/07/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	24/06/2015
GBS052	25/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS078	10/07/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS088	27/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS089	19/06/2014	26/08/2014				
GBS090	29/05/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS091	27/05/2014	26/08/2014				
GBS093	11/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS094	11/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS097	20/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS098	3/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS099	29/05/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS100	3/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015

GBS110	3/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS113	5/07/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS131	13/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS135	13/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS140	17/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS144	31/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS148	5/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS156	4/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS157	11/07/2014	26/08/2014	4/05/2015	20/08/2015		
GBS159	28/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS161	24/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS166	26/06/2014	26/08/2014	4/05/2015	20/08/2015		
GBS168	19/06/2014	26/08/2014	6/05/2015	6/06/2015	8/06/2015	20/08/2015
GBS172	21/06/2014	26/08/2014				
GBS175	31/05/2014	26/08/2014	4/05/2015	20/08/2015		
GBS268	11/07/2014	26/08/2014	4/05/2015	20/08/2015		
GBS724	23/06/2015	20/08/2015	22/08/2015	9/09/2015		
GBS725	9/06/2015	12/08/2015	22/08/2015	9/09/2015		
GBS726	9/06/2015	16/08/2015	22/08/2015	9/09/2015		

Table notes:

- Some before and after periods were further refined during analysis due to gaps in electricity data.
- Two separate after periods were defined for the CVR groups because the outdoor temperature went over 18°C for a period of time.

Support activities for home upgrade involved one main visit by the Home Energy Helpers, and for a small number of households involved a second visit for extra (high-needs) upgrades. These upgrades were conducted at various times after the first (before) research visits to the homes. The main home energy visits and high needs visits (where applicable) are treated as a single activity for the majority of analysis. This means that before and after periods sit either side of high needs support activities. Actual interventions for each house are listed (specified) in the case studies for each participant house. High needs upgrades are also listed there.

2.4.2 Individual Electricity Use Analysis

Initial electricity use analysis used data from the before and after periods to sum up overall energy consumption and provide average per day consumption for:

- total household electricity consumption
- total household electrical heating consumption
- hard-wired heating consumption
- plug-in heating consumption
- overall light and power consumption including plug-in heating
- light and power consumption without plug-in heating
- hot water consumption
- photovoltaic production (where applicable).

A comparison was made on all of these parameters of the average daily consumption in the before and after periods.

2.4.3 Individual Temperature/humidity

Temperature/humidity data from each house were used to show typical thermal performance for any given house. Initial analysis of temperature and humidity identified:

- average temperatures experienced over the defined before and after periods (°C) in the various rooms monitored
- average outdoor temperature at the house during the before and after periods
- difference between inside outside temperatures (ΔT)
- difference in ΔT between the before and after period, and
- time spent within the defined 18-24°C comfort zone and the difference in time within comfort zone between the before and after periods.

Initial analysis provided a picture of the thermal performance of each house and understanding of physiological comfort/discomfort experienced by householders in winter before compared to after GBS activities.

In selected cases that showed problems with humidity, before and after humidity data was reviewed using graphical analysis of the thermal data. Graphed humidity data identified the significance of reported moisture and mould problems and highlighted how often dew point may have been reached inside homes. Householders were also asked about moisture and mould in the homes and this qualitative self-reported information was considered when assessing humidity or dew point issues in homes.

Comfort zones were defined to be between 18-24°C after reviewing international standards and local research on comfort zones (Ranson 1988; Roaf, Crichton et al. 2005; Watson 2013).

2.4.4 Combined temperature and electrical analysis

Combined temperature and electrical analysis provided the opportunity to understand house performance further and to examine heating efficiency. Combined analysis of the thermal performance and the electrical use showed overall efficiency and provided a means for summarising quantitative outcomes. Further, this combined analysis supported integrated analysis with the qualitative data.

The measure of heating efficiency was derived using average winter temperature difference between inside and outside ΔT (°C) and average winter heating power consumption (kWh/day) to identify average winter heating efficiency (°C-hours/kW/day). The change in this heating efficiency measure between the before and after periods was then compared. Summaries of combined temperature and electrical analysis steps follow.

Steps for Heating Efficiency Analysis

1. Identify two periods before/after energy efficiency upgrade date that were similar in temperature (max temp less than 18°C).
2. Determine average ΔT for each of the before and after periods (°C).
3. Determine total average daily heating energy consumption during those periods (kWh/day).
4. Calculate heating efficiency (°C-hours/kWh/day).
5. Calculate changes to heating efficiency before/after intervention date (%).

Steps for Comfort Zone Analysis

1. Determine % of time within the 18-24°C for before and after periods
2. Determine change in % between the before and after periods.
3. Determine comfort zone heating efficiency % time/kWh
4. Determine change in comfort zone heating efficiency between the before and after periods.

Data presented in case studies in results tables and in graphs describe temperature and electricity data generated through using the steps described above. Note that where heating is provided by non-electric sources such as gas or wood fire, the heat delivered by these sources is not picked up by electricity consumption and hence the heating efficiency ratio is not comparable. The heating efficiency ratio also tends to vary widely depending on the absolute amount of heating being used. Small amounts of heating will tend to deliver a bigger heating efficiency ratio, but very cold temperatures within the house. Hence heating efficiency can be of use as an indicator when comparing between houses, with the understanding of these limitations and when considered in relation to the other indicators such as overall heating use and thermal comfort ratings.

2.5 Qualitative data collection

Qualitative forms of data collection and then analysis enable researchers to relate to participant contexts, perceptions, opinions and details of their situations otherwise unattainable or unmeasurable via other means. Qualitative data for the detailed report involved: longitudinal semi-structured interviews with householder participants; house observations; surveys and interim conversations at sensor swap-overs.

2.5.1 Interviews

Longitudinal semi-structured interviews were conducted with all detailed households to gather in-depth qualitative information. Interviews were conducted in homes at initial 'before' and final 'after' home visits. Notes from conversations were also taken at interim home visits as sensors were swapped.

Collecting the participants and stakeholders' experiences and opinions through interviews was seen as a critical element of data collection because it engaged with the nuance of everyday life that informs how people use energy and manage comfort (Crosbie and Baker 2010; Watson 2013). Interview data allowed exploration of participant and stakeholder opinions, perspectives and experiences and allowed richer understanding of the dynamic 'terrain' of an issue. Examination of in-depth narratives provided through interviews allowed researchers to understand the dynamics and variability between houses, common themes across houses, and uncover inaccessible information or unrecognised impacts and influences.

Interviews followed a schedule, but were semi structured so that householders were able to raise issues that they felt were important and that may not have been anticipated by the interviewers. This avoided researchers having to guess or presume outcomes prior to data collection. Interviewers made efforts to ensure they were respectful and receptive during interviews and that they provided background for the research, the questions and themselves. The looser structure and the efforts made to engage respectfully allowed participants to have some control over their contributions. In most cases this allowed householders to better trust researchers, creating space for sharing of information, mutual examination of the topic and mutual construction of knowledge which ensured maximum possible learning was taken away from interviews.

Interviews were recorded with permission from participants. Notes were also taken in case of a poor quality recording or if participants did not want to be recorded. Only one household chose not to be recorded and have notes taken instead during their interviews.

In interviews participants were invited to talk about:

- experiences of the GBS energy efficiency upgrades/interventions and community activities
- perceived indoor thermal performance (summer and winter)
- ways thermal comfort was managed and heating practices
- effects of discomfort
- energy use practices
- effects of 'high' energy bills (relatively speaking)
- changes participants had and were planning to make to their home
- barriers stopping participants making changes
- assessment of the outcomes of GBS activities
- choices made between thermal comfort, affordability and other housing needs when energy use reduced (trade-offs)
- social networks involved or influencing their energy efficient upgrade and practice change activity, and
- Perceived influences (if there is any) of the community capacity-building activities.

All recorded interviews were transcribed and notes taken were stored for analysis.

2.5.2 Housing observations

Observations of physical house conditions were recorded in order to identify key physical characteristics of houses that influenced energy use and comfort performance and to ascertain the general physical housing conditions and thermal performance participants lived with. Before the initial household visit, the researchers examined Google Earth satellite and 'Street View' images of the houses in order to record information about the surroundings, and to get an initial idea of the orientation and construction of the house. Researchers observed physical house conditions at initial 'before' household visits via a checklist and documented conditions with photos. Observed information was also gathered via discussions about logger positioning in homes and during interviews.

Housing observations were made of various aspects of the house, for example:

- orientation of house and windows
- building materials – walls, floors, roofs, glazing
- hot water and heater type
- heating system types and locations
- window frames
- window coverings
- lighting types
- floor coverings
- air vents, and
- access to sunlight and obstructions in the surroundings.

Observations took the form of checklists, descriptions, counts categorisations, drawings, photos, diagrams, and measurements. To gather this data, researchers looked around (the inside and outside of) houses with the householder. During the process of these observations, householders were able to discuss various parts of the home, explaining the quirks of the physical dwelling and the social interactions that took place with and within the structure. For example, walking into wind-blown parts of houses allowed participants to point out the prevailing wind directions and the windows or doors most affected by draughts. Observations were also collated as loggers were installed. The researcher installing loggers, for example, talked to participants about cold bedrooms, heater types and house layouts and contributes this information to the observation set. This parallel collection of observations meant that researchers limited the time they spent in the householders' personal space. Key house observations have been integrated into the case studies with assessments made of house performance based on these observations.

2.5.3 Surveys

Surveys were given to all householders involved in the project, including those taking part in the detailed study. Surveys are being used to build a baseline and to compare across the GBS approaches. Surveys asked participants about:

- occupant numbers
- occupant age groups, education and employment
- dwelling features, including heating and hot water systems
- home energy efficiency measures undertaken and changes for comfort
- prevalence of moisture and mould in their home
- indoor comfort levels
- their concerns about energy consumption and costs, and
- their views of the local community.

Survey design and questions are further outlined in the Bulk Study description of methods. The survey data contributed to the detail cases providing information on: house ownership, occupants, bedrooms, house structure and materials, confidence of the householders in sourcing energy efficiency information, confidence about community connections, moisture and mould and draught accounts, and changes listed as having been made to the home.

2.6 Qualitative analysis

Qualitative analysis is conducted to generate in-depth descriptive information on the householders living circumstances, householder practices, constraints and needs which are helpful when interpreting the figures derived from quantitative processes. Qualitative data allows examination of the dynamics of situations and the variability of outcomes.

Qualitative analysis extracts key themes, descriptors, context, trends, and comparisons from the details of specific cases in the form of narratives, comments and researcher observations gathered during interviews and surveys. Data for analysis is contributed in the form of voice recorded interviews, researchers' notes and transcriptions, survey content descriptions and comments, and researcher observations.

2.6.1 Interviews

Before and after interview transcripts provide in-depth narratives from participants. Transcripts were reviewed in NVIVO analysis software by researchers. Multiple reviews of each transcript were conducted to identify layers of findings, in particular: content descriptors; participant opinions, perspectives and experiences; key thematic dynamics and patterns; and narratives.

Extracting content helps to build a basic (descriptive) picture of a participant's situation. For example, content was extracted about what jobs people did, who they connected with in the community, changes in occupants, and lists of changes made to the house. Content from interviews often paralleled and complimented data collected in surveys. Content from interviews added to survey information by providing a richer, less static understanding of content.

Participant opinions, perspectives and experiences shared by participants helped researchers understand comfort practices and energy use and what households do in reaction to their comfort and energy situations. This data provides us with understanding of contextual information, value bases, attitudes, priorities and daily household practices allowing us to discern drivers and barriers to making energy and comfort.

Multiple points can be taken from each comment made. People might provide comments that highlight not only a daily practice but the reasons they undertake that practice. For example, 'I open up the house in the morning even though we are cold. Gerry hates it but I don't see how else to deal with the crying windows'. This comment informs researchers about daily household practices and household micro-politics. Aligned with this, people may communicate explicitly or implicitly. Implicit communications are examined as well.

Transcripts are also examined to identify key thematic dynamics and patterns. For example, after reading the transcripts we identified that habits of householders around animals in houses can play an important role in the level of thermal comfort of participants and that teenagers in various houses repeatedly spent a lot of time in the shower using a lot of hot water. Thematic understanding such as this helps build understanding of key issues being examined.

Text and term searches were also conducted in NVIVO software by researchers to examine specific data and concepts. Using an iterative and emergent process of examining findings has highlighted critical issues of context, situation, capacity, influences, and outcomes from the community capacity building process.

2.6.2 Observations and free form survey answers

Housing observations and written (as opposed to ticked) survey answers also provided qualitative data in the form of: content, contextual information, participant values, opinions, perspectives. Despite the collected qualitative data being in various formats, such as lists, photos, notes, and short text answers, they are able to be 'read' and reviewed in the same ways that transcripts are. As information is considered, absorbed and synthesised from these sources, key content and descriptors, key themes and key trends emerge which are then considered in conjunction with all other data sources.

2.7 Combined quantitative and qualitative analysis

In order to ensure we paint a picture that includes in depth and contextual aspects of GBS outcomes, qualitative and quantitative data are analysed together and findings are presented as an integrated whole in detail cases studies. Temperature and energy consumption data is compared with interviews, survey data and house observations to identify commonalities, trends and variations. By combining the data into case studies we present an integrated analysis that shows comfort and energy outcomes with connections made to overall household contexts, behaviours and routines, wellbeing and affordability thereby examining underlying issues and barriers that affect thermal and energy performance in the home.

Key stages for combining data and conducting overall analysis were:

1. Gather qualitative and quantitative data.
2. Analyse quantitative data (for a participant).
3. Analyse qualitative data (for same participant).
4. With knowledge of participant's qualitative data, review participant's thermal and energy data. Note key changes in logged data, key changes reported by participants, trends and patterns emerging, anomalies and useful themes.
5. Develop case study profile. Include observation and survey data.
6. Add key bill outcomes, check against case study data.
7. Revisit qualitative transcripts to further contextualise cases.
8. Develop findings for participant's case.
9. Identification of key themes emerging from the individual case study to use in synthesis of overall findings.

Importantly, the combined analysis was conducted by data consultants and the qualitative data researchers in conjunction, ensuring that understanding gathered from both sources were integrated and informed the overall synthesis of findings.

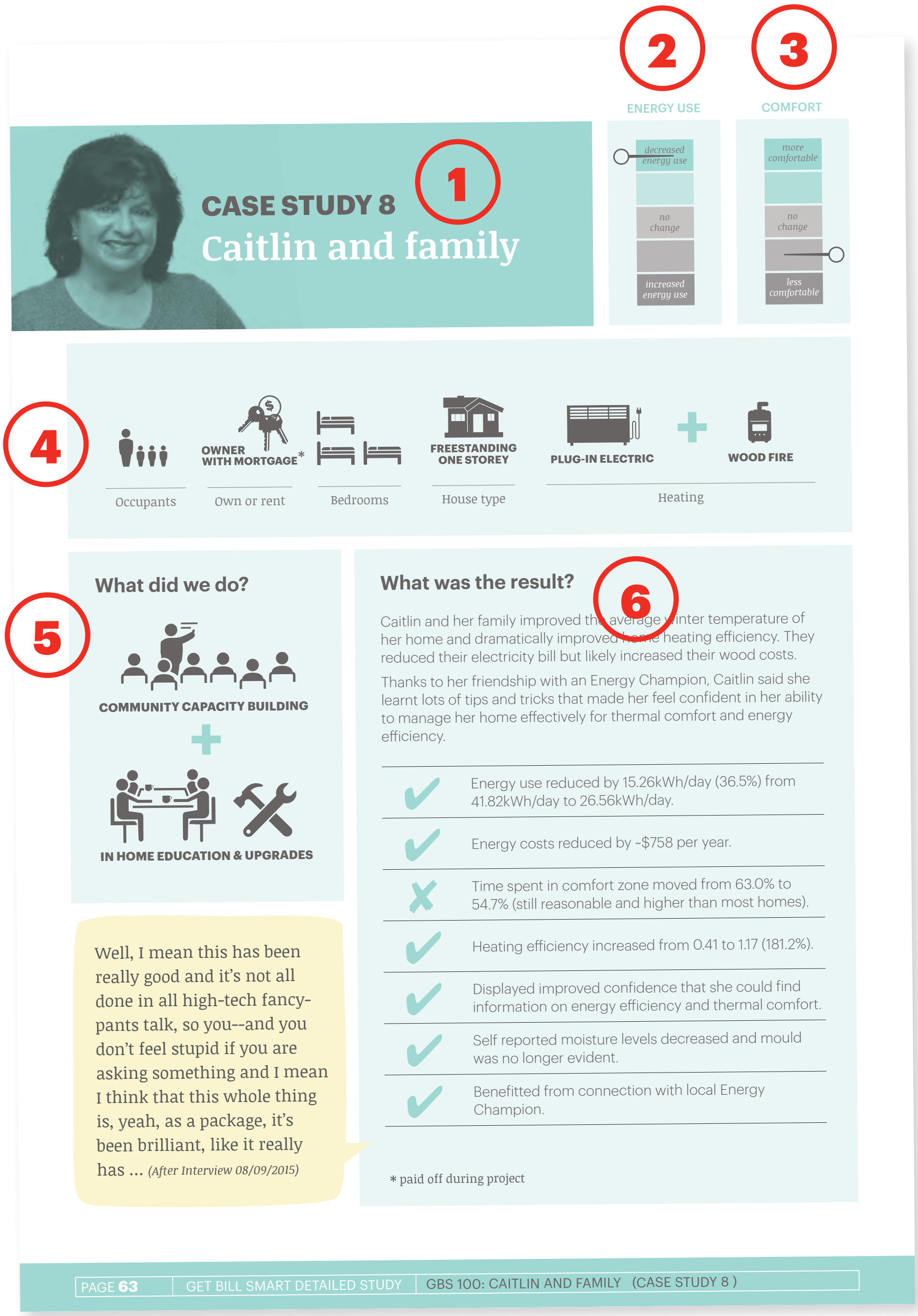
2.7.1 Methods for outcomes and assessments in cases

Cases are presented in two lengths – long with extensive description, short with one overall description. There are at least three long cases studies per approach group.

On the following page is an example front page of a case study (Figure 6), with key elements numbered, these numbers correlate with explanatory text below the image. These key elements are described on the subsequent pages, along with other subject headings used to present the findings in the case studies.

The methods used to develop descriptions and ratings in the case studies in this report are described here under headings used in the case studies.

Figure 6: example of first page of case study



1. Case Study Title

Each Detailed Study participant household has a case study in this report. Each household has been assigned a case study number. This is different from the GBS reference number that references all 504 households in the GBS project. All householders who participated in the research are provided with an alias. Other household members are described generically. Most often either one or two adults per house provided information to GBS.

2. Energy Use increase/decrease

This gives an indicator as to overall energy use outcome for each household. The use change between before and after data is rated on a five level scale from 'increased energy use' through to 'no change' and 'decreased energy use 'This rating is generated by reviewing the energy use changes quantified by electricity monitoring data and also from energy bill comparisons.

3. Comfort increase/decrease

This gives an indicator as to overall thermal comfort outcome for each household. The comfort change between before and after data is rated on a 5 level scale from 'less comfortable' through 'no change' to 'more comfortable'. This rating is developed by reviewing the comfort ratings participants gave in surveys, the comments made about comfort in interviews and the time in comfort zone data generated from thermal logging data. It is important to note that this is relative change. A household that has greatly increased comfort levels is not necessarily a warm house.

4. House and Household Characteristics

This section notes a series of household characteristics through a series of icons.

- Occupants: this is the number of occupants (adults and children) living in the house through the majority of the GBS study (changes to occupancy that occurred during the study are noted in the text)
- Household tenure: whether the house is owned with or without a mortgage, or rented.
- Bedrooms: the number of bedrooms in the house are depicted as beds.
- House types: describes whether the house is freestanding, or conjoined, and one or two storey.
- Heating: describes the two main types of heating used in the house. Images describe plug-in electric, hard-wired electric resistance, hard-wired heat pump, wood fires and gas heaters.

5. What did we do?

This section notes the GBS approaches this participant household was involved with. If the participant household received an in home education and upgrade visits, the image is presented here. If the household was in the community where community capacity building was rolled out the community capacity building icon is shown. Note that being within the community that received capacity building activities, does not necessarily mean that the participants attended capacity building activities. Attendance at capacity building events is noted further down in the body of the case study.

6. What was the result

This section presents a brief summary of the outcomes of the GBS project for the household. The first five of these indicators are the same for each case study:

- Daily energy use
- Energy costs
- Time in comfort zone
- Heating efficiency, and
- Confidence of householders in sourcing energy efficiency information.

Two additional indicators are provided to highlight specific aspects that may be relevant for individual cases. For each indicator, a tick or a cross represents a positive or negative change in regard to that parameter. A tilde (~) is used to show that something is unclear or borderline.

Existing physical conditions of the house:

House descriptors and ratings are listed in the case study to provide a picture of existing physical housing conditions as they relate to thermal comfort and energy use. Various key building elements are rated according to the following system:

Rating descriptor	Meaning
VERY POOR	Thermal performance/ performance is extremely poor and is clearly **far below** current energy efficiency standards in the Building Code of Australia.
POOR	Thermal performance/ performance is poor and **still significantly below** current energy efficiency standards in the Building Code of Australia for new builds and renovations.
NEAR STANDARD	Thermal performance/ performance is **below** current energy efficiency standards in the Building Code of Australia for new builds and renovations.
TO STANDARD	Thermal performance/ performance **meets** current (or very recent) energy efficiency standards in the Building Code of Australia for new builds and renovations.
ABOVE STANDARD	Thermal performance/ performance **exceeds** current (or very recent) energy efficiency standards in the Building Code of Australia for new builds and renovations.

Most thermal performance of existing housing observed in the GBS project was within the VERY POOR, POOR and NEAR STANDARD categories, which is why there are three lower than standard categories. Features that are rated as TO STANDARD and ABOVE STANDARD have features which meet (or could) contribute to current 5 and /or 6 star thermal resistance standards.

Changes to home

In this section we describe two types of changes that may have occurred to the house or household in the intervening time between the before and after data collection periods. For households who received home upgrade visits cases list the specific upgrades that were undertaken. For all household cases also list other changes that are unrelated to the GBS project. Changes may have related to occupant numbers of have been physical or behavioural in nature.

Energy and comfort

In this section tables are presented that summarise the quantitative energy and comfort data collected from the households. The data used here shows peak cold weather energy use.

The table showing average daily energy use and heating efficiency during winter conditions contains parameters defined as follows:

- *T31 Heating (plug in heating)* = all plug in heater energy recorded for the given (before or after) period presented as average kWh/day consumption.
- *T41 Heating (hard wired heating)* = all hard wired heater energy recorded for the given (before or after) period presented as average kWh/day consumption.
- *Total heating* = the total heating energy recorded for the given (before or after) period presented as average kWh/day consumption.
- *Other light and power* = light and power energy use, with plug in heating energy removed, for the given (before or after) period presented as average kWh/day consumption.
- *Hot water* = Total hot water heating energy recorded for the given (before or after) period is presented as average kWh/day consumption.
- *Total household electricity* = Combines hardwired and plug-in electricity consumption for the whole house. The total energy recorded for the given (before or after) period presented as average kWh/day consumption.
- *House heating efficiency* = cumulative degree-hours above outdoor temperature based on the average of measured rooms in the house over the given (before or after) period, divided by the heater electricity consumption for the house over the (before or after) period. This is described as a ratio (degree-hours/kwh/day). Notes that where heating is provided by non-electric sources such as gas or wood fire, the

heat delivered by these sources is not picked up by electricity consumption and hence the heating efficiency ratio is not comparable.

- *Before* = the before period as defined in method description 'Identifying comparative before and after periods for quantitative analysis'.
- *After* = the after period as defined in method description 'Identifying comparative before and after periods for quantitative analysis'.
- *Change (electricity use)* = Change between before and after average use per day, expressed as an absolute amount in kWh/day and as a percentage (%). A negative % means that there was a reduction in use. A positive % means there was an increase in use.
- *Change (in heating efficiency)* = the difference between the before and after heating efficiency expressed as an absolute amount and as a percentage. A negative % means that the heating is less efficient in the *after* period, and a positive % means that the heating is more efficient in the *after* period (%). Note when comparing heating efficiencies that heating efficiency is the product of the building shell thermal resistance and electrical heating choices and technology in each individual house.

The table showing average daily temperatures and time in comfort zone during winter conditions contains parameters defined as follows:

- *Living Temp* = average temperature (°C) in the living room in the before and after periods and the difference between the two periods.
- *Bedroom Temp* = Average temperature (°C) in the bedroom in the before and after periods and the difference between the two periods.
- *Outdoor Temp* = Average temperature (°C) in measured outside at the house, in the before and after periods and the difference between the two periods.
- *Avg out/in temp diff* = the difference between outdoor temperature and the average indoor temperature in the before and after periods and change in this difference between the two periods.
- *% time in comfort zone* = percentage of time spent in comfort zone between 18°C and 24°C in the before and after periods and the difference between the two periods.

Graphs showing example before and after temperature/humidity energy

Longer length case studies also show example temperature and electricity performance graphs of typical winter weeks (see Figure 7 below for an example). These graphs show energy use compared to temperatures over a chosen example week from the before and a chosen example week from the after period. The graphical analysis allows different energy use consumption practices to be analysed along with the impact of these practices on temperatures within the house. These examples also provide a visual representation of the absolute temperatures being maintained with the house, the difference between outdoor and indoor temperatures and the times when temperatures are within the comfort zone.

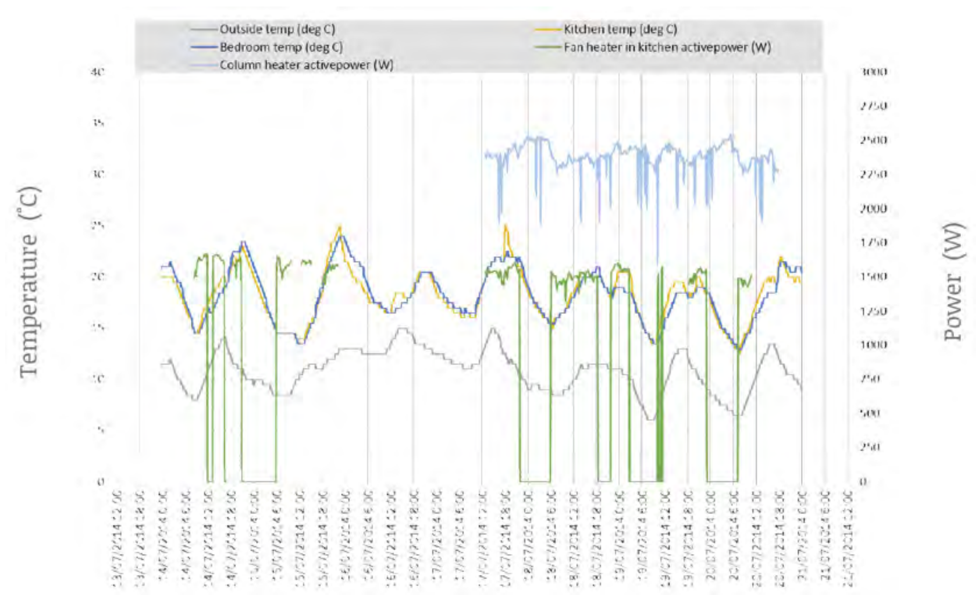


Figure 7: example of graphically presented temperature and energy data.

Left vertical axis = temperature (°C)

Right vertical axis = heating energy use in watts (W)

Horizontal axis= date and time of day

For some specific households where humidity/moisture issues have been noted, analysis of the humidity levels has been undertaken and graphical representation is provided as per the example below (Figure 8). The thermal data loggers sensed both temperature and relative humidity, allowing dew point temperature to be calculated. When the air temperature reaches the dew point temperature, condensation occurs. The graphical analysis provides a visual representation of these parameters and shows when temperature and dew point are close and at risk of causing condensation and mould in a house.

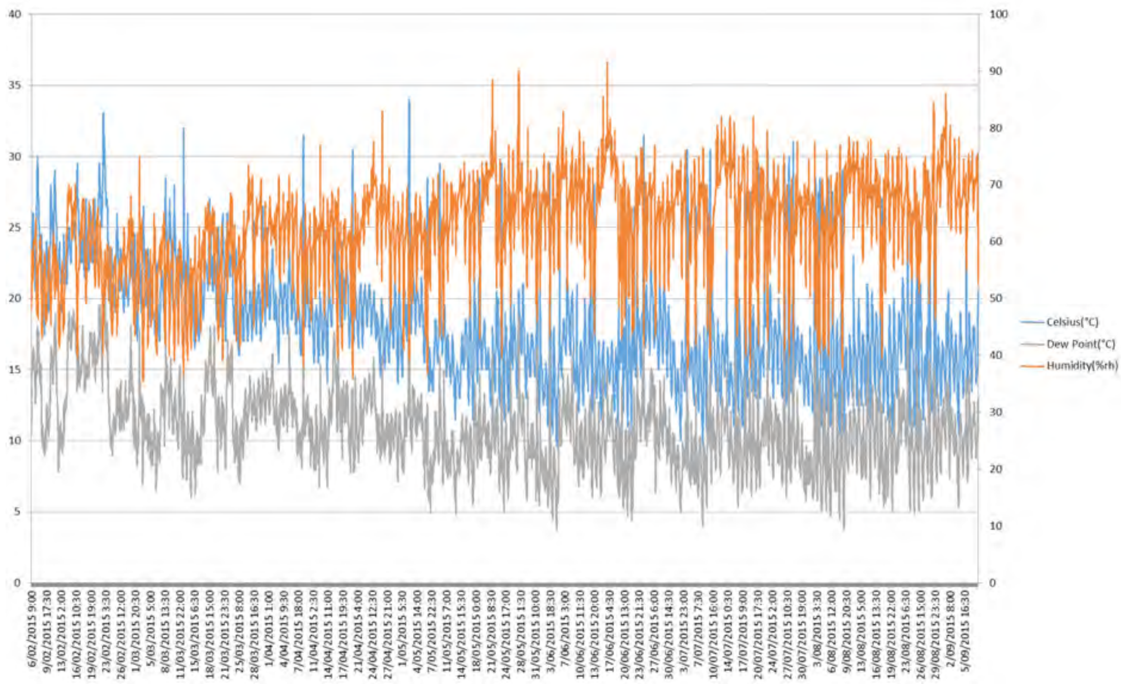


Figure 8: example of graph showing humidity and dew point.

Energy affordability

Information for this section is taken from energy billing data and energy affordability discussions in interviews. Energy bills analysis is described in the Bulk Study.

Personal and community change

This section presents a review of the information presented in the case and overlays findings from interviews in about personal backgrounds, community context and critical influences that have affected comfort and energy change outcomes. Critical findings from the case are reiterated here.

3. Case studies: house by house findings

Detailed group case studies

In this section we present the summarised findings for all households involved in the detailed study. These summaries draw on data from before and after surveys and interviews, electricity and temperature/humidity loggers, billing data from the electricity supplier, and house observations. The data collection and analysis are described fully in the methods (see 2.7.1, p24).

The detailed synthesis and discussion that follows on page 273 is based on the findings reported in these case studies.

The findings are presented in four groups:

Cases 1-11: Includes households that were provided with home energy upgrade/education visits and were exposed to community capacity building and local energy champions.

Cases 12-27: Includes households that were exposed to community capacity building and local energy champions.

Cases 28-39: Includes households that were exposed to home energy upgrade/ education visits.

Cases 40-51: Includes households that provide representative data and did not receive any support activities.

Cases are presented as a mixture of both long and short reports. The short reports provide a snapshot of the key outcomes and changes within each household and key factors relating to these changes. The longer case studies provide insight into the process of data synthesis and provide more detail and context for understanding the complexities of managing thermal comfort and energy efficiency in the home.

Please note that there are also four special comparisons within the cases. Three of the special comparisons (CASE 14, 18, 19) look at the energy efficiency and thermal comfort for families who have moved house. For each family energy use and comfort are examined in both houses. Case 26, looks at the performance of the same house with two different occupying families.

Cases 1–11

HOME ENERGY UPGRADES AND COMMUNITY CAPACITY BUILDING

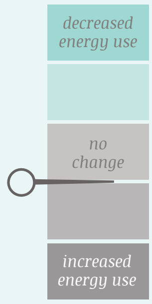
GBS support activities for these cases were:

1. Home energy upgrade/ education visits by experienced home energy helpers.
2. Exposure to community capacity building, which included local energy champions.

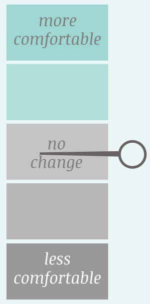
These houses were all in the suburbs of Clarendon Vale and Rokeby where community capacity building activities were also held.

CASE STUDY 1
Maureen

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	OWNER	3	FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

Well I haven't any control with visitors, but when I'm on my own, of course you do. You're conscious of the cost. You sort of begrudge paying [the electricity bill] because you don't see anything for it. It's not as though you get a chocolate or something.
(Before Interview 19/06/2014)

What was the result?

Maureen attended many of the Get Bill Smart events within the community. She reported that the events were informative and helpful but also very enjoyable socially. Very little changed in terms of her energy use but she felt more confident in seeking information on thermal comfort and energy efficiency.

✗	Energy use increased by 0.89kWh (5.5%).
✓	Energy costs reduced by ~$5 per year ($1134-$1129).
~	Time spent in the comfort zone remained constant at 34%.
✓	Heating efficiency increased from 0.40 to 0.43 (7.7%).
✓	Displayed significantly improved confidence that she could find information on comfort and remained confident that she could access information on energy efficiency if needed.
✓	Draughts reduced.

Existing physical conditions of the house

The position of the living area, single glazing and the high uninsulated suspended floor over the garage creates an uncomfortable indoor winter environment.

While the physical house is in better condition than many in the area, it still performs at a poor level.

Type	Stand alone, suburban.
Age	30-40.
Construction	Brick veneer, tile roof, suspended timber (carpeted) floor with garage under.
Insulation	Ceiling only.
Windows	Single glazed, aluminium frame.
Window coverings:	Thick and think curtains, some pelmets.
Access to sun	Most rooms some sun over the course of the day, living area on south side.
Heating	Heat pump and electric blankets.

Changes to the home

Other changes to the home:

- Maureen had family visiting from Queensland who really felt the cold so used more heating and more hot water.
- Maureen now turns her heat pump off overnight to save power after advice from a Home Energy Helper.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Door snakes
- ✔ Hot water system insulated
- ✔ Small fridge thermometer
- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklet
- ✔ Hot water valve cosy
- ✔ Lights changed
- ✔ Shower timer

Overview

Maureen is retired and lives alone. She has family nearby and sometimes looks after her grandchildren. While Maureen is conscious of the cost of energy she manages her budget carefully and remains in control. When we first met her she managed the comfort of her home by opening and closing curtains to maximise sun, heating on the rooms she was in and using a lap rug to help keep herself warm.

Over the course of the project Maureen maintained her comfort levels to a standard that she was happy with. She maintained an average temperature in the living area of 17.8°C which is slightly lower than the average but at the median for the detailed study.

The only thing that changed Maureen's energy use was an increase in hot water use (35.8%). This was despite upgrades to her hot water system (insulation, efficient showerhead). Such an increase may be because of interstate visitors, or a small shift in her own patterns of hot water use. Maureen's other energy use remained constant across the 12 months of the project.

Maureen attended many of the Get Bill Smart events within the community. She reported that the events were informative and helpful but also very enjoyable socially.

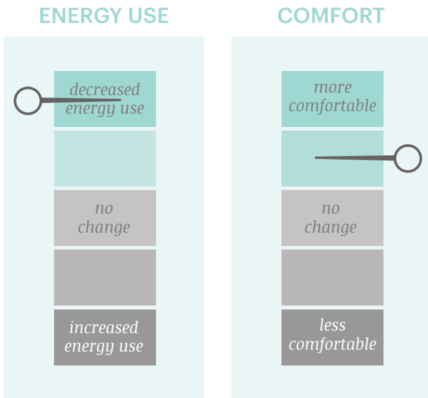
Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.04	0.00	-0.04	-93.0%
T 41 Heating (hard wired heating)	12.76	12.48	-0.29	-2.2%
Total Heating	12.80	12.48	-0.32	-2.5%
Other Light and Power (T31)	-0.04	0.00	0.04	-93.0%
Hot Water	3.27	4.45	1.17	35.8%
Total Household Electricity	16.03	16.92	0.89	5.5%
House Heating Efficiency (degree-hours/kWh/day)	0.40	0.43	0.03	7.7%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.8	12.4	10.0	5.1	34.0%
After	17.8	11.5	9.3	5.4	34.0%
Difference between before and after	0.0	-0.9	-0.7	0.3	0.0%

CASE STUDY 2
Nonie and family



OWNER WITH MORTGAGE		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC
Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

> The only biggest thing I've got is the walls still cry... and I'm losing furniture, bedding, you name it.
>
> *(After Interview 08/09/2015)*

What was the result?

Nonie and her family felt warmer in their house and had reduced their bills. They acknowledged that the house was letting them down and that if they had more money they would have insulated the walls.

Fixing the draughts was probably what contributed most to their sense of increased comfort although the insulation was certainly important.

- ✔ Energy use reduced by 10.65kWh/day (21.8%) from 48.87kWh/day to 38.22kWh/day.
- ✔ Energy costs reduced by ~$181 per year.
- ✘ Time spent in comfort zone decreased from 17.1% to 12.7%.
- ✔ Heating efficiency increased from 0.66 to 0.89 (33.5%).
- ✔ Displayed improved confidence that she could find information on energy efficiency and comfort.
- ✔ Self reported moisture levels improved (high to medium), although mould still present in the bedrooms and temperatures still met dew point in cold weather.
- ~ Reported that draughts had improved but still present.

Existing physical conditions of the house

Nonie and her children live in a stand-alone one storey dwelling in suburbia. Although the living room is on the north end of the house, the windows only allow north west sun to enter the space. Bedrooms are along the west and south side of the house. The house is weatherboard, timber framed, with a low suspended floor (with carpet and vinyl covers) and a corrugated iron roof. The age of the house is unknown but is possibly 40-50 years old.

With little insulation, single glazed windows and poor thermal resistance in the building skin, this house does not provide much winter comfort and can overheat in summer. The very poor thermal performance also parallels with high levels of moisture in the house. Nonie installed a number of heaters to alleviate discomfort. The (initially installed) heat pump in the living room is now not used because it is ineffective. Instead, 5 plug in electric fan heaters have been hung on walls (2 in the living and 3 in bedrooms) and are used to warm the house.

Insulation	None prior; Added to ceiling at upgrades.	VERY POOR	improved to	NEAR STANDARD
Windows	Single glazed, aluminium frames.			POOR
Window coverings	Vertical blinds and medium weight curtains throughout.			POOR
Under floor space	Suspended timber at 0.2-0.4m off ground, enclosed underfloor with block. No insulation.			POOR
Mould and moisture	Reported high moisture levels and mould in bedrooms. Carpet in bedroom gets moist. Temperatures meet dew point regularly May through September 2015.			VERY POOR
Other conditions of note	House is generally well maintained. Small house for number of occupants (they make it work, but overcrowded).			

Changes to the home

Other changes to the home:

- On advice from Home Energy Helpers, Nonie and her family weighted the bottoms of their curtains to help reduce heat loss.
- Nonie changed the time of day she washes clothes to take advantage of cheaper power.
- The freezer temperature was adjusted (up) to reduce power.
- Nonie had solar panels installed in approximately July 2015 (4,000 Watt).

GET BILL $MART UPGRADES

- ✔ Ceiling insulation
- ✔ Shower timer
- ✔ Draught proofing of doors
- ✔ Door snakes
- ✔ Hot water valve cosy
- ✔ Small fridge thermometer
- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklet
- ✔ Lights changed
- ✔ Water saving shower head

Energy and comfort

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (%)
T 31 Heating (plug in heating)	7.50	5.24	-30.1%
T 41 Heating (hard wired heating)	0.00	0.00	0.00
Total Heating	7.50	5.24	-30.1%
Other Light and Power (T31)	19.36	11.76	-39.3%
Hot Water	22.01	21.21	-3.6%
Total Household Electricity	48.87	38.22	-21.8%
House Heating Efficiency (degree-hours/kWh/day)	0.66	0.89	33.5%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.4	15.3	11.4	5.0	17.1%
After	16.4	14.2	10.7	4.6	12.7%
Difference between before and after	-1.0	-1.1	-0.7	-0.3	-4.4%

Referring to the tables and graphs presented, multiple changes were noted. Nonie's household saved electricity over the study period with a 21.8% reduction in electricity use. Reductions came from a 30.1% reduction in heating energy and a 3.6% reduction in hot water. Heating efficiency improved 33.5% from 0.66 to 0.89(oh/kwh/day). Despite these improvements, time spent in the comfort zone reduced from 22.1% of the time to 12.7% of the time (which is comparatively low). This means that some comfort was lost for the heating savings made (please note that before after period average temperatures were similar with only about one degree colder in the after period).

The reduction in time spent in comfort zone was not noted by Nonie, who actually reported that the family's comfort had improved. Improved comfort was likely in part due to a reduction of draughts from draught proofing and installation of ceiling insulation during GBS upgrade. Insulation effects are not always well represented in daily averages (as we are using here) but can assist at critical times of cold to hold in heat and improve comfort.

Despite better perceived comfort, Nonie reported children were still getting ill in the winter. The low internal temperatures may have affected illness rates. High occupancy levels are likely to have added to humidity levels and mould issues which would also affect illness rates.

Similar before and after average daily temperatures and continuing moisture issues indicates that the thermal performance of the building skin was so poor that it undermined possible effects of GBS upgrades. Nonie was aware of this continuing poor physical performance saying how much she would appreciate it if she could organise a payment plan for installation of sisalation in the walls.

Nonie's household saw a very slight reduction in hot water use, but was still using 21kWh per day (in the after period) to heat water. This level of water heating is the highest of any house in the detail study (and would mean the hot water was heating 10 hours a day) but is not surprising considering the number of occupants.

Other light and power use is quite high in the table summary. We cannot fully account for this and suspect there may have been other heaters that were not plugged into sensors (or there were new heaters) that we did not know about. It is likely that, due to a lack of power points, existing sensors installed on plug in heaters were intermittently removed as children plugged in/pulled out chargers and electrical appliances. Removing sensors would have meant that heating was only registered on the light and power circuit.

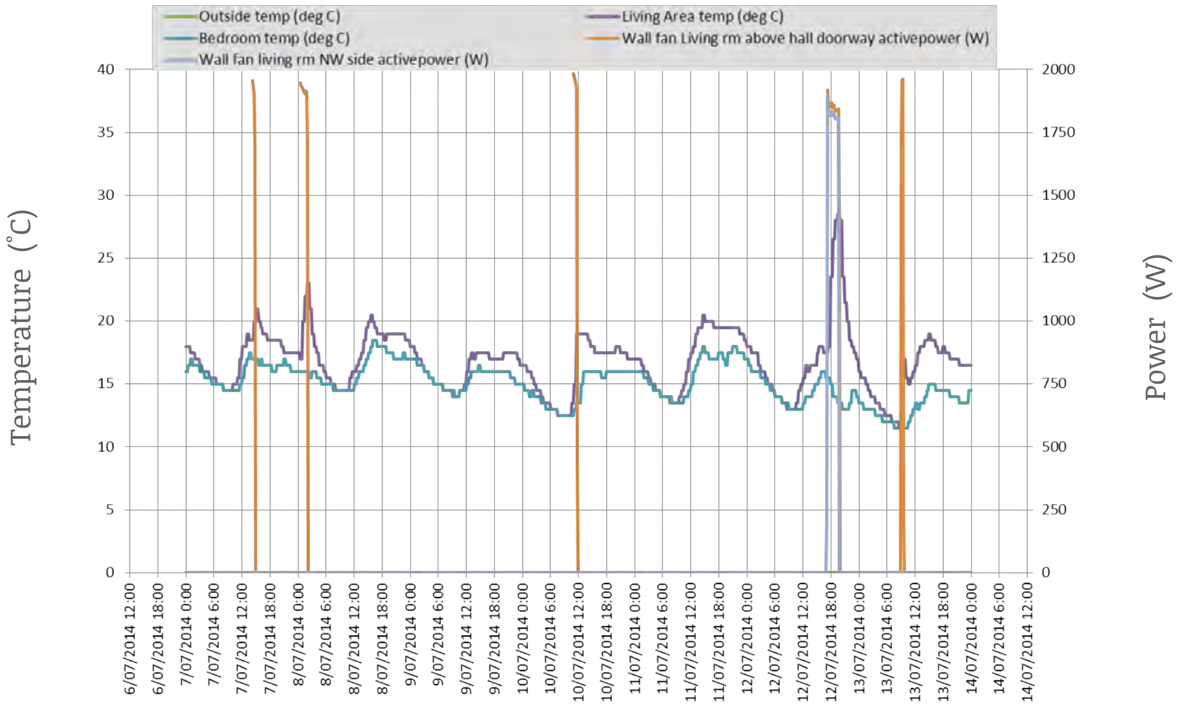
> She's had asthma most of the winter. It hasn't been as bad this year due to the--I'm positive--of the warmth. It's [the insulation in the roof] made a difference to her asthma... You don't realise what insulation can do... which sounds absolutely stupid, but you know... *(After Interview 08/09/2015)*

Nonie had solar panels installed several months before the end of the project, which likely reduced her energy bills somewhat. The effect of the on-site power generation was not measured in this detail study.

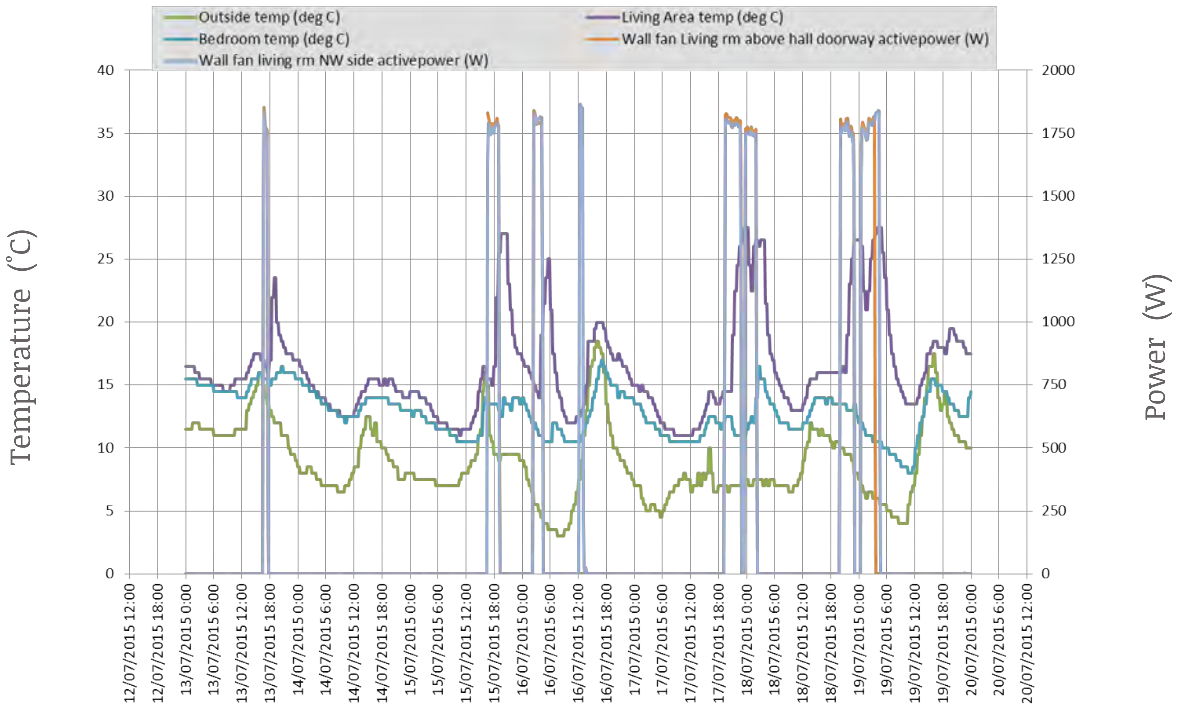
While upgrades helped with heating efficiency, temperatures were still meeting dew point regularly in the after period. The living and bedroom sensors recorded temperature meeting dew point throughout cold weather (May to September) which continued in the after period. The bedroom was the most susceptible to moisture condensing, but the living area was also vulnerable. Humidity rose a little in the after winter period – ranges before were 35% to 85% and increased to 40-90% afterwards. The extra time spent around 80 and 90% relative humidity indicates there was more opportunity for dew point to occur. Along with self-reported moisture and mould accounts, this data shows us that Nonie and her family had to deal with persistent moisture and mould issues. Moisture and mould was in part due to the number of occupants (all of whom breath and shower), but was also due to the very poor thermal performance and poor moisture extraction in the house. More draught proofing could have added to indoor moisture levels a little because it stopped some (drying) air movement. Even at times when air temperature may have improved, uninsulated walls and single glazed window surface temperatures would still be the same, so condensation would still occurred on these surfaces. Another likely cause of moisture issues in this house is the poor construction and detailing and proximity of floor to soil (with no barriers).

> It's horrible to warm up.... And the house doesn't hold heat. There's actually nowhere really in the whole house that gets warmer.
> *(Before Interview 10/6/2014)*

Before period: example week in winter showing selected energy use and temperature readings

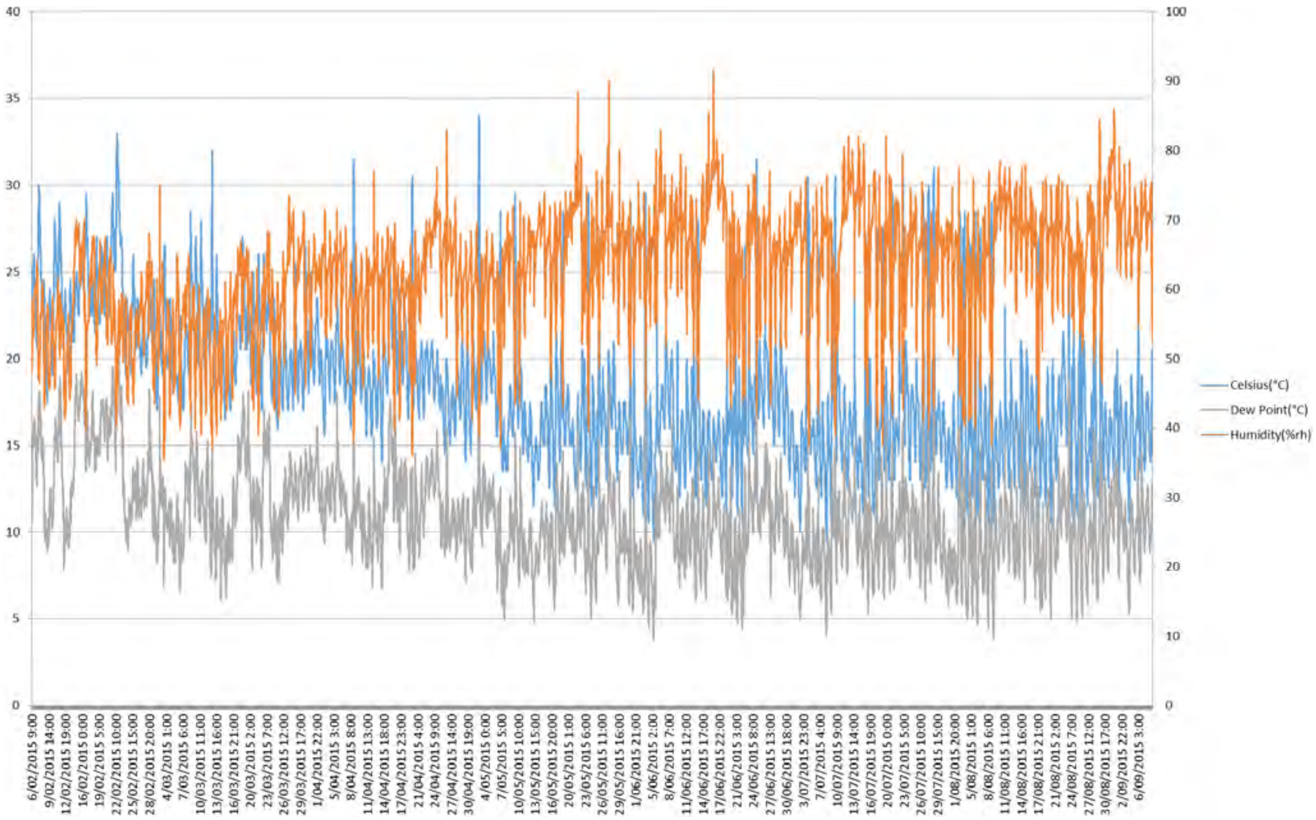


After period: example week in winter showing selected energy use and temperature readings



Energy and comfort

Temperatures, humidity and dewpoints example (living room sensor) recorded Feb 2015 to Sep 2015



Energy affordability

With ten people in the house to feed Nonie was often stressed about the price of electricity. She explained:

It concerns me on the amount of electricity we use because I know we use a lot… I'd like to do it [be more energy efficient] for affordability plus other reasons. That way I can do things with the kids because I'd have the money. *(Before Interview 10/16/2014)*

Nonie regularly had to juggle bills and admitted to cutting back on groceries in order to pay for electricity. Such restrictions made her stressed.

You do, you get stressed and you feel down because you can't provide what you've got to provide. You [I] can go without but it's horrible seeing your kids go without. *(Before Interview 10/16/2014)*

After the GBS assistance Nonie's bills decreased by ~$181 per year – a significant amount. When asked whether the changes she made to her practices (such as when she used the washing machine) had many any difference she laughed and said:

Oh yeah!

Personal and community change

Nonie and her 9 children lived in a small, cold, draughty and very damp house. Nonie and the children used to put their bedding in the living room and all sleep together to keep warm. After the upgrades Nonie said that they felt warmer. While the data above shows that the temperature of the house was no warmer on average, the reduction in draughts and the insulation seems to have made a difference to their comfort experience. Nonie said they no longer had to all snuggle together as often.

Before the upgrades moisture was a significant problem in the home, Nonie explained that:

> Every winter we've got to nearly redo the whole bedroom, furniture and that, we've got to replace it nearly every winter because the mould gets into the furniture. *(Before Interview 10/6/2014)*

After the upgrades moisture was still a problem. Walls in the house 'wept'.

Nonie and her family had noticed the effects of the GBS support. She thought it had been great and had helped. She did say that:

> The only thing I could suggest is someone out there that is willing to help with the insulation in the walls, the sisalation throughout and there's a payment plan. I think they need more of the payment plans to help keeping it warm. I'd jump at the chance.
>
> *(After Interview 08/09/2015)*

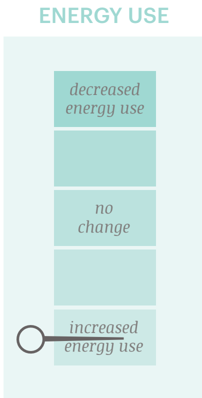
During the upgrades the Home Energy Helpers insulated the pipes on the hot water heater. Nonie had recounted (to the HEHs) how the dog had pulled insulation they had previously wrapped around the hot water heater off. The HEHs had responded by wrapping the tanks well and used a lot of extra tape. The dog chewed this off. Despite the HEHs returning and trying a different technique the dog still managed to destroy the insulation! Given the amount of hot water used, finding a solution to this problem may help Nonie and her family reduce energy use a little more.

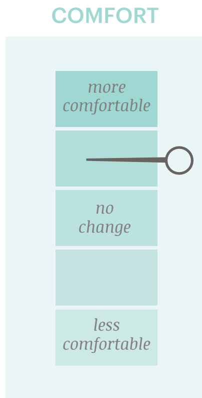
This family is in a relatively constant dynamic state. Occupancy changed with the coming and going of a boyfriend and the time people were home with illness. Nonie was heavily pregnant at the final interview and this may have changed her energy use.

Nonie showed an increased sense of community connection in the before and after surveys/ interviews and an increased awareness that there were people within her community who she could ask for advice about thermal comfort and energy efficiency.

Although minor improvements were made in terms of comfort, and these were greatly appreciated by the householders, the thermal performance of this house remained very poor.

CASE STUDY 3
Emily and family





Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HARDWIRED RESISTIVE

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

We're using heaps more power now because we had a baby and my partner has changed his work hours and goes to bed after me – I'm not awake to turn the heater off!

(After Interview 25/05/2015)

What was the result?

Emily and her family increased their power bills and improved their thermal comfort. Power bills increased due to changes in family employment and a new baby.

Improvements were primarily due to changes in heating practices and increased awareness.

Mould was a huge issue and was the catalyst for Emily and the family to move house.

- ✗ Energy use increased by 24.27kWh/day (70.7%) from 34.31kWh/day to 58.59kWh/day
- ✗ Self reported energy costs increased significantly (no billing data available for this participant)
- ✓ Time spent in comfort zone moved from 20.6% to 63.9%
- ✗ Heating efficiency decreased from 0.77 to 0.31 (60.4%)
- ✓ Displayed improved confidence that she could find information on energy efficiency and comfort
- ✗ Self-reported moisture and mould increased (medium – high)
- ✗ Draughts remained problematic but were reported to have reduced at front door which helped.

Existing physical conditions of the house

Emily and her family's house (at the time of GBS before they moved) was a standalone suburban house on a smaller-sized block. The house is timber framed with corrugated iron and fibre board cladding and has suspended timber floors with carpet. Constructed in 2012 this house was constructed under en energy efficiency code (one of only a few in the GBS study) and therefore has some insulation. The long axis of the house sits north to south, which means the house is (mainly) open to sun on the long east and west sides of the house.

The living room sat on the southwest of the house generally receiving afternoon sun only. Heating was provided by a wired in radiant heater in the living room and by a plug in radiant heater. Even with some insulation and more recent construction, the orientation, single glazing and poor construction detailing undermined indoor performance. Emily found the house difficult to heat, moist and mouldy. Emily was so uncomfortable in summer and winter that she didn't think they had any insulation at all.

Insulation	In ceiling.	NEAR STANDARD
Windows	Single glazing with aluminium frames.	NEAR STANDARD
Window coverings	Blinds (thin) throughout.	POOR
Under floor space	Suspended timber floor (carpeted), underfloor enclosed with corrugated iron.	NEAR STANDARD
Mould and moisture	Noted as high in survey. Humidity measures show dew point reached regularly in winter and intermittently over rest of year.	VERY POOR
Other conditions of note	House maintained and in working order.	
	House brought to site in two pieces which were joined poorly. Water leaked through poor detailing of this join.	

Changes to the home

Other changes to the home:

- The family stopped using plug in heater.
- Emily attempted to spend less time in the shower.
- Emily regularly used moisture absorbent beads in her son's bedroom and regularly changed pillows to limit moisture and mould growth.
- Emily had a baby (soon after the first GBS visit) bringing the total occupants to 4.
- Emily's partner changed work hours and heating use practices.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Lights changed
- ✔ Shower timer
- ✔ Door snakes
- ✔ Small fridge thermometer
- ✔ Stay Warm education booklet

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	5.55	0.00	-5.55	-100.0%
T 41 Heating (hard wired heating)	4.91	34.79	29.89	609.3%
Total Heating	10.46	34.79	24.33	232.6%
Other Light and Power (T31)	10.77	13.78	3.01	27.9%
Hot Water	13.08	10.01	-3.07	-23.4%
Total Household Electricity	34.31	58.59	24.27	70.7%
House Heating Efficiency (degree-hours/kWh/day)	0.77	0.31	-0.47	-60.4%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	15.9	15.4	7.6	8.1	20.6%
After	18.5	18.2	7.7	10.6	63.9%
Difference between before and after	2.6	2.8	0.1	2.5	43.3%

Energy and comfort

Referring to the tables and graphs presented, multiple changes were noted. Overall electricity use increased by 70.7%. Contributing most to this increase was an increase in heating. While the plug in heater use decreased to zero, hard wired heating used increased by 609.3%. As Emily explained, energy use habits of her household changed with the arrival of a new baby and her partner's change in working hours. Emily's partner felt the cold more than she did and often got home late from work, turned the heater on and then fell asleep. Emily was much more energy conscious but her partner's late arrival time meant she was often not awake to remind him to turn things off.

While energy use went up, time spent in the comfort zone also increased significantly from 20.6% to 63.9%. Almost no time was spent above the comfort zone of 24 degrees. This increase in the time spent in the comfort zone took the family into a much better temperature range for a greater length of time, which would have better supported health.

Average temperatures were similar in the living area and bedroom which seemed to be heated to similar levels. Average temperatures increased from approximately 15°C (before) to approximately 18°C (after). There was a reasonable difference between inside and outside temperatures in the before and after periods. These in/out door temperature differences were above both average and median for the detailed study cohort. This was in part because of the house being built with some insulation as part of energy efficiency standards.

Heating efficiency of the house went from 0.77 to 0.31, a 60.4% decrease. This change was largely because of the significant increase in heating being used. As is to be expected as heater use increased, house heating efficiency decreased. The before heating efficiency was over the average for the detailed housing group and so was comparably high (in this study that mainly has poorly performing stock). The after efficiency was more common of the rest of the detailed group houses.

Other light and power (with plug in heating removed) increased by 27.9% from 10.77kWh/day to 13.78kWh/day. This increase was likely from more than just an increased use of lighting and may have been from an increase use of appliances or changed habits.

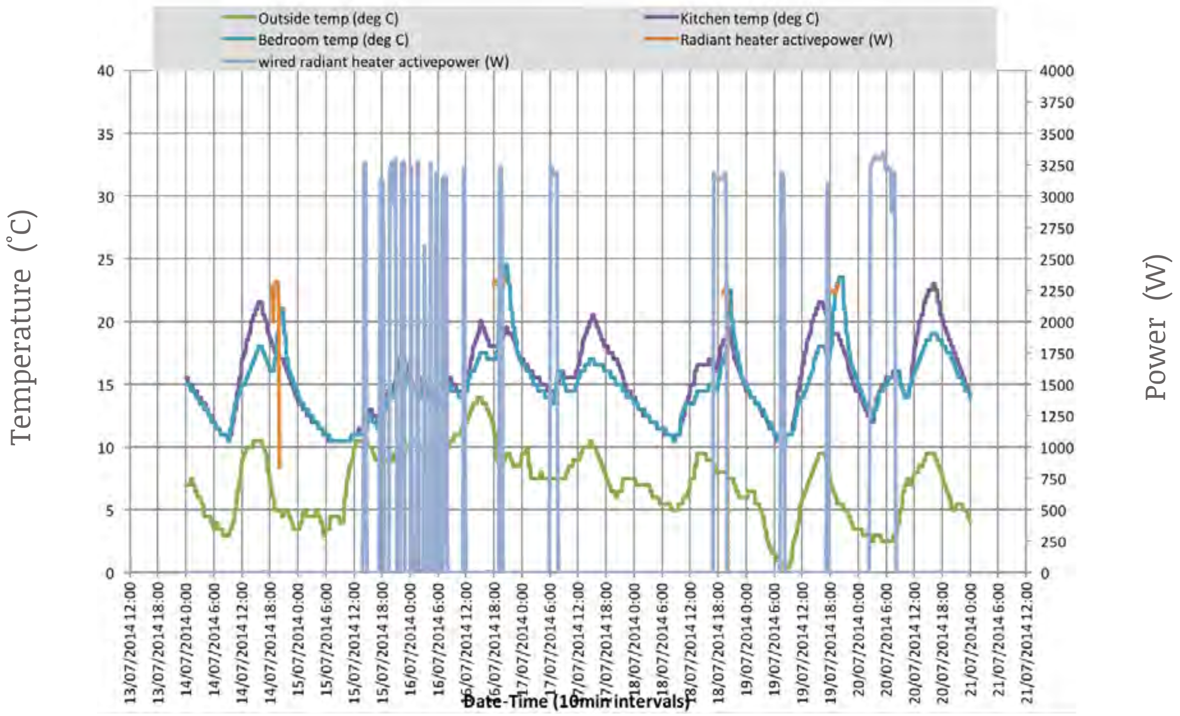
Hot water usage decreased from 13.08 kWh/day to 10.01 kWh/day (23.4%). This is likely due to Emily's increased attention to the time she (and her children) spent in the shower – something she was attempting to reduce.

Humidity was an ongoing problem for Emily and her family. Both bedroom and living area temperature/humidity loggers recorded indoor temperatures regularly reaching dewpoint throughout winter and intermittently during the rest of the year. Temperature and dew points recorded in the bedroom up to the interim visit are provided as an example. Maintaining warmer temperatures should have helped to reduce the likelihood of temperatures reaching dew point, however in this case, where the house had design and detailing issues that caused entrenched moisture and mould problems, increased heating was not much help.

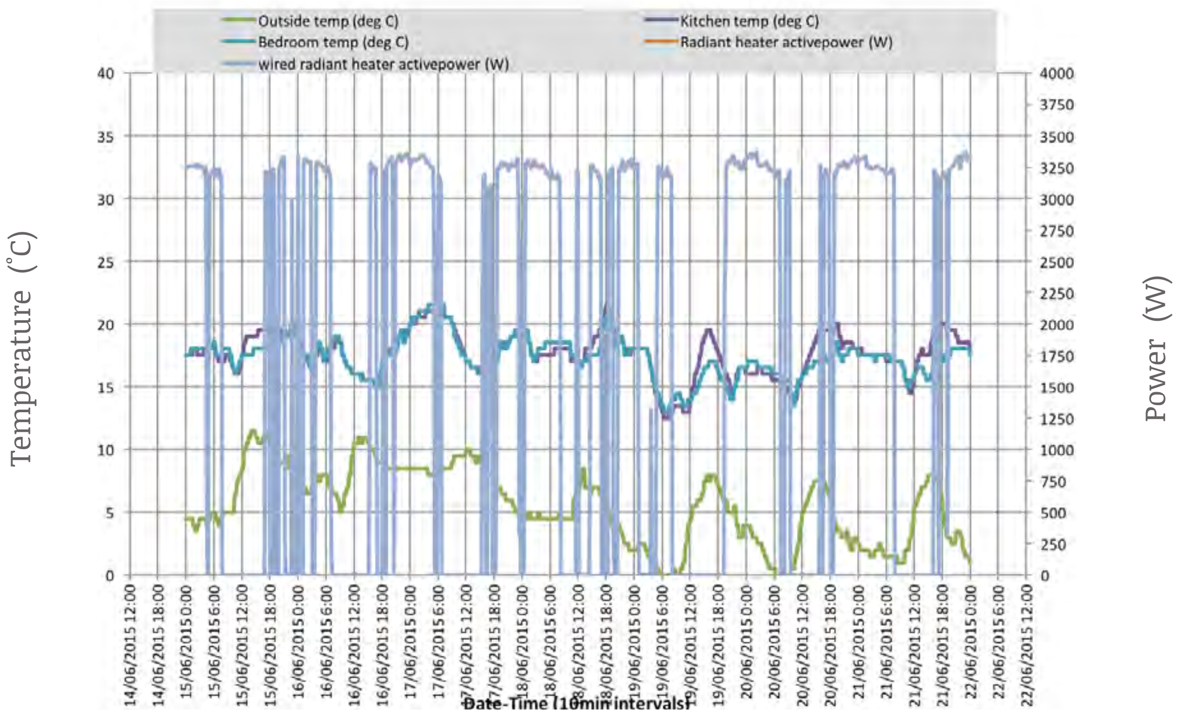
> The heater will warm the house up, but then it just doesn't stay warm, like that heater will have to keep going constantly, it doesn't click off, with the thermostat. The wind comes straight through, I sit on the couch, you can feel the draught. *(Before Interview 04/07/2014)*

> The windows still rattle, but yeah, there's no door draught now. *(After Interview 25/05/2015)*

Before period: example week in winter showing selected energy use and temperature readings

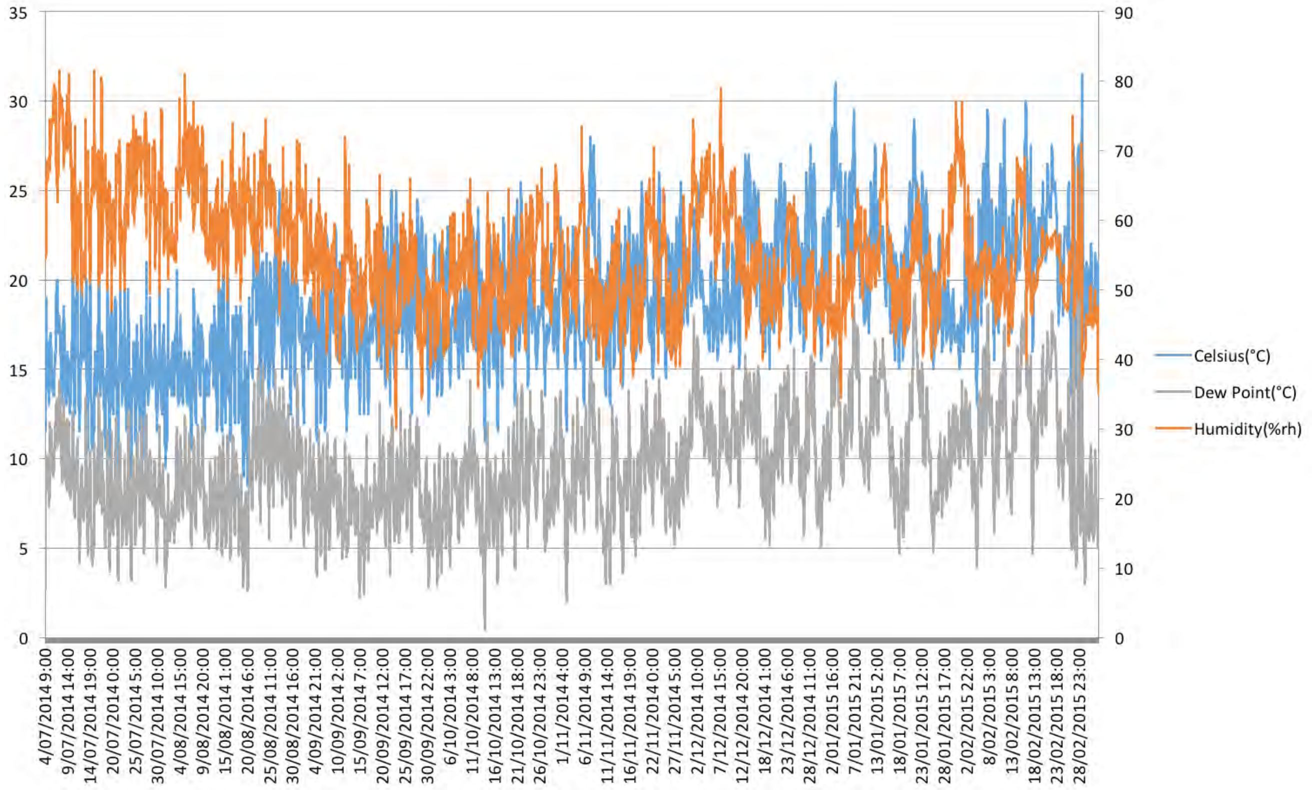


After period: example week in winter showing selected energy use and temperature readings



Energy and comfort

Temperatures, humidity and dewpoints recorded July 2014 to February 2015



Energy affordability

While we were unable to obtain billing data for Emily, she reported that her bills were substantially higher. This matches with the data above showing a dramatic increase in energy use.

Emily very carefully monitored power use and electricity costs in her home. She was very strict about this when we first met her and continued to be so throughout the project. Emily reported that she turned appliances off at the powerpoint and encouraged energy saving behaviours:

Yeah, and that's why I've got blankets on the couch because I tell my partner, put a blanket over you because I'm not putting the heater on, as it costs too much.

(Before Interview 04/07/2015)

Energy costs in her household increased significantly due to a new baby and a very different work schedule for her partner:

Yeah it was $7.33 a day. I think my bill was $600 or $700. We pay $50 a week so we still got in credit, but still $50 a week is quite a bit for power. *(After Interview 25/05/2015)*

When we met Emily she lived in her house with her partner and three year old son. At the time she was pregnant with her daughter who arrived just weeks after the first GBS visit.

Emily described the house as horribly cold in winter and horribly hot in summer. The draughts in winter contributed significantly to her discomfort. When it was too hot in summer, Emily would take her son for a drive in the air-conditioned car to get away from the heat that made them cranky. In winter, she used the living room heater (wired into the wall) and sometimes a plug in electric heater in the hallway to heat the bedrooms.

One of the biggest challenges for Emily and her family was managing the moisture in the house. Prior to the upgrades she explained that while she kept some doors of the house closed to stop heat loss, she did have to keep others open to manage the mould:

I keep the bathroom[s]… closed, and the baby's rooms closed, but I can't keep them closed all the time because that's where the mould is in too, so I need to open that up as well. *(Before Interview 04/07/2014)*

To prevent mould Emily regularly used moisture absorbent beads and wiped moisture from the windows, especially in her son's bedroom. Despite this, mould growth continued. In her son's room the moisture problem was so bad that his pillow had to be changed every few months because it would go mouldy.

After the home energy upgrades Emily reported increased moisture in the living areas. She explained that:

Last year it was on most windows, and it seems to be more in the windows this year, yeah, it's thicker. Normally I'd wipe it over with a towel and that would be enough, but now I'm going, you know, two or three towels will dry it. *(After Interview 25/05/2015)*

Extra moisture on windows may have been due to: colder outdoor temperatures, more moisture being generated indoors, or draughts being reduced somewhat by the GBS home visit.

Prior to the GBS activities Emily kept a close eye on the energy use in her home. She did this by monitoring power usage and attempting to reduce costs. She tried to keep this monitoring up after the GBS home visit as well.

I try and make my partner stop watching the TV so late at night because he falls asleep with it on, but I always go out and check my meter, with the Aurora thing and see how my bill is going and all that, too.
(after Interview 25/05/2015)

Emily displayed increased confidence that she knew where to go to get further information on thermal comfort and energy efficiency after the GBS home visit. Emily also expressed a greater sense of control over her energy use, explaining that she knew the places where she could cut down if she was desperate.

While Emily's house was relatively new, it was poorly built which undermined thermal performance and moisture management:

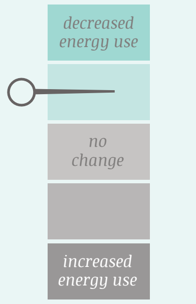
It was two houses together, it came as a kit-home or whatever like this because they didn't join it up very well and see where it's leaked, because this came on the truck and then that bit came on the truck, that's why this wall's double the width, and then they joined them together, so I don't know, because they are quite cheap, and everything is made quite cheap in them.
(Before Interview 04/07/2014)

Overall although there were minor improvements made in terms of comfort that were appreciated by the householders, they came at high financial (and energy) costs. Emily did gain from the GBS home visit, but this support was undermined by the poor thermal, moisture and energy performance of this house.

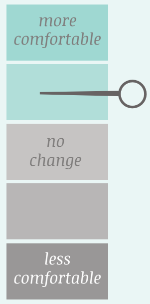
The poor performance of the house meant Emily and her family decided to move to a more functional home.

CASE STUDY 4
Ralph and Sally

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
2	OWNER WITH MORTGAGE	3	FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HARDWIRED RESISTIVE

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

> [I'd like the government to know] how high our power bills are. Reduce the cost of power. We are supposedly a hydro state, we have dams and something, you'd think power would be a little bit cheaper. *(After Interview 04/09/2015)*

What was the result?

Ralph and Sally were warmer in their house for slightly longer periods of time after the GBS upgrades visit but they also used more power. While power use overall went up, savings were made in hot water and lighting. Ralph was unwell and had been for an extended time and needed to keep warm. Upgrades and changes to energy use behaviour helped to limit energy costs associated with keeping Ralph warm.

- ✗ Energy use increased by 1.94kWh/day (5.3%) from 36.55kWh/day to 38.49kWh/day.
- ✓ Energy costs decreased by ~$50 per year.
- ✓ Time spent in the comfort zone increased from 38.0% to 41.3%.
- ✗ Heating efficiency decreased from 0.38 to 0.31.
- ✓ Displayed improved confidence that they could find information on energy efficiency.
- ✓ Self-reported moisture levels decreased (high – low) and no longer throughout the entire house. Measures show temperatures close to dew point in living and bedroom in winter before and after, but winter humidity ranges reduced in both areas in the after period.
- ✓ Draughts still present but reduced.

Existing physical conditions of the house

Ralph and Sally live in a one storey suburban standalone house on a standard sized suburban block. The house is approximately 30-39 years old and is constructed of brick with timber frame, a tile roof and suspended timber floors (with carpet and vinyl). The long axis of the house sits north east to south west. Sun comes into the kitchen in the morning and the living room during the middle of the day. For the majority of the house the sun comes in during the afternoon.

The living room is located on the north west corner of house. The living and kitchen are open plan. The main heat source is a large wired-in radiant resistance heater which is located in a disused fire place. The fire place is blocked off. There is also a radiant panel heater on the wall in the hallway.

Uninsulated walls and floor and the single glazed windows and the orientation all contribute to making the thermal performance in this house poor.

Insulation	Ceiling insulation.			POOR
Windows	Single glazed, aluminium frames, no pelmets.			POOR
Window coverings	Blinds and light weight curtains.			POOR
Under floor space	Suspended timber floor 0.2-0.8m off ground, underfloor enclosed with brick, no insulation.			POOR
Mould and moisture	Measures show temperatures close to dew point both before and after in the living and main bedroom in winter.	POOR	improved to	NEAR STANDARD
	Winter humidity ranges, however, reduced in both areas in the after period. Self-reported moisture levels decreased (from high – low) with less of the house affected than during the before period.			
Other conditions of note	House is well maintained.			
	Issues with draughts (reduced in after period).	POOR	improved to	NEAR STANDARD

Changes to the home

Other changes to the home:

On the advice of the Home Energy Helpers, Ralph and Sally have changed some of their behaviours and now:

- Unplug appliances when not in use
- Use the fan on the heater rather than just bars
- Close the door to the living room, heating only the space they are in.

Ralph has been unwell and has recently spent considerable time in hospital.

GET BILL $MART UPGRADES

- ✔ Temperature turned down on hot water system
- ✔ Water saving shower head
- ✔ Draught proofing of doors
- ✔ Shower timer
- ✔ Hot water system insulated
- ✔ Door snakes
- ✔ Hot water pipes insulated
- ✔ Small fridge thermometer
- ✔ Hot water valve cosy
- ✔ Stay Warm education booklet
- ✔ Lights changed

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	3.23	2.41	-0.82	-25.3%
T 41 Heating (hard wired heating)	17.48	24.17	6.69	38.3%
Total Heating	20.70	26.58	5.88	28.4%
Other Light and Power (T31)	8.01	6.49	-1.52	-19.0%
Hot Water	7.84	5.42	-2.42	-30.8%
Total Household Electricity	36.55	38.49	1.94	5.3%
House Heating Efficiency (degree-hours/kWh/day)	0.38	0.31	-0.07	-17.8%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.3	16.2	8.9	7.9	38.0%
After	17.5	16.7	8.8	8.3	41.3%
Difference between before and after	0.2	0.5	-0.1	0.4	3.3%

Referring to the tables and graphs presented, multiple changes were noted.

There was a slight increase (1.94 kWh/day) in Ralph and Sally's Total Household Electricity from 36.55kWh/day to 38.49 kWh/day (5.3%).

Ralph and Sally reduced their use of plug in heating by 25.3% (0.82kWh/day) and increased their hard wired heating use by 38.3% (6.69kWh/day). The hard wired heater is a large radiant heater in the living room. Overall energy use for heating increased by 5% which reduced the Household Heating Efficiency from 0.38 to 0.31 (17.8%). Ralph and Sally reported changing the way they used the wired in living area heater. They used it more often on medium and reduced their use of the low and high settings.

They also began using the fan function in the heater and not just the radiant aspect by itself.

Average indoor temperature figures were lower than the average and median figures for the detailed participants and international comfort standards, but were higher than many other detailed participants. Temperatures stayed within the comfort zone for over a 1/3 of the day with increases in the after period. In the before period, the house sat in the comfort zone 38.0% of the time. In the after period it sat in the comfort zone for 41.3% of the time. Temperatures went over the comfort zone in the living area in the before period for 1.3% and in the after period for 5.1% of the time. The average temperature in the bedroom did not ever go above

24°C (and so never went above the comfort zone). Therefore there were significant periods where Ralph and Sally lived below the comfort zone.

The increase in energy use can in part be explained by Ralph's poor health – this was a problem during the after period.

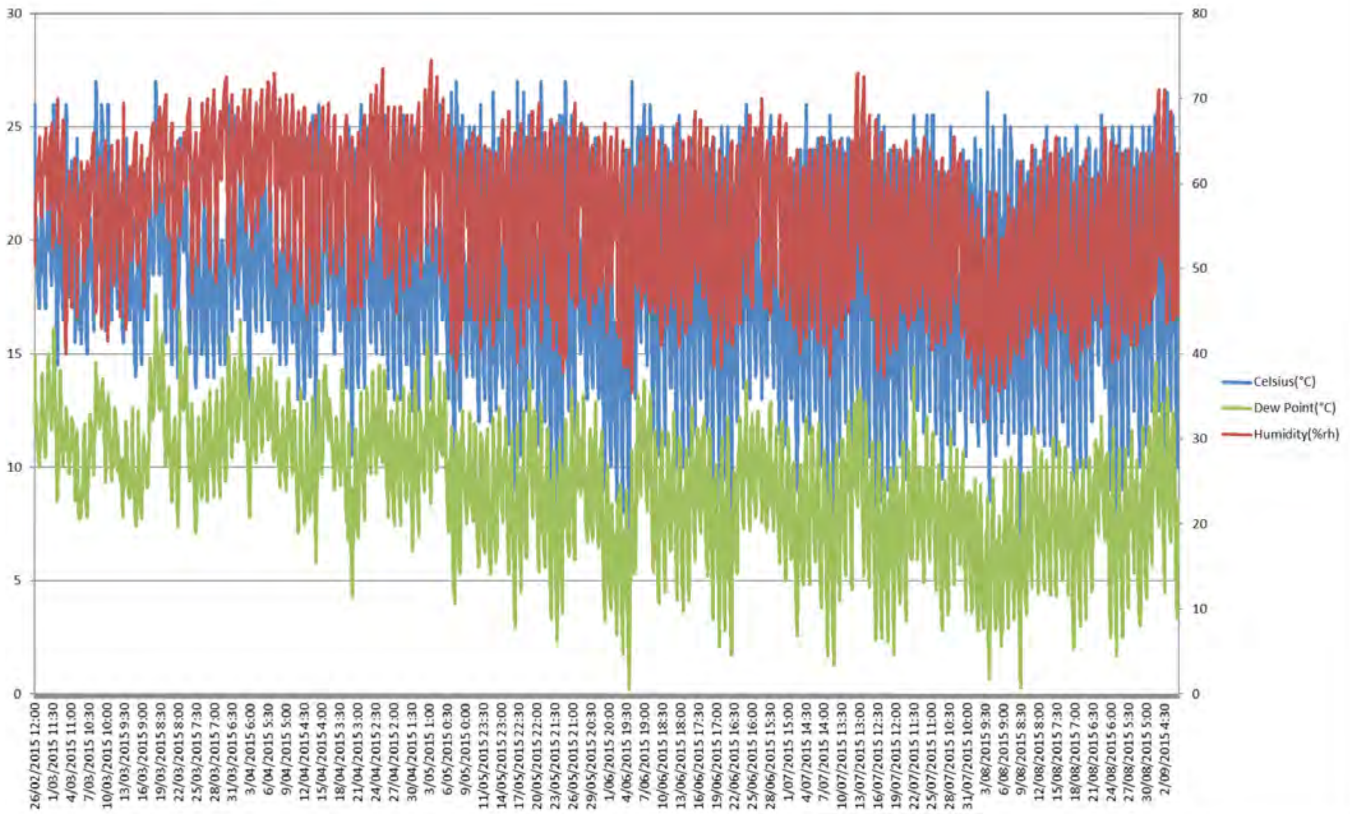
Other light and power and hot water energy use both decreased. Light and power decreased by 19%, while hot water decreased by 30.8%. Ralph and Sally received lighting and hot water upgrades during the GBS home visit, likely influencing these energy reductions.

Ralph and Sally reported moisture issues in the before survey and some improvement in the after survey. Temp/humidity measures in the living and bedroom show that temperatures tended to regularly go to a point just above dew point in both before and after periods in winter. Living room temperatures more regularly got close to dew points. Temperature close to dew point can cause condensation on some surfaces, particularly cooler external walls and windows. Humidity improved in the after period. The bedroom improved from a winter humidity range of 50-85% to 45-75% after. The living room improved from a winter humidity range of 45-80% before to 35-70% after. These humidity reductions align with Ralph and Sallys' accounts of moisture becoming more manageable.

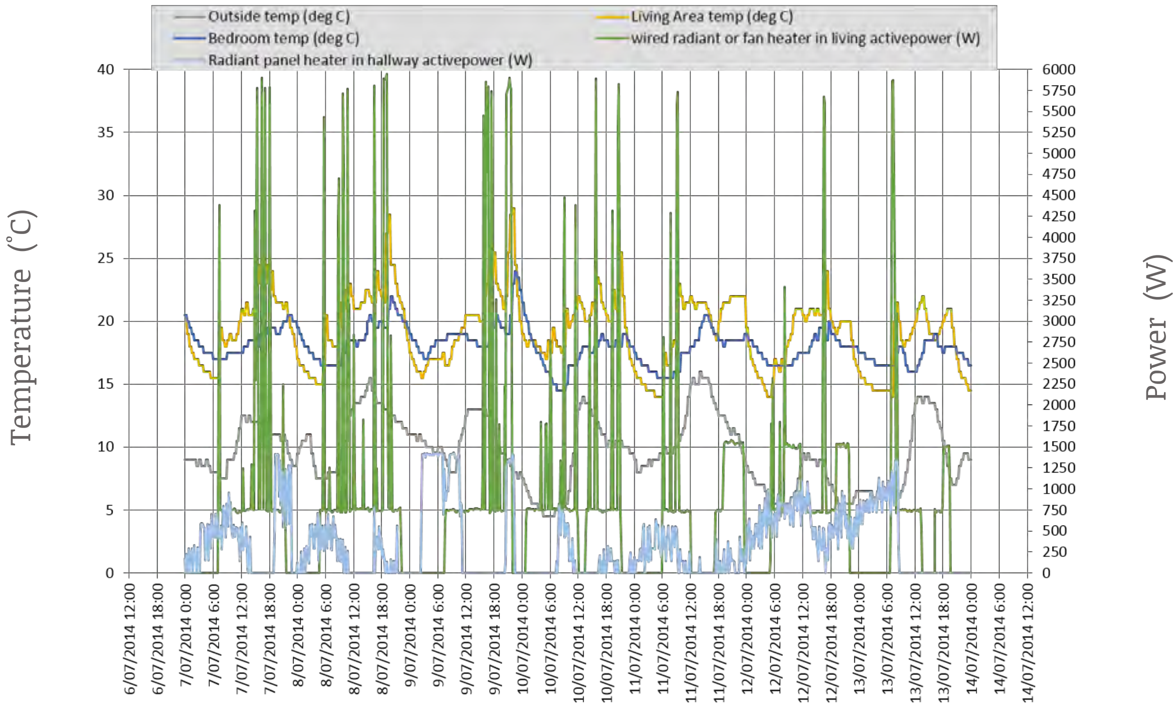
> Yeah and a terrible draft comes down the hallway. I guess with these houses you kind of expect it.
> *(Before Interview 28/05/2014)*

> Oh, we have been going to bed early too of a night. [A] nice place to be on a cold night, and we're saving on power. *(After Interview 04/09/2015)*

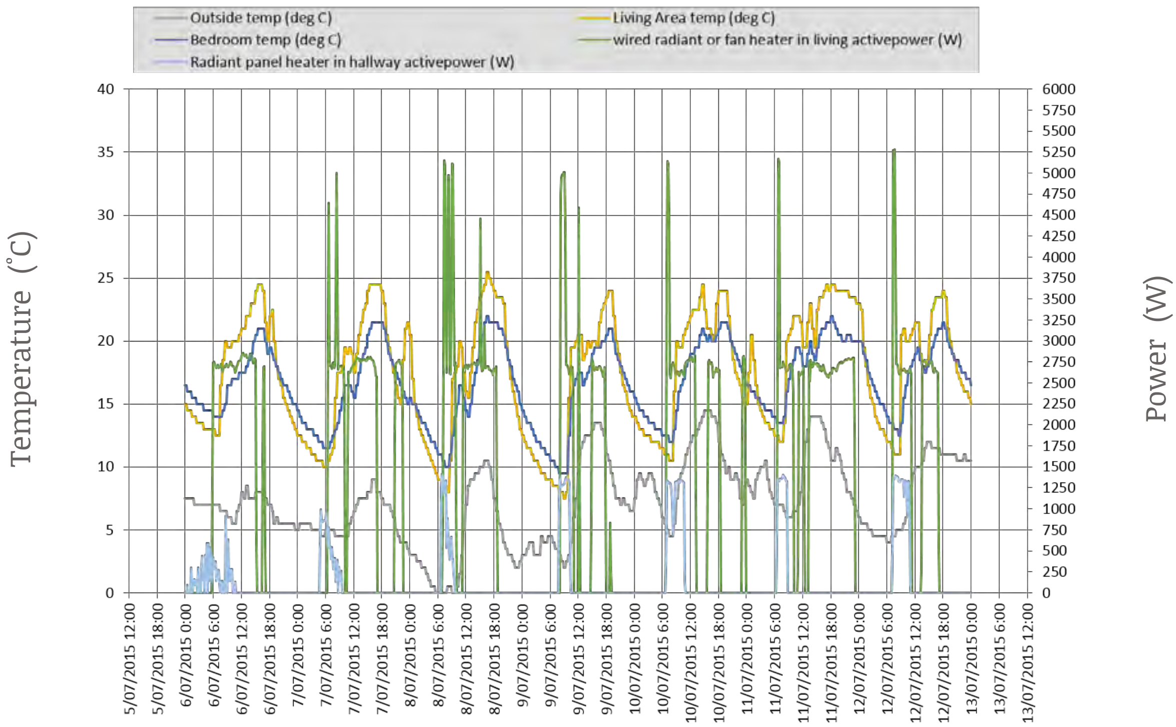
Temperatures, humidity and dewpoints example (living room sensor) recorded May 2015 to Sept 2015



Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Until he got sick, Ralph had been the main breadwinner for the family. With this history he tends to feel more stress and greater responsibility when the household bills arrive. Sally explained:

[The bill] bothers my husband more than it bothers me. Because he's been active and working, yeah, being a carpet layer, vinyl layer. Now my husband's illness you know, so I'm his carer so we kind of used all our Super, not that we had much. So now we're on the pension, so it worries him more than it worries me. I'm the one that sort of sits down, pays the bills. When he comes across a [power] bill he goes 'ah my god we can't do this...' I just say 'steady on, cool down, it'll be right, [and I] fix it'. *(Before Interview 28/06/2014)*

While Ralph and Sally's energy use increased, their bills suggests that their costs reduced by approximately $50 per year. These savings likely came from a reduction in kWh costs, the reduced light and power and hot water energy use and the changes of heating to the wired in heater, which was cheaper to use.

Sally said that she felt that she was doing everything that she could to reduce energy costs:

I mean, I only wash, I wait until the clothes basket's full before I wash. And we do turn all the power points off, and the TV off, and stuff like that. *(After Interview 04/09/2015)*

Personal and community change

Ralph and Sally are a couple in their 60s and 70s. They have lived in their house for over thirty years tending to it and keeping it kept it neat and tidy. Previously a tradesman and the type of person who 'got the job done', Ralph would attend to maintenance jobs around the home. Just as involved, Sally ensured the house ran smoothly.

As an older couple, and with Ralph's health problems, they have been heating the house. Ralph is feeling the cold. As Ralph said:

I feel the cold, I've got blood like water. *(Before Interview 28/05/2014)*

While Sally wasn't too badly affected by the cold, Ralph said that when he was cold:

You sort of don't feel like doing anything.

and that he got

...a bit dirty in the cold weather, I'm a summer person. *(Before Interview 28/05/2014)*

Sally explained that she staved off the cold by being:

Constantly on the go, I mean I'm not having a dig at my husband, well I am a couple of years younger than him. Thank god I'm in reasonably good health. *(Before Interview 28/05/2014)*

It was not only Ralph's health that affected how they heated their home. Ralph and Sally often looked after a young granddaughter with asthma. To reduce the impact of the asthma they used the hallway panel heater to keep the air warmer for her to breathe.

Personal and community change

Ralph and Sally carefully balanced comfort/health and the consequent energy use with the costs. Sally sometimes decided to choose comfort and explained that:

[When Ralph says] to me, 'turn the TV off' or 'turn the heater [off]', because sometimes I'll sneak it on two bars, and he'll be 'what are you doing that for?' I just say I want to be warm rather than having to worry about the bill. I think I'll worry about that when it comes.
(Before Interview 28/05/2014)

As they said in the second interview, this is just:

Something to try and balance.
(After Interview 04/09/2015)

The reductions in light and power and hot water energy use (after GBS upgrades) and a kWh price reduction allowed Ralph and Sally to better afford the power they needed to heat their home to a comfortable temperature while Ralph is ill.

Ralph and Sally expressed agreed strongly in the survey that there were people within their community whom they could ask for help and advice on energy efficiency and thermal comfort. This agreement remained high in the after survey. During the After Interview they also acknowledged that their children were likely to be helpful sources of information, mostly because:

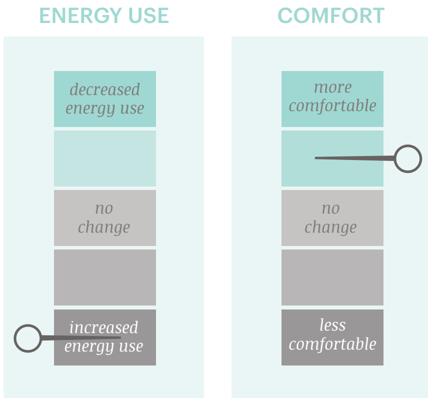
...they're greenie-type people.
(After Interview 04/09/2015)

who would be interested and willing to help. While Sally explained that she and Ralph tended to keep to themselves a bit, they also clearly knew their community and 'belonged' to the community. Having lived in their home for over thirty years they were familiar with many people in the area, including other family members. Even when 'keeping to herself', Sally was always willing to give someone a lift home from the shops and have a chat to them.

Sally was unable to attend any of the Get Bill Smart community events and activities as they either clashed with family events or she was busy looking after Ralph while he was sick.

Ralph and Sally, while they live in an under-performing house, manage their house well and make clear choices about using energy. They were receptive to the GBS home visit, are well connected and are willing to learn about things that may help them out. However, Ralph's health and a limited budget were major limits to making energy use and comfort choices. After the GBS home visit/upgrade they took action to be a little warmer in their house for a longer period of time and had to use a little more energy to do this.

CASE STUDY 5
Matthew and Narelle



Occupants	Own or rent	Bedrooms	House type	Heating
2	OWNER	3	FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HARDWIRED RESISTIVE

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

When we want to [reduce energy use], at the moment we've got no damn control over it. We try to do the right thing but nobody else does.

(After Interview 08/09/2015)

What was the result?

For Matthew and Narelle, significant changes to household occupancy (from 2 – 7) overrode any sense of control or ability to manage thermal comfort and energy efficiency.

As a result of changed occupancy levels energy use increased as did the time spent in the comfort zone. Unfortunately for a household already conscious of bills, energy bills also increased.

The Get Bill Smart upgrades did not seem to make a difference to the home given the significant change in occupancy.

- ✗ Energy use increased by 12.71kWh (36.7%) from 34.67kWh/day to 47.38kWh/day.
- ✗ Self-reported increase in energy bills (no data available from energy supplier).
- ✓ Time spent in the comfort zone increased from 37.3% to 41.8%.
- ✗ Heating efficiency decreased from 0.32 to 0.27 (13.9%).
- ✓ Displayed significantly improved confidence that they could find information on thermal comfort and energy efficiency if needed.

Existing physical conditions of the house

Despite uninsulated floors and (some) walls and the single glazing, the solar access of the living room, the inclusion of insulation during an extension ten years ago, and the addition of front and back door airlocks (during the extension) created a house that is more thermally resistive than other pre 2003 energy efficiency standards houses in the study.

Matthew and Narelle installed photovoltaic prior to Get Bill Smart visits and therefore were also able to produce power and reduce the cost of their energy bills. Overall this house performed better than many in the study and sat at an almost near standard performance.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Concrete block painted, tin roof covered with tiles, suspended timber floor (.2-2m high) (carpet, vinyl, tiles), workshop and laundry under.
Insulation	Ceiling (batts 7 yrs old and 45 yr old insulation under), in walls in extension (7 yrs old).
Windows	Single glazed, aluminium frame.
Window coverings	Vertical blinds and curtains in living and bedrooms; curtains in other beds, noted as heavy.
Access to sun	All day, northwest orientation, living room on north corner with east and west windows.
Heating	Column heater in bedroom, wired storage heater in living room, wired storage heater bedroom.

Changes to the home

Other changes to the home:

- Matthew and Narelle installed roller shutters on the outside of the windows for privacy and warmth.
- Four family members have moved back into the house (son and teenage grandchildren aged 11, 13 and 14).

GET BILL $MART UPGRADES

✔ Draught proofing of doors	✔ Door snakes
✔ Hot water pipes insulated	✔ Small fridge thermometer
✔ Hot water valve cosy	✔ Stay Warm education booklet
✔ Water saving shower head	
✔ Lights changed	
✔ Shower timer	

Overview

When we first met Matthew and Narelle they lived together in their suburban home. They had installed solar panels prior to participation in the Get Bill Smart program, showing an interest in energy use. Matthew explained that he hoped the solar panels would help to reduce bills. However, the first bill that they received after the PV installation suggests that there is a fault with the solar system.

At our After Interview Matthew and Narelle said that their son and three of his children had moved in with them. This change in household make up put a financial strain on the couple and contributed to an overall increase of energy use of 36.7% (12.71kWhrs/day). Much of this increase can be seen in hot water and heating use. Matthew and Narelle felt that they lost a lot of control of house management at this point and they appeared stressed by this change.

In the before period the couple had been using what was a fairly normal amount of energy for two people, not too high or low. Interestingly the increase in energy use was not actually that high for the addition of another five occupants.

Matthew and Narelle were quite security conscious and in between our visits had installed some security window shutters for safety and to help manage indoor temperatures. They felt that this change had helped to keep the heat in.

The couple had attended to several Get Bill Smart events in their community (likely the BBQs). They reported that not many people attended and there was no discussion of energy efficiency or thermal comfort but that they were socially enjoyable.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.73	0.00	-0.73	-100.0%
T 41 Heating (hard wired heating)	20.27	28.57	8.30	41.0%
Total Heating	21.00	28.57	7.58	36.1%
Other Light and Power (T31)	10.38	12.91	2.53	24.4%
Hot Water	3.30	5.90	2.60	78.7%
Total Household Electricity	34.67	47.38	12.71	36.7%
House Heating Efficiency (degree-hours/kWh/day)	0.32	0.27	-0.04	-13.9%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	19.0	13.6	9.6	6.7	37.3%
After	19.6	13.9	8.9	7.8	41.8%
Difference between before and after	0.6	0.3	-0.7	1.1	4.5%

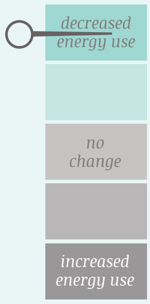
Overview

While they had a GBS home education/upgrade visit, Matthew and Narelle did not really feel that they learnt anything new. With the changes they and already made and the conversation they had with GBS researchers it was clear that they were already reasonably informed about energy efficiency. It appears though that addition of more householders strongly overrode earlier energy practices in the home.

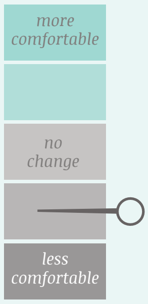
As a result of the change in household make up energy use increased as did the time spent in the comfort zone. For a household already conscious of bills, energy bills also increased. The Get Bill Smart upgrades did not seem to make a difference to the home which would in part be because of the change in occupancy and the higher level of thermal performance in this house compared to others.

CASE STUDY 6
Caitlin and family

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER WITH MORTGAGE*		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + WOOD FIRE

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

Well, I mean this has been really good and it's not all done in all high-tech fancy-pants talk, so you--and you don't feel stupid if you are asking something and I mean I think that this whole thing is, yeah, as a package, it's been brilliant, like it really has ... *(After Interview 08/09/2015)*

What was the result?

Caitlin and her family improved the average winter temperature of her home and dramatically improved home heating efficiency. They reduced their electricity bill but likely increased their wood costs.

Thanks to her friendship with an Energy Champion, Caitlin said she learnt lots of tips and tricks that made her feel confident in her ability to manage her home effectively for thermal comfort and energy efficiency.

✔	Energy use reduced by 15.26kWh/day (36.5%) from 41.82kWh/day to 26.56kWh/day.
✔	Energy costs reduced by ~$758 per year.
✘	Time spent in comfort zone moved from 63.0% to 54.7% (still reasonable and higher than most homes).
✔	Heating efficiency increased from 0.41 to 1.17 (181.2%). (wood heater affected this)
✔	Displayed improved confidence that she could find information on energy efficiency and thermal comfort.
✔	Self reported moisture levels decreased and mould was no longer evident.
✔	Benefitted from connection with local Energy Champion.

* paid off during project

Existing physical conditions of the house

Caitlin and her children live in a one storey standalone suburban house, on a standard sized suburban block. The house is approximately 40-49 yrs old. It sits on a (close to) north to south long axis. A shed sits to the north of the house which blocks some sun, but otherwise there is all day solar access to the house. The kitchen/dining receives northern and afternoon sun and the living room receives afternoon sun. The bedrooms sit to the south and the south east so receive less sun.

The house is timber framed, with concrete block veneer walls, a tile roof and a suspended timber floor (covered with carpet and vinyl). Heating is provided by a wood heater, a fan heater in kitchen and (in the before period) a column heater.

A lack of effective insulation, the age of the house, the single glazing and the western orientation of the living all undermine this house's thermal performance, which is poor.

Insulation	Old loose rock wool in ceiling only.	POOR
Windows	Single glazed, aluminium frames, no pelmets.	POOR
Window coverings	Vertical blinds and heavy weight curtains.	NEAR STANDARD
Under floor space	Suspended timber floor approx. 1.0m above ground, underfloor enclosed with block wall, no insulation.	POOR
Mould and moisture	Some mould and moisture. Mould reduced in after period. Measures show winter temp irregularly neared dew point with high humidity (reaching 80%) occasionally, which may have led to some surface condensation at times.	POOR
Other conditions of note	Uses wood heater along with a couple of other heaters. House is reasonably well maintained.	

Changes to the home

Other changes to the home:

- Caitlin no longer uses a plug in heater.
- On the advice of the Home Energy Helpers Caitlin installed bubble wrap on the front door and laundry door windows.
- Caitlin's teenage boys have learnt about power savings and now try to turning things off at the power points when not in use.
- Generally Caitlin has been more conscious of the little things she can do around the house.
- Caitlin changed the way she uses her blinds to bring heat into the house (to warm the house).

GET BILL $MART UPGRADES

✔ Draught proofing of doors	✔ Door snake
✔ Hot water system insulation	✔ Small fridge thermometer
✔ Hot water pipes insulated	✔ Ecoswitches (2)
✔ Water saving shower head	✔ Stay Warm education booklet
✔ Lights changed	
✔ Shower timer	

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	17.96	6.53	-11.43	-63.6%
T 41 Heating (hard wired heating)	0.00	0.00	0.00	0.0%
Total Heating	17.96	6.53	-11.43	-63.6%
Other Light and Power (T31)	12.17	12.12	-0.05	-0.4%
Hot Water	11.68	7.91	-3.78	-32.3%
Total Household Electricity	41.82	26.56	-15.26	-36.5%
House Heating Efficiency (degree-hours/kWh/day)	0.41	1.17	0.75	181.2%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	19.5	18.7	11.5	7.4	63.0%
After	19.1	17.6	10.5	7.6	54.7%
Difference between before and after	-0.4	-1.1	-1.0	0.2	-8.4%

Referring to the tables and graphs presented, multiple changes were noted. Overall electricity use decreased by 36.5%. Most of the decrease can be attributed to the removal of the plug in heater (a reduction of 11.43kWh/day) and decreased hot water use (a reduction of 7.91kWh/day).

The decreased use of hot water is likely due to the insulation on the hot water system and pipes and the energy saving shower head. Caitlin did note that the shower head was not as nice as the old one but that it meant her son spent less time in the shower.

Example graphs show by the temperature peaks that after Caitlin stopped using the plug in column heater (and only used the fan heater every few days) she continued using the wood fire. The Heating Efficiency of the home increased dramatically with her change in heating practices from 0.41 to 1.174 (181.2%). This increase in efficiency is in large part due to the use of the wood fire instead of the column heater (which was a less powerful heater) but would have also been affected by a reduction in draughts and efforts made to resist heat loss (like the bubble wrap put on the doors). Heating efficiency figures used only measure electrical energy, so the wood fire energy is not factored in. If it was the heating efficiency would not have increased this much.

Given that Caitlin paid off her house over the GBS study period and now owns it outright, she also has had more money in the after period to spend on wood and can heat the house more often. Related to this, the example graphs show that inside temperatures became less responsive to the outside temperatures in the after period. This change correlates with the change in heating practices, more use of the wood fire and the actions taken to stop heat loss from the house. Other Light and Power use remained fairly constant.

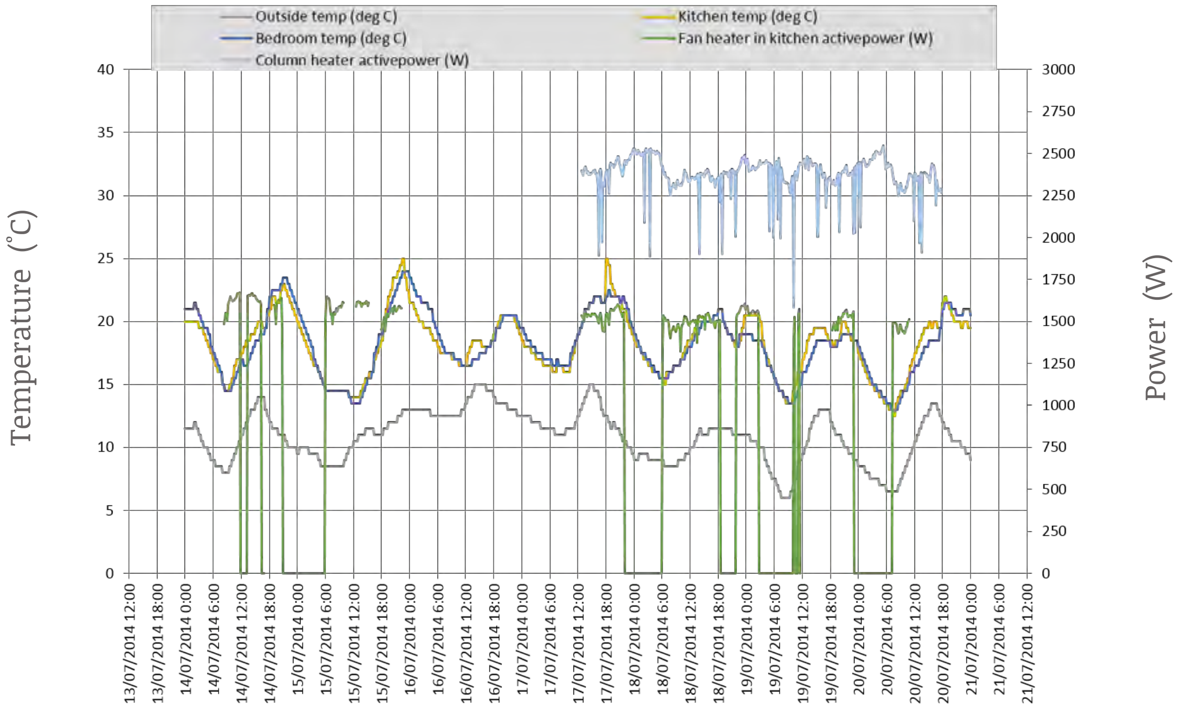
With such notable changes elsewhere, time spent in the comfort zone also changed reducing somewhat from 63.0% of the time to 54.7%. Although this change reduced time in the comfort zone, the after percentage is a high comfort zone percentage when compared to other houses in the detail group and is regarded as quite reasonable when compared with reports from other studies from Tasmania. While 5.8% of the time in the living room was spent above the comfort zone before GBS activities (and 3.0% above the comfort zone in the main bedroom), notably time above the comfort zone reduced in the living room to 2.7% and 0.1% in the bedroom in the after period. This time spent over the comfort zone likely occurred when the wood fire was used as that heat is hard to control. Despite the changes in comfort zone, average living room and bedroom temperatures only decreased a little (-0.4°C for living and -1.1°C for bedroom).

Some mould and moisture was reported (with reduced mould in the after period). Measures showed that there were occasional times when condensation could occur on surfaces (where temps almost met dew point and humidity was high enough), but there is little evidence of it being a serious issue in this house. There was a slight improvement, or a lessening of temp nearing dewpoint, in the living area in the after period. Humidity ranges did get up to 80% at times in winter, which would have contributed to surface condensation. The HEHs noted a small amount of mould in the kitchen which also had the highest humidity recorded. Caitlin reported she felt it had reduced.

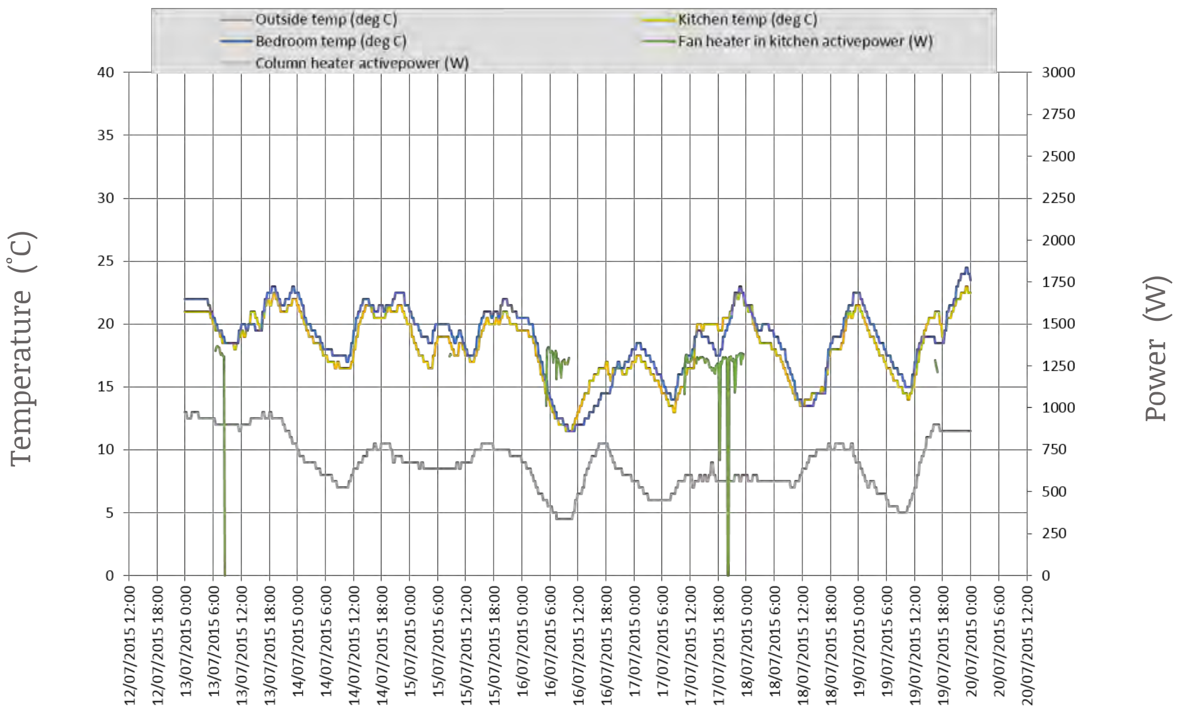
I would link his cold, yeah, his asthma flaring up to if the house happened to be particularly cold and [Reuben] and I also notice that if I couldn't keep the house fairly warm for him that, yeah, he was just forever getting ear infections... *(Before Interview 02/05/2004)*

I really think the only thing that I could do to probably make it a little bit better is maybe ... save up the money and get insulation because I've only got that poxy stuff that I think was in the house like when I originally bought it. *(After Interview 08/09/2015)*

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Caitlin used a wood heater as the primary means of heating her home. She said it cost approximately $180 for a tonne of wood. Given the price she could not often buy either the amount or the quality of wood that she wanted. Caitlin was frustrated by this saying,

> Yeah. It craps me because I can't get the house warm for the kids. *(Before Interview 02/05/2014)*

Caitlin's electricity use decreased by approximately $570 per year – primarily because she stopped using her plug in heater and had upgrades to her hot water.

When we first spoke to Caitlin she said she could not afford as much wood as she would like. When we spoke to her a second time she had paid off her mortgage and it is likely she was able to spend more on heating her home. These costs are not captured in the electricity data.

Personal and community change

Caitlin had lived in her house for over twenty years. She lived with her two teenage sons and her three year old. Caitlin had always made an effort to manage her home effectively for comfort and affordability.

> When I actually moved in [pause] there was a front you know where you walked in the front door there used to be a door there so I blocked that up because that was just ridiculous in winter time. You'd go and open the front door and all the hot air was just thrown straight out of the lounge room.
> *(Before Interview 02/05/2014)*

Caitlin was practical and careful about her energy use and explained how she would bring her youngest son into bed with her on really cold nights. She said,

> When it has been a real cold night and if I only have like the electric heater going, yeah, I've put [Ron] in bed with me and just shut his bedroom door. What's the use in heating it, you know, and it's less space that the heater has to find.
> *(Before Interview 02/05/2014)*

Personal and community change

Get Bill Smart Energy Champions and the home upgrades visit project helped her to make some significant practical changes. During the GBS home visit Home Energy Helpers suggested (as an extra thing to do) that Caitlin bubble wrap the windows on some of the doors to keep the heat in. Caitlin did this and was pleased with the result.

In the after period, Caitlin also slightly changed the way she opened her vertical blinds to enable the sun to 'beam in' for more warmth. She was pleased to have learnt this and other small tips:

> You know, I mean I've been here, what? Twenty years ... I mean the sun's out, pulling those verticals back just like, you know, just how much difference it made, like the kitchen wasn't like <shudder> at four o'clock in the afternoon. I was like, 'Gees, you know, this is all right'. <laughs>
> *(After Interview 08/09/2015)*

She reflected that the program had been good because of the "things that have just been brought to my attention that I could be doing differently, so yeah, more control" (After Interview 08/09/2015).

Caitlin was involved in the local community. She had lived in the area a long time and was socially well networked. Caitlin became involved in the Get Bill Smart project because one of the Energy Champions is a close friend and the aunt of her son.

Caitlin explained that:

> When [the Energy Champion] first mentioned about it... I said to her: 'come and tell me all about it. If it helps you out, money in your pocket. It's only going to help me out'. *(After Interview 08/09/2015)*

Caitlin did not attend any of the Get Bill Smart events within the community because they were inconveniently timed. She did explain however that she could always talk to her friend who was the Energy Champion,

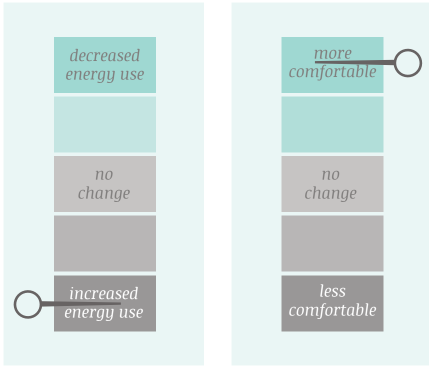
> I'll just ring her and just say--I mean and she's always, ta-ta-ta-ta-ta-ta-ta-ta-ta about it because I know her personally too.
> *(After Interview 08/09/2015)*

Compared to many people in this study Caitlin and her family were able to keep their house reasonably warm. Home Heating Efficiency (of the electrical heating) improved greatly. After GBS activities Caitlin felt more empowered when managing thermal comfort and energy efficiency in her home. She benefitted from both the home energy visit and her connection with a local Energy Champion.

CASE STUDY 7
Erica and family

ENERGY USE

COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER WITH MORTGAGE		FREESTANDING TWO STOREYS	HARDWIRED RESISTIVE + HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

I've been really monitoring the power points, turning lights off when not needed, haven't been using the heat pump running all the time because we're not here half the time. And instead of leaving heaters on just using it to warm up the room rather than leaving it on.
(After Interview 25/09/2015)

What was the result?

Erica was really pleased to be involved in the project and felt that she had learnt a lot. She changed the way she used her heat pump and paid extra attention to her energy use practices. Erica was surprised to see her power use had increased so dramatically in the after period. This may have been due to another adult living in the house and changed household practices, including changes in heater use.

- ✗ Energy use increased by 20.22kWh/day (54.1%) from 37.35kWh/day to 57.57kWh/day.
- ✗ Energy costs increased by ~$694 per year ($2,060-$2,754).
- ✓ Time spent in the comfort zone increased from 13.9% to 30.3%.
- ✗ Heating efficiency decreased from 0.26 to 0.20 (22.8%).
- ✓ Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
- ✓ Self reported moisture levels decreased (high – medium), mould levels also decreased. Measures show instances where temp may reach dew point decreases in after period, but with problematic humidity peaks of 85%.

Existing physical conditions of the house

Erica's house has little thermal resistance with single glazing, vertical blind window coverings and a poor orientation. GBS installed ceiling insulation, but the walls and floor are uninsulated. The house is open plan and also has an internal stairwell between a downstairs room and the living area. These open spaces mean it is hard to zone. Mould was noted by Erica and Home Energy Helpers in the bedrooms. Although points where temperature could reach dew point reduced in the after period, humidity still peaked at 85% in winter. Overall the house performs at a poor standard, but did improve from a very poor standard in the before period.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Upper floor (main living area) timber frame, weatherboard cladding, suspended timber floor (polished finish, tiles, carpet); lower floor (bedroom, garage) brick walled, concrete floor, open (unzoned) stairwell.
Insulation	None IMPROVED TO ceiling only.
Windows	Single glazed, aluminium frame, skylight in kitchen.
Window coverings	All vertical blinds.
Access to sun	Long axis northwest to south east, house morning and afternoon sun, living room southwest – receives some afternoon sun.
Heating	Heat pump (living), radiant fan (bedroom), radiant column (bedroom), panel heater, electric blankets (3).

Changes to the home

Other changes to the home:

- Erica's partner moved into the home at the end of summer.
- Erica has been turning power points off and has stopped using the clothes dryer.
- The heat pump is now turned off when Erica leaves the house.
- Erica has introduced a new plug in heater to her house.

GET BILL $MART UPGRADES

✔ Ceiling insulation	✔ Shower timer
✔ Hot water system insulated	✔ Door snakes
✔ Hot water pipes insulated	✔ Small fridge thermometers
✔ Hot water valve cosy	✔ Stay Warm education booklet
✔ Water saving shower head	
✔ Lights changed	

Overview

When we first met Erica she lived with her two children in a two story suburban home. Halfway through her involvement in the Get Bill Smart project her partner moved into the house, changing some of the patterns of the household.

Erica was really pleased to be involved in the project and felt that she had learnt a lot. She changed the way she used the heat pump and paid extra attention to her energy use practices. When Erica received her 2015 winter energy bill she was shocked to note that her energy use was almost double that of the previous year. Erica said that in her mind the bill should have been less.

Erica's use of her heat pump more than doubled in the after period, from 15.40kWh/day to 31.37kWh/day. At the same time, the time spent in the comfort zone also more than doubled, from 13.9% to 30.3%. Likely because of this extra heat pump use, Erica noted that the mould levels in her house had decreased. Erica also felt that the house held heat longer, which was likely due to the ceiling insulation.

Hot water heating increased 2.62kwh/day (40.2%). Erica worried the hot water system might be faulty, but this increase could conceivably come from showering and use by a new occupant.

As an employee of a local community provider, Erica was well known and well networked in the community. She used the information she gained through participation with Get Bill Smart to provide advice to others. Erica did not attend any Get Bill Smart community activities as she was too busy working, parenting and studying.

Erica felt that the thermal performance of the house had improved and it is likely that the insulation helped this. However, existing thermal performance issues and significant energy increases that came with a new occupant meant that improvements were swamped and energy use significantly increased.

Average daily energy use and heating efficiency during winter conditions

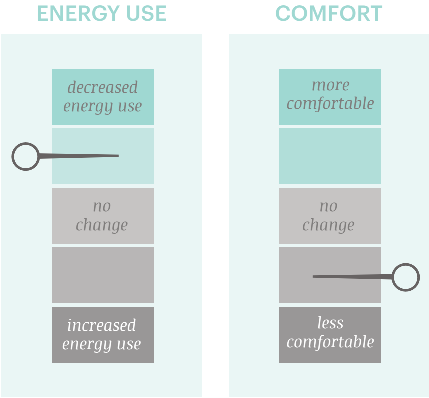
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	1.38	1.08	-0.30	-22.0%
T 41 Heating (hard wired heating)	15.40	31.37	15.97	103.7%
Total Heating	16.78	32.44	15.67	93.4%
Other Light and Power (T31)	14.07	16.00	1.94	13.8%
Hot Water	6.50	9.12	2.62	40.2%
Total Household Electricity	37.35	57.57	20.22	54.1%
House Heating Efficiency (degree-hours/kWh/day)	0.26	0.20	-0.06	-22.8%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	16.6	14.0	9.9	4.4	13.9%
After	17.8	12.7	9.1	6.5	30.3%
Difference between before and after	1.2	-1.3	-0.8	2.2	16.4%

CASE STUDY 8

Jess and her daughters



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER WITH MORTGAGE		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

What was the result?

Jess and her daughters lived in a cold house with low average temperatures and little time spent above 18°C. Minor reductions in energy use helped with bills. Jess appreciated the Get Bill Smart upgrades and was interested in attending community activities however she lacked the time and capacity to do so.

- ✔ Energy use decreased by 2.41kWh (2.4%).
- ✔ Energy costs reduced by ~$117 per year ($1,062 – $945).
- ✘ Time spent in the comfort zone decreased from 6.8% to 5%.
- ✔ Displayed significantly improved confidence that she could find information on thermal comfort if needed.
- ✘ Displayed a decrease in confidence that she could access information on thermal comfort and remained confident that she could access information on energy efficiency if needed.
- ~ Self-reported moisture remained low, some mould noted, Temperature occasionally near dew point in living. Humidity readings up to 80-85% in bed and living which can cause condensation.

> I don't know what more I could do without becoming a power Nazi. My youngest daughter has asthma and I have adult onset asthma, I'm a little bit croaky at the moment. So when that cold sets in, which is why I tend to light the fire when my youngest daughter is here she's only here half a week at a time. *(Before Interview 12/06/2014)*

Existing physical conditions of the house

Despite a wood fire and two thirds of the day with solar access, this house is uncomfortably cold. The uninsulated wall and floors, single glazing, the shading of the living area from the north east and the light window coverings lead to poor thermal performance in this house.

Type	Stand alone, suburban with open field behind.
Age	30-39 years.
Construction	Concrete brick, tile roof suspended timber floor boards (0.2-1.25m high), carpet, floorboards, tiles.
Insulation	Ceiling only (batts).
Windows	Single glazed, aluminium frame.
Window coverings	Mostly timber venetians, living also light drape, kitchen/ laundry none.
Access to sun	Mainly midday through afternoon. Living room on NE corner but large shrub and tree overshadows on NE.
Heating	Wood fire in living, plug in electric heater in bedroom, heat exchange from living room to bedroom.

Changes to the home

Other changes to the home:

- Jess and her family switched bedrooms which changed how they used and heated their house.
- Pulled up carpet in the living room.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Door snakes
- ✔ Lights changed
- ✔ Small fridge thermometer
- ✔ Hot water valve cosy
- ✔ Stay Warm education booklet
- ✔ Hot water pipes insulated
- ✔ Water saving shower head
- ✔ Shower timer

Overview

Jess and her daughters (5 to 18 years old) have lived in their home for over a decade. The two younger daughters live with Jess half-time (and half with their father). Jess has suffered with depression which impacts management at home. She has also had difficulties sorting out home content clutter after separating from her husband. Despite this she has managed (around her job) to install a warm and dry air exchange and to gradually work towards energy and comfort change.

During the before period the family heated with the wood fire and occasionally a plug in column heater (in the bedrooms). The plug in heating stopped in the after period and what heating they did continued with the wood fire. The average temperature, comparatively low, decreased in the after period to 12.2°C (living) and 12.5°C (bedroom). The average time in comfort zone (18-24°C) also reduced from 6.8% to 5%. Some time was still spent above 24°C when the wood heater was in use but this was minimal (and also indicated the wood heater was not often used). The heat transfer system assisted to keep temps a little more even between living and bedrooms.

The sense that there were people nearby who could help with thermal comfort improved over the GBS study period. Despite interest, Jess did not attend Get Bill Smart activities. Activities were often on when she was at work and text reminders were sent too late for her to plan ahead. Previously Jess had been an active community member (and had a local business) but found she didn't have the time or energy to engage anymore.

Jess valued her participation in the Get Bill Smart project and was appreciative of the upgrades. In particular she felt 'encouraged and supported' and 'not judged' in any way.

Overall the family lived in a cold house with low average temperatures and little time spent above 18°C. Minor reductions in energy use helped with bills. Jess appreciated the GBS upgrades and while interested in connecting with the community and GBS activities, found she didn't have the capacity for it.

Average daily energy use and heating efficiency during winter conditions

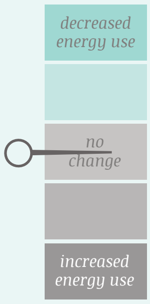
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.18	0.00	-0.18	-100.0%
T 41 Heating (hard wired heating)	0.00	0.00	0.00	0.0%
Total Heating	0.18	0.00	-0.18	-100.0%
Other Light and Power (T31)	8.21	6.93	-1.28	-15.6%
Hot Water	5.58	6.70	1.12	20.1%
Total Household Electricity	13.97	13.63	-0.34	-2.4%
House Heating Efficiency (degree-hours/kWh/day)	22.67	0.00	0.00	0.0%

Average daily temperatures and time in comfort zone during winter conditions

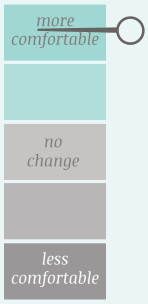
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	13.2	13.5	9.2	4.2	6.8%
After	12.2	12.5	8.0	4.4	5.0%
Difference between before and after	-1.0	-1.0	-1.2	0.2	-1.9%

CASE STUDY 9
Dale and Joanne

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	HARDWIRED RESISTIVE + HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

What was the result?

Dale and Joanne had generally improved their energy efficiency knowledge, had some more little tips and tricks and reduced moisture levels.

With an already comparatively efficient house (mostly due to a renovation 9 years ago), small adjustments to heating and practices seemed to make a big difference to time in comfort zone and heating efficiency. Overall this was an efficient house with good outcomes. They used less energy and were warmer because they used more efficient heating.

- ✔ Energy use reduced by 0.22kWh/day (1.3%) from 17.37kWh/day to 17.15kWh/day.
- ✘ Energy bills increased by ~$80 per year.
- ✔ Time spent in the comfort zone increased from 34.3% to 54.4%.
- ✔ Heating efficiency increased from 3.5 to 5.23 (49.3%).
- ✔ Displayed improved confidence that they could find information on energy efficiency and thermal comfort if needed.
- ✔ Self reported moisture reduced from low to none. No mould reported.
- ✔ Self reported reduction in draughts (from some to none).

> Yes we work on a budget each pension day we've got a set amount for groceries, a set amount for our bills and a little bit of spending money for ourselves. The bill money and the groceries come first and after that... *(After Interview 04/09/2015)*

Existing physical conditions of the house

This house whilst fairly old was renovated and extended in 2007 with insulation added at the time. The house had heat pumps for heating and a warm and dry transfer and also had enclosed zones under the house. Along with the insulation all these features assisted with thermal performance. Dale and Joanne use gas for cooking and often cooked outside on their eastern deck. Self-reported moisture reduced from low to none. No mould reported. Measures show temperature does not reach dew point in bedroom and in the living room it did only occasionally in before period (not in after). Humidity peak was 70%. The dry bedroom was likely from heat pump use and warm air transfer system.

This house is quite efficient. Despite the vertical blinds and single glazing, insulation put in during the renovation and heating being provided with heat pumps and a warm and dry transfer has helped this house performs at a near standard level, which is above the standard of most houses in the study.

Type	Stand alone, large suburban block
Age	40-49 years.
Construction	Rendered block veneer, corrugated metal roof with mill roof vents, suspended timber floor (carpet and vinyl), workshop under and enclosed with wall. Extension with new rooms 7 years ago.
Insulation	Ceiling (batts, 9 years ago), walls in living room.
Windows	Single glazed, aluminium frame, awnings.
Window coverings	Vertical blinds.
Access to sun	All day sun with square plan, living room on northern corner receiving northern sun, eastern sun blocked by deck.
Heating	3 heat pumps (living, rear living, bedroom), radiant heater (kitchen), warm and dry circuit.

Changes to the home

Other changes to the home:

- Dale felt more aware of energy efficiency and thermal comfort and made an effort to keep some doors closed.
- Dale and Joanne had blocked off some air vents in the ceiling
- Dale had experienced some illness this year and felt the cold more.
- Due to the colder winter, Dale and Joanne set their heat pump at 21 degrees rather than their usual 18.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Small fridge thermometer
- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklet
- ✔ Hot water valve cosy
- ✔ Water saving shower head
- ✔ Shower timer
- ✔ Door snakes

Overview

Dale and Joanne had lived in their house for over a decade. They had strong family connections and are the 'go to people' for their friends and family in the community.

Dale was a bit of a handy man and did things like helping his daughter to clean the filter on her heat pump.

Their renovation included insulation and new heat pumps which have assisted this house to be impressively (comparatively) efficient. The heating efficiency ratio was very good, even when they did use heating. A small reduction in heat pump use of 0.19kWh/day provided significant improvement in their heating efficiency (3.5 to 5.23). Hot water and heating reduced in the after period which might be attributable to the hot water upgrades they received. There was a slight rise in Other Light and Power. Hot water and heating energy were both low for two occupants.

Despite the reduction of heating they spent more time in the comfort zone in the after period. This suggests one of two things, either: an un-sensored heater was used; or the insulation, heat pumps and warm and dry worked quite well. The warm and dry transfer would be able to make use of solar gain throughout the house and transfer it elsewhere, which could also improve comfort zones without heating input.

These are really good results.

Average daily energy use and heating efficiency during winter conditions

	Before	After	Change	Change
	(kWh/day)	(kWh/ day)	(kWh/ day)	(%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	1.76	1.56	-0.19	-11.0%
Total Heating	1.76	1.56	-0.19	-11.0%
Other Light and Power (T31)	10.87	11.33	0.46	4.2%
Hot Water	4.75	4.26	-0.48	-10.2%
Total Household Electricity	17.37	17.15	-0.22	-1.3%
House Heating Efficiency (degree-hours/kWh/day)	3.50	5.23	1.73	49.3%

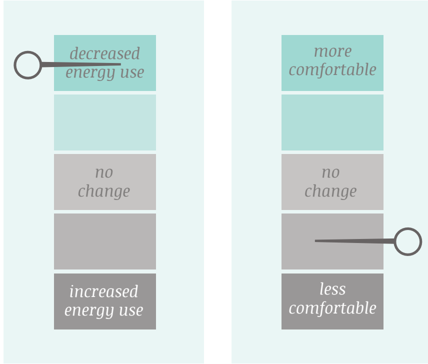
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.1	15.8	10.4	6.2	34.3%
After	20.1	16.3	9.8	8.2	54.4%
Difference between before and after	2.0	0.5	-0.6	2.0	20.1%

CASE STUDY 10
Susie and family

ENERGY USE

COMFORT



RENTER		FREESTANDING ONE STOREY	HARDWIRED RESISTIVE + HEAT PUMP
Own or rent	Bedrooms	House type	Heating

Occupants

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

Yeah it was easier, I mean down at my other house I used to go home and I used to crawl into bed because it was a cold house and watch TV where here I don't. The big difference was the first night I moved in here I had my sister down and she would normally have seven blankets on her bed down at the old house. The first night she was here she slept with one doona. *(After Interview 21/09/2015)*

What was the result?

Susie reduced her energy use and subsequently decreased the time she spent in the comfort zone, however this still remained relatively good.

Although frustrated by the draughts in the home, Susie did apply some of the lessons from the Home Energy Helpers and felt warmer as a result.

Most significantly for Susie, she had recently moved from a very poorly performing house and felt relief at the contrast.

✔	Energy use reduced by 9.88kWh/day (28.2%) from 35.03kWh/day to 25.15kWh/day.
~	No data available from electricity supplier. Likely that electricity bills decreased with reduced energy use.
✘	Time spent in comfort zone decreased from 49.3% to 32.5%.
✔	Heating efficiency increased from 0.47 to 0.66 (40.6%).
✔	Displayed improved confidence that she could find information on energy efficiency and thermal comfort.
✔	Self-reported decrease in mould.

Existing physical conditions of the house

This house has little thermal resistance in the walls but has ceiling insulation, some solar access and a heat pump that provides effective heat. This house feels much more comfortable to Susie than the one she lived in previously. Overall this house is poor to near standard.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Brick veneer, timber framed, tile roof, suspended floor enclosed with brick (carpet and tiles).
Insulation	Ceiling only.
Windows	Single glazed, aluminium frame.
Window coverings	Curtains in living and dining after home visit.
Access to sun	Long axis north east, dining with a deck to the north, living to the west with clear solar access to the north.
Heating	Heat pump (living).

Changes to the home

Other changes to the home:

- Susie started to set the heat pump at 16°C rather than a higher temperature.
- Susie hung curtains in her living area to keep the heat in.
- Prior to moving into this house, Susie had been involved in some Get Bill Smart activities (see case study #18).

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Small fridge thermometer
- ✔ Hot water system insulated
- ✔ Stay Warm education booklet
- ✔ Hot water pipes insulated
- ✔ Lights changed
- ✔ Shower timer
- ✔ Door snakes

Overview

Susie and her family moved to their house in January 2015. This move was partly in response to the poor performance of her original house (see case study #18).

When Susie first moved into this home she was frustrated that there was no door between the laundry and the rest of the house. Without a door draughts and cold air flowed through into the living space. Susie approached the landlord to get this changed but he was not interested. It was clear that Susie would have made further changes to the home if she had the money and/or owned the place herself.

The Home Energy Helpers could not fit a door but they did draught proof the external doors of the house and this did improve comfort somewhat.

Susie did reduce her energy use after the Home Energy Upgrades. Most of this reduction came from changes to how she used the heat pump – using it less and maintaining it at lower temperatures. However Susie's family spent less time in the comfort zone (from 49.3% to 32.5%). At the same time they also reduced the time they spent above the comfort zone by ~18% (time spent above 24°C).

Keeping kids warm so that they didn't get sick was a priority for Susie. It was also important for her own health,

If I'm not comfy then I'm grumpy.
I get shivery and then I throw up.
(After Interview 21/09/2015)

Susie felt more in control of her energy use thanks to a shift to the Pay As You Go system. She said that this helped her to manage her use. When use did get too high however it meant that she didn't go out and her socialising was limited.

Susie was well networked in the community with friends she could talk with about thermal comfort and energy efficiency. She had previously attended some Get Bill Smart activities (before moving into this house) and felt confident that the Energy Champions would be able to answer any questions she might have. Susie was also good friends with several other participants in the program and they were all able to share their experience.

Susie really appreciated what she was provided through the Home Energy Upgrades and valued the educative component.

Average daily energy use and heating efficiency during winter conditions

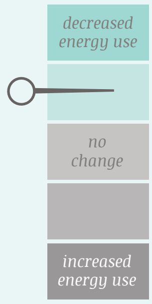
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	22.53	11.71	-10.82	-48.0%
Total Heating	22.53	11.71	-10.82	-48.0%
Other Light and Power (T31)	5.35	5.23	-0.12	-2.3%
Hot Water	7.16	8.21	1.05	14.7%
Total Household Electricity	35.03	25.15	-9.88	-28.2%
House Heating Efficiency (degree-hours/kWh/day)	0.47	0.66	0.19	40.6%

Average daily temperatures and time in comfort zone during winter conditions

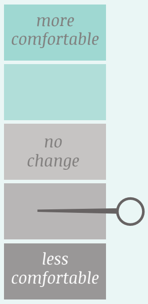
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	20.6	17.0	8.2	10.6	49.3%
After	17.4	15.1	8.5	7.8	32.5%
Difference between before and after	-3.2	-1.9	0.3	-2.9	-16.8%

CASE STUDY 11
Selena and family

ENERGY USE



COMFORT



	OWNER WITH MORTGAGE		FREESTANDING ONE STOREY	HEAT PUMP
Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

COMMUNITY CAPACITY BUILDING

+

IN HOME EDUCATION & UPGRADES

Yes we did we just sort of had it set at 22 and so I have dropped the temperature down but in saying that, somebody else in the house puts it back up again. <laughs>

(After Interview 25/09/2015)

What was the result?

Selena and her family reduced their energy use but also reduced the time they spent in the comfort zone. A reduction in draughts helped the family to feel more comfortable than they otherwise would have.

Selena found the upgrades and education helpful but struggled to find a solution to the moisture and mould problems present in the bedroom.

- ✔ Energy use reduced by 5.17kWh/day (12.4%) from 41.77kWh/day to 36.60kWh/day.
- ✘ Time spent in the comfort zone decreased from 27.2% to 18.5%.
- ✔ Heating efficiency increased from 0.79 to 1.17 (48.8%).
- ✔ Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
- ✔ Self-reported draughts reduced.
- ✘ Mould remains problematic on bedroom walls.

Existing physical conditions of the house

From the evidence from the householder and observation of the poor thermal performance of the building materials this house performs at a very poor level. The suspended timber floor is just above ground and as a result significant moisture is likely coming up from below. This moisture has led to problematic levels of mould in the bedrooms.

Type	Stand alone, suburban.
Age	30-39 years.
Construction	Weatherboard, corrugated metal roof, suspended timber floor (polished floorboards, tiles, carpet), old brick chimney, small block skirt around underfloor.
Insulation	Possible ceiling.
Windows	Single glazed, wood frame.
Window coverings	Curtains (heavy), venetians (kitchen).
Access to sun	Main living access to northern sun, all day sun, long axis is east west.
Heating	Heat pump.

Changes to the home

Other changes to the home:

- Open windows to let moisture out.
- Set the heat pump to 20°C rather than 22°C.

GET BiLL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Door snakes
- ✔ Draught proofing of windows
- ✔ Small fridge thermometers
- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklets
- ✔ Water saving shower head
- ✔ Lights changed
- ✔ Shower timer

Overview

Prior to moving into their home, Selena and her family had lived in another house in the same area. As a result they had previously been exposed to the Get Bill Smart program.

Energy use decreased by 12.4% (from 41.77kWh/day to 36.6kWh/day). This decrease is mostly seen in the reduction of heating (from 9.71kWh/day to 5.87kWh/day) and from the reduction in hot water use (17.89kWh/day to 16.85kWh/day). Selena noted that she had made an effort to reduce heat pump temperatures. Hot water use is very high in the house (well above both average and mean use for the CVR area) and reductions are possibly due to the upgrades conducted.

Heating efficiency of the home improved but this is most likely due to a reduction in heating rather than any significant improvement to the thermal efficiency of the building.

The time Selena's family spent in the comfort zone also decreased with the decrease in energy use (from 27.2% to 18.5%). In the AFTER interview Selena explained that due to lifestyle changes, they spent significantly longer out of the house than previously. Despite an active lifestyle, this is still a poor amount of time in the comfort zone.

Selena was grateful for the education and upgrade and felt that it had made a difference to her home. In particular draughts improved and she felt more empowered to actively manage moisture in her home (unfortunately with little success thus far).

Selena noted that it had taken several years for her to feel a part of the community and the community centre but now has some employment in the area and this has helped. While she didn't really know who she could ask for help, she had previously lived next door to one of the Energy Champions and when prompted agreed she could talk to her. She did not attend any community activities.

Selena was motivated to be energy efficient not only to save money but to save resources and reduce her environmental impact.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	9.71	5.87	-3.84	-39.5%
Total Heating	9.71	5.87	-3.84	-39.5%
Other Light and Power (T31)	14.16	13.88	-0.28	-2.0%
Hot Water	17.89	16.85	-1.04	-5.8%
Total Household Electricity	41.77	36.60	-5.17	-12.4%
House Heating Efficiency (degree-hours/kWh/day)	0.79	1.17	0.39	48.8%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.0	15.1	8.4	7.7	27.2%
After	15.9	14.8	8.4	6.9	18.5%
Difference between before and after	-1.1	-0.3	0.0	-0.8	-8.7%

Cases 12–27

COMMUNITY CAPACITY BUILDING

GBS support activities for these cases were:

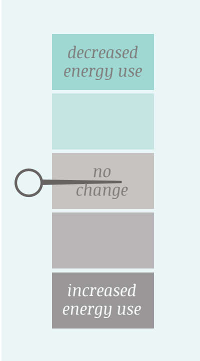
1. Exposure to community capacity building, which included local energy champions.

Houses in this case group were all in the suburbs of Clarendon Vale and Rokeby where community capacity building activities were held.

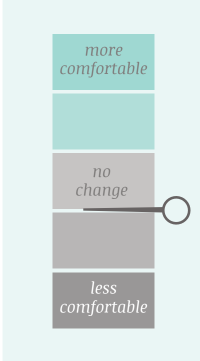
CASE STUDY 12

Troy

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HARDWIRED RESISTIVE

What did we do?

COMMUNITY CAPACITY BUILDING

It's been a colder winter and I've had the heater on more.

(After Survey 22/09/2015)

What was the result?

Troy lives in a cold house that is hard to warm. Troy was a relatively low energy user. He has not reported any attempts to improve the comfort or energy efficiency of his home and did not attend any of the community events.

- ✔ Energy use reduced by 1.74kWh/day (6%).
- ✘ Time spent in comfort zone reduced from 1.4% to 0.7% – very poor.
- ✔ Heating efficiency increased from 0.16 to 0.28 (74.5%) – efficiency is still very low.
- ✔ Displayed improved confidence that he could find information on energy efficiency and comfort.
- ✘ Self-reported moisture levels increased (none – medium). Dew point was reached May-Sept (before and after).
- ✘ Draughts remained a problem.

Existing physical conditions of the house

Troy's house is a 30-40 years old three bedroom detached house on a standard sized suburban block. The house is an L-shape with the long axis running north to south. Despite some walls facing north windows are mainly on the long east and west sides, so sun is poorly controlled. The living room sits on the southwest side of the house and has three external walls enclosing it which makes this room more thermally reactive to outside temperatures. The house is constructed with timber frames, brick veneer walls, a tile roof and suspended timber floors. The floors are covered with carpet and vinyl. Troy reported the house had some insulation, but the GBS team suspect there is little to no effective insulation in the house. For heating Troy uses an electric resistive heater wired into the wall and a plug in heater in the hallway (near the bedrooms). With the age of the house, general poor thermal resistance in construction materials, east west exposures and three external walls on the living area, this house overall has very poor thermal performance.

Overall this house performs at a poor to very poor level.

Insulation	In ceiling (self-reported).	NEAR STANDARD
Windows	Timber framed, with gaps, single glazed.	POOR
Window coverings	Aluminium blinds throughout.	VERY POOR
Under floor space	Suspended timber floor (carpet and vinyl) 0.3 -0.9m above ground, underfloor enclosed with brick walls, no insulation.	POOR
Mould and moisture	Self-reported moisture levels increased. Humidity measures show dew point reached regularly May-Sept in bedroom and Apr-Aug in living and intermittently over rest of year in both.	VERY POOR
Other conditions of note	Kitchen electrical circuitry unusable at second visit.	VERY POOR
	Infiltration through windows and doors.	POOR

Changes to the home

Other changes to the home:

- Troy used the heater more due to colder winter in 2015.
- Troy changed his working hours and began studying so changed the times he was in the house.
- Due to a change in work patterns Troy used less electronic music equipment.
- The electrical circuit in Troy's kitchen blew and this changed his appliance use.
- Troy's girlfriend started staying over some nights.

GET BILL $MART UPGRADES

Not relevant for this participant.

Referring to the tables and graphs presented, changes were observed in energy use and comfort. Overall electricity use reduced by 6%. This was due to shifts, both up and down in heaters, light and power and hot water use.

Total heating reduced by 30.2% – 12.67 kwh/day to 8.8 kw/h. This shift came from significant reduction in use of the plug in heater. There was a slight increase in Troy's use of the wired in resistive heater.

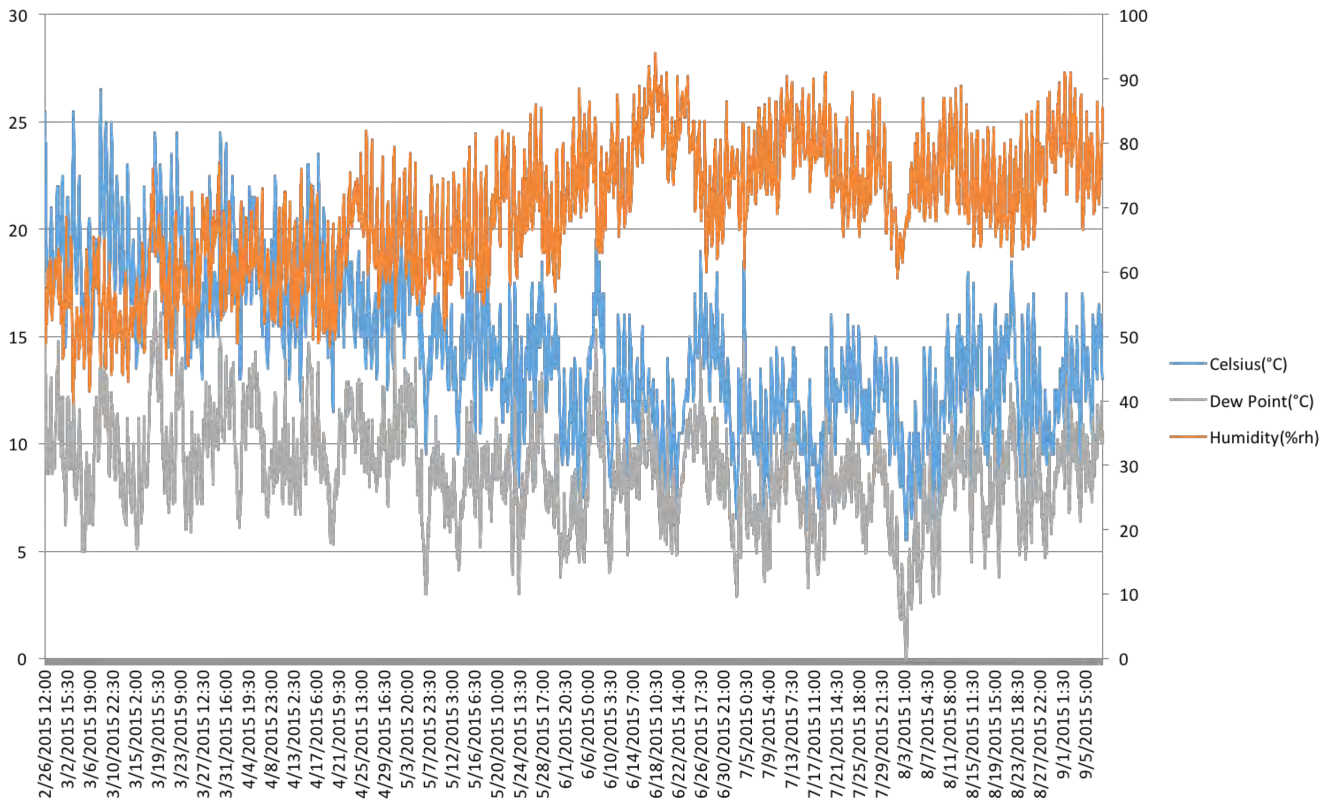
Troy's heating efficiency increased somewhat from 0.17 – 0.28 (74.5%). This increase in efficiency is likely due to the fact that Troy reduced his overall heating. The heating efficiency of Troy's house remained low, even in comparison to many other houses in this project.

Troy still spent very little time in the comfort zone: 1.4% of time before and 0.7% after. No time was spent above the comfort zone. The average living room temperature was at 12.1°C before which decreased to 11.5 degrees. The average outdoor/indoor temperature difference was 2 °C before and 2.5°C afterwards, so the house was tracking close to the outdoor temperatures on many occasions. The heating efficiency and temperatures indicate that the building skin was doing little to resist heat flow. Even when Troy heated the house he was living in a cold house. The graphs provided show more response to the cycle of the day than to the heating.

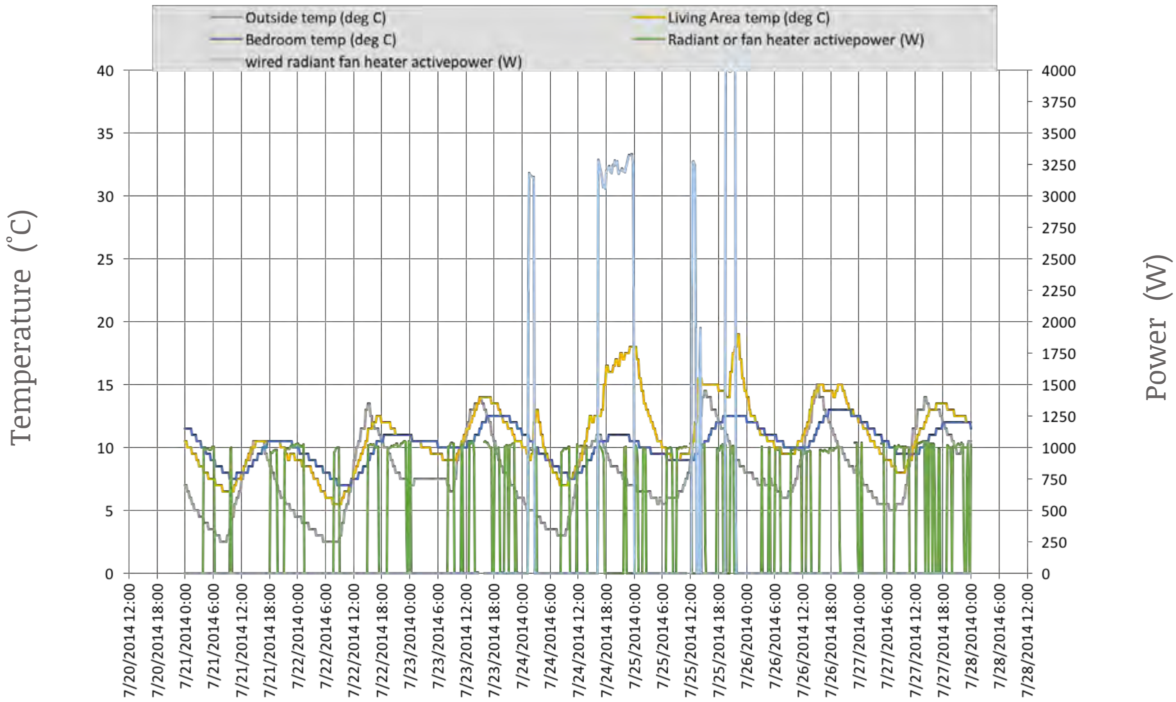
Hot water use did increase somewhat over the period of logging. This and other shifts may be due to: the presence of a girlfriend who began to stay over in the after period; Troy beginning a course which took him out of the house regularly on weekdays and changed his night time heating patterns; and, the electrical circuit in the kitchen being out of action (changing how Troy used the kitchen and prepared food).

Overall this house has a very poor thermal environment. Troy's time spent in the comfort zone was one of the lowest of all the detailed households.

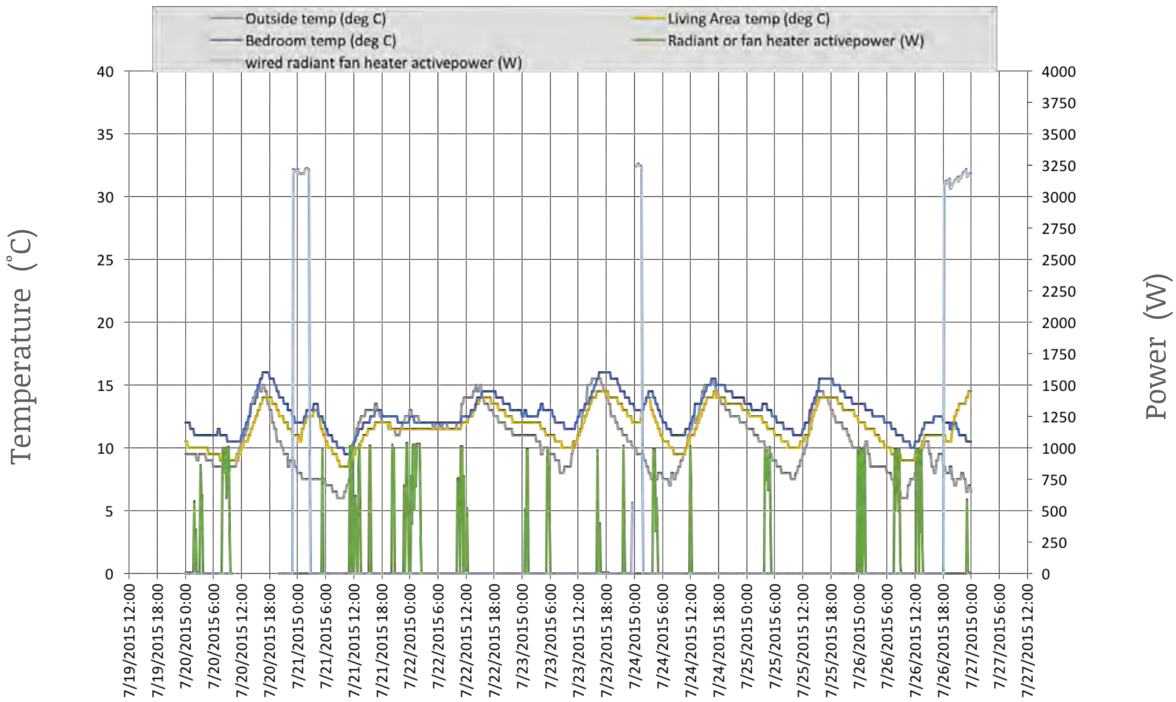
Temperatures, humidity and dewpoints example (bedroom sensor) recorded February to September 2015



Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy and comfort

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	6.97	0.76	-6.20	-89.0%
T 41 Heating (hard wired heating)	5.71	8.08	2.37	41.6%
Total Heating	12.67	8.84	-3.83	-30.2%
Other Light and Power (T31)	4.30	4.88	0.58	13.5%
Hot Water	12.26	13.77	1.51	12.3%
Total Household Electricity	29.23	27.49	-1.74	-6.0%
House Heating Efficiency (degree-hours/kWh/day)	0.16	0.28	0.12	74.5%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	12.1	11.7	9.9	2.0	1.4%
After	11.5	12.3	9.4	2.5	0.7%
Difference between before and after	-0.7	0.7	-0.4	0.4	-0.7%

Energy affordability

While we have no billing data for Troy, it is likely that his bills have reduced in line with the reduction in energy use.

Troy was a reasonably low user of energy and explained that:

It's the lack of money. I don't have many hours at work. I try to keep the power bill down. *(Before Interview 25/06/2014)*

Yeah, it makes me feel uncomfortable if I get too hot. I don't like it too hot, I prefer to be in a cool house.

(Before Interview 25/06/2014)

Personal and community change

Troy mostly lives in his house alone, occasionally has his two children for short visits and his girlfriend over to stay.

Troy described the house as very cold, saying that:

It takes a while, it takes about 30 minutes [to warm the house with the heater].
(After Interview 25/06/2015)

Even then, the temperature data suggests the house is never really warm. Troy seemed accepting of the indoor comfort challenges and tended to put on more clothing when he was cold.

In the before period Troy usually heated the bedrooms in his house with a plug in heater located in the laundry by heating the hallway. He explained that:

[the plug in heater] tends to heat up those rooms up and down the corridor, but I close the doors. Like my son's room is closed and the daughter's and the bathroom, so it just heats up that side of the house and the bedroom. *(Before Interview 25/05/2015)*

In the after period Troy changed his heating practice and began more frequently using the wired in resistive heater in the living room.

Troy had mentioned that he would have liked to make some small changes, like hanging a curtain over the open doorway to hold in heat, but then said:

It's not my house to do it.

and

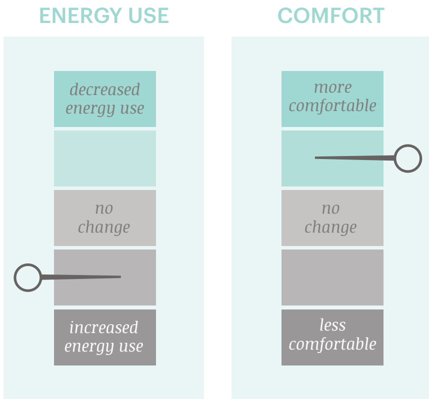
I guess I don't want to ruin their house.

(Before Interview 25/6/14)

Troy did not really engage with the community around him and made no use of the Get Bill Smart activities. He mentioned that he had not talked to anyone in the community for 4 years. He was not deliberately isolated from the community, rather his activities took him elsewhere and he was limited in his capacity and motivation to seek community assistance.

Overall Troy's house was cold and hard to heat up. As a lower energy user there was not a lot he could do to reduce his energy use and he felt he shouldn't make changes in the house because the landlords would not like it.

CASE STUDY 13
Deirdre and child



RENTER

FREESTANDING ONE STOREY

HEAT PUMP

Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

COMMUNITY CAPACITY BUILDING

> Oh, you can pretty much just go and talk to pretty much all of [the Energy Champions]. Like [my friend], I can duck up to her place and, you know, ask her things or she'll come down … Oh she's brilliant… She'll just go and yack, yack, yack, yack, and yeah she's good.
>
> *(After Interview, 9 Sep 2015)*

What was the result?

Thanks to helpful advice from both her landlord and an Energy Champion, Deirdre felt more in control of how she managed her home for thermal comfort and energy efficiency.

Her house sat more consistently in the comfort zone rather than swinging between temperatures. Deirdre was keen to continue to improve the comfort of her home and intended to draw on skills in the community to help make better curtains.

✗	Energy use increased by 5.07kWh (6.5%), from 78.45kWh/day to 83.51kWh/day.
✗	Energy costs increased by ~$537 (18%) (self-reported decrease in winter bills).
✓	Time spent in the comfort zone increased from 74.4% to 83.5%.
~	Heating efficiency remained consistent changing from 0.19 to 0.20 (0.7%).
✗	Displayed decreased confidence that she could find information on thermal comfort if needed.
✓	Displayed increased confidence that she could find information on energy efficiency if needed.
✓	Self-reported moisture decreased (from medium to none) and mould was no longer a problem.

Existing physical conditions of the house

Deirdre reported mould on her window frames, likely due to some surface condensation because of the single glazing and poor thermal resistance. Humidity in the before period peaked at 75% and at 55% in the after period, so the heat pump was keeping things dry. Inside temperatures did not reach dew point. There were noticeable draughts. The internal brick walls contributed to the thermal mass of the building, but overall, despite having some thermal mass holding heat inside, the thermal resistance of the windows and the walls was poor, leading to an overall poor performance rating.

Type	Stand alone, suburban with rural neighbour.
Age	20-29 years.
Construction	Brick veneer, tile roof, suspended timber floor (0.3 – 1.0m off ground) (vinyl, tiles, carpet).
Insulation	Ceiling only (batts – five years old).
Windows	Single glazed, aluminium frame.
Window coverings	Vertical blinds (living and bedrooms) and medium curtains (dining).
Access to sun	Large gumtree to northeast of house, living room sits on the north corner of the house and gets midday to afternoon sun.
Heating	Heat pump, electric radiant panel heater, plug-in radiant bar heater (bathroom).

Changes to the home

Other changes to the home:

- Changed heating practices (from spiking to more consistent heating) on advice from landlord and GBS team.
- Closed doors and use of curtains and door snakes to retain heat.
- Some broken venetian blinds replaced with vertical blinds.
- Reduced tea/coffee intake (kettle boiled less often).

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

It was very important to Deirdre to keep her house warm because her daughter had health problems — she suffered from recurring runny noses and chest infections and was constantly using an asthma pump. Before the GBS project, Deirdre had heated her home with a 'spiking' pattern, turning the heat pump up to 30 and then turning it off again. Following advice from her landlord, who is an electrician, she started setting it on 18° and leaving it on. As a result, she and her daughter spent more time in the comfort zone and less time above 24°. Deirdre thinks that this change also helped her daughter's health. The temperature in the living room and bedroom is never below 18° (comparatively making it a well heated house in this study).

Deirdre's landlord was difficult to get on to, but helpful when he was around. He has agreed to remove the carpet in the home; this will make the house feel colder but will help Deirdre's daughter's dust mite allergy. He also intends to remove the internal brick wall at the same time, however, which will probably negatively affect the thermal performance of the home, and demonstrates the importance of landlord literacy regarding thermal comfort and energy efficiency.

Deirdre reported that her electricity bills had decreased dramatically, but this was not evident in the billing data. Her perception may have been muddled by the fact that she was paying off the electricity bill of the previous tenant (combined with her own high use, this was very stressful) and because she had recently changed her payment plan arrangements.

Deirdre had good connections with her local community. She often had family and friends dropping in, which may have contributed to some of the changes in her energy use (e.g. hot water). She was also good friends with one of the Energy Champions, who came over to her house and swapped her light bulbs over (although Deirdre later changed them back). Deirdre had attended some of the GBS activities and found them useful and enjoyable. She was planning to use her community networks to get someone to help her make new curtains to replace her existing, poor quality ones.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.01	0.01	–0.01	–54.4%
T 41 Heating (hard wired heating)	53.46	54.05	0.59	1.1%
Total Heating	53.47	54.05	0.58	1.1%
Other Light and Power (T31)	14.07	16.25	2.18	15.5%
Hot Water	10.91	13.21	2.31	21.1%
Total Household Electricity	78.45	83.51	5.07	6.5%
House Heating Efficiency (degree-hours/kWh/day)	0.19	0.20	0.00	0.7%

Average daily temperatures and time in comfort zone during winter conditions

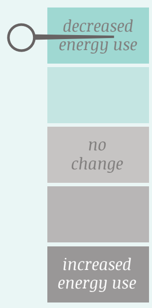
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	22.3	23.8	12.7	10.4	74.4%
After	21.9	23.3	12.0	10.5	83.5%
Difference between before and after	–0.5	–0.5	–0.7	0.2	9.2%

CASE STUDY 14

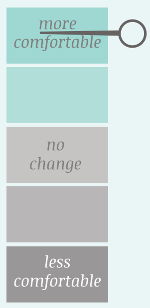
Pam and family

(a 2 house comparison before and after moved)

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating	
	RENTER		FREESTANDING ONE STOREY (both houses)	PLUG-IN ELECTRIC (044) +	HEAT PUMP (724)

What did we do?

COMMUNITY CAPACITY BUILDING

> With the heat pump we have decent heating, which we didn't have down at the old house. We had no heating.
>
> *(724 After Interview 21/09/15)*

What was the result?

Pam and her family felt much more comfortable once they had moved house (from 044 to 724). Pam chose 724 because of the heat pump and the existing curtains and capacity to zone. The second house (724) also sat in a higher and sunny spot. Pam's choice to move enabled her to reduce her energy use and dramatically improve her comfort and wellbeing.

- ✔ Energy use decreased by 18.06kWh (22.2%).
- ✔ Time spent in the comfort zone greatly increased from 22.7% of time to 80.0%.
- ✘ Displayed reduced confidence that she could find information on thermal comfort.
- ✔ House 044 was draughty while 724 reportedly had not draughts.
- ✔ Moisture and mould reduced 044 had medium moisture throughout house and mould in bath, 724 had no moisture and no mould.

Existing physical conditions of the house

House 1: 044

Internal temperatures occasionally approached dew point, especially in July 2014. There may have been problems in the bedrooms during winter with a maximum of 80% humidity.

Medium moisture levels were reported in the house and mould was reported in the bathroom.

The landlord did not maintain the house to Pam's satisfaction.

The house was brick veneer, timber framed construction with a suspended timber floor and a tile roof; the house required insulation but had little to none. Sun hit the long axis of the house. Pam found the house was always uncomfortable. With poor thermal resistance in the building skin and single glazed windows this house provided POOR opportunity for thermal comfort indoors.

Type	Stand alone, suburban.
Age	30-40 years.
Construction	Brick veneer walls, tile roof, timber suspended floor (0.3m off ground) (carpet, tiles), unused old chimney.
Insulation	Unknown, suspected none.
Windows	Single glazed, aluminium frame.
Window coverings	Curtains and blinds (some light weight, some medium weight).
Access to sun	All day sun to house, living room north east but window sheltered by roof of deck.
Heating	Heat pump, radiant fan in hall, hardwired heaters in bedrooms (not used because not needed).

House 2: 724

Moisture was not a major problem in this house. Curtains and draught proofing was already present in the house when Pam and family moved in.

Single glazing, lack of insulation and living orientation make this house perform poorly

Curtains for zoning areas off and draught proofing already in when moved in. Single glazing, lack of insulation and living orientation make this house perform poorly, however the heat pump, reasonable solar access to kitchen and curtains hung for zoning appeared to assist it to perform better than 044.

Type	Stand alone, suburban.
Age	30-40 years.
Construction	Brick veneer walls, corrugate metal roof, floor (height), unused chimney.
Insulation	Unknown, suspected none.
Windows	Single glazed, aluminium frame.
Window coverings	Vertical blinds, blinds and curtains.
Access to sun	Northwest to south east long axis, living to west with afternoon sun access, shed north west blocks a little sun (to kitchen).
Heating	Heat pump in living, radiant fan in hall, electric blankets.

Changes to the home

GET BiLL $MART UPGRADES

Not relevant for this participant.

Overview

When we first met Pam and her family Pam was pregnant with her third child who arrived only weeks later. Pam and her family were cold in the original house (044).

One of Pam's children had health problems exacerbated by the cold and in a cold house this added considerable stress to Pam's life.

The landlord of house 044 was unwilling to make necessarily maintenance changes to the home which Pam and her family found incredibly frustrating.

Seeking to improve her comfort Pam moved to house 724.

The new was substantially better and Pam declined GBS upgrades because she felt they were unnecessary. With the move to the new house, Pam's partner also moved in.

One reason that Pam chose to move to 724 was because of heat pump which would enable her to control comfort levels in both summer and winter.

When Pam made the move from 044 to 724 she was able to reduce her energy use by 22.2% (from 81.27kWh/day to 63.21kWh/day). These savings can be attributed primarily to a reduction in plug in heating (from 51.78kWh/day to 6.12kWh/day, a saving of 88.2%). Wired in heating did increase in house 724 from 0 to 22.10kWh/day, but this was much less than was used by the plug in heater in 044.

Notably time in the comfort zone was dramatically different between the two houses. In 044 Pam and her family spent 22.7% of their time in the comfort zone, while in 724 this increased dramatically to 80% of the time. As expected, House Heating Efficiency also increased significantly (by 311.2%) from 0.08 to 0.32.

Hot water also decreased in 724 despite the addition of an extra adult. It is likely that showers were used less to stay warm and/or that the hot water system was more efficient.

When Pam moved into her new house she was pleased to note that the house already had some good systems for thermal comfort such as good curtains and zoning. We also noted that Pam seemed to have used her improved understanding of energy efficiency when choosing her new home.

Pam had friends in the neighbourhood who also participated in the Get Bill Smart project and she was able to share experiences.

In house 044 Pam had been exposed to the in home education and upgrades and it is likely that she took some of this knowledge with her to 724, indeed this knowledge helped her to choose a more comfortable home.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	51.78	6.12	-45.66	-88.2%
T 41 Heating (hard wired heating)	0.00	22.10	22.10	–
Total Heating	51.78	28.22	-23.56	-45.5%
Other Light and Power (T31)	12.22	21.15	8.93	73.1%
Hot Water	17.27	13.84	-3.43	-19.8%
Total Household Electricity	81.27	63.21	-18.06	-22.2%
House Heating Efficiency (degree-hours/kWh/day)	0.08	0.32	0.24	311.3%

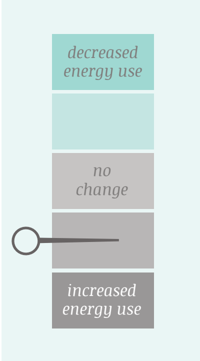
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	13.9	16.9	11.4	4.1	22.7%
After	20.4	18.4	10.3	9.1	80.0%
Difference between before and after	6.5	1.5	-1.1	5.1	57.3%

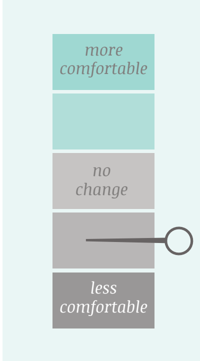
CASE STUDY 15

Gayle, Dennis and family

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

> If I had my time over again to do the house the way I wanted, I would have had double glazed windows, floor insulation and I would have insulated inside the walls.
>
> *(After Interview 08/09/2015)*

What was the result?

Gayle, Dennis and family increased their power bills and increased the temperature they heated their home to. Thermally their home performs badly but by using two heat pumps they manage to be comfortable most of the time.

While they had family access to an Energy Champion, they did not really apply any of the tips.

✗	Energy use increased by 4.21kWh/day (5.1%) from 82.31 – 86.52 kWh/per day.
✗	Energy costs increased by ~$300 per year.
✗	Time spent in the comfort zone decreased from 86.2% to 78.3% (still reasonable and higher than most homes).
✓	Heating efficiency increased from 0.20 to 0.24 (17.8%) (efficiency is still very low).
✓	Displayed improved confidence that they could find information on energy efficiency and comfort.
✗	Draughts remained a problem.

Existing physical conditions of the house

Gayle, Dennis, their daughter and their granddaughter live in a standalone suburban house that is approximately 40 years old. Their block is slightly larger than average and on a corner, allowing the house to receive all day sun. The long axis of the house sits (close to) north to south. The living room projects out on the west of the house and receives midday and afternoon sun. The kitchen/dining area receives sun in the middle of the day. Gayle and Dennis built a deck on the north east which is roofed and partly enclosed, which provides a place to dry clothes on wet days and a buffer to winds and draughts. It does however limit morning sun entering areas of the house.

The house has block veneer walls, timber frames, a tile roof, and suspended timber floors (covered in carpet, vinyl, masonite and polished timber). The house uses a gas cooktop but uses electricity to heat. Gayle and Dennis have installed 2 heat pumps, use a fan heater in the southern bedroom and a radiant bar heater in the south eastern bedroom. They also have a heater in their waterbed.

With no insulation in the walls and floors and single glazing this house's thermal performance is poor.

Insulation	Batts in ceiling (installed 2009), insulation on hot water piping (prior to GBS).	POOR
Windows	Single glazed, aluminium frames, no pelmets.	POOR
Window coverings	Curtains (heavy weight and/or lace), one venetian.	POOR
Under floor space	Suspended timber floor 0.5-1.2m off ground, underfloor enclosed with block wall, no insulation.	POOR
Mould and moisture	Low levels of self-reported moisture in living and bedroom, but no mould. Measurements show that temperature only very occasionally went near dew point in winter which would mean some surface condensation but not much more.	POOR
Other conditions of note	Well maintained house but draughty. The household is on a guaranteed continuous supply of power because of Gayle's health issues.	

Changes to the home

Other changes to the home:

- Carpet removed from living room (Gayle disliked it).
- Eco-switches placed in granddaughters' bedroom and the main living area.
- Gayle and Dennis looked after their new-born grandchild for a significant amount of time in 2015.

GET BILL $MART UPGRADES

Not relevant to this participant.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	23.41	16.39	-7.03	-30.0%
T 41 Heating (hard wired heating)	18.85	24.06	5.22	27.7%
Total Heating	42.26	40.45	-1.81	-4.3%
Other Light and Power (T31)	17.22	25.55	8.33	48.4%
Hot Water	22.83	20.52	-2.31	-10.1%
Total Household Electricity	82.31	86.52	4.21	5.1%
House Heating Efficiency (degree-hours/kWh/day)	0.20	0.24	0.04	17.8%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	21.3	18.2	11.2	8.6	82.6%
After	22.2	18.5	10.6	9.7	78.3%
Difference between before and after	0.8	0.2	-0.6	1.1	-4.3%

Referring to the tables and graphs presented, multiple changes were noted. Overall electricity use decreased by 5.1%. Heating efficiency increased by 17.8%, going from 0.20 to 0.24 through a reduction in plug-in heating and an increase in heat pump usage. The after heating efficiency ratio is still low, showing that reaching comfort levels takes a lot of energy.

The house was in the comfort zone for 78.3% of the time – a decrease from 82.6%, but still a high percentage of time. This means that the house was at least 18°C for over 18.5 hrs a day. Added to this increase was an increase in time spent above the comfort zone in the living area– before 2.1% of time was above 24°C but after 13.5% of the time was above 24°C. Average temperatures in the living room and bedroom increased (for example the average living room temperature went from 21.3 degrees to 22.2 degrees), highlighting the increased time spent above the comfort zone in the living area.

The high level of heating that would be needed to stay in or above the comfort zone was likely influenced by Gayle's illness, along with the various needs and practices of the other householders.

Total heating reduced by 4.3% (from 42.46kWh/per day to 40.45kWh/per day). The after winter use shows there was a significant reduction in the use of plug in heating (down by 30%) and a significant increase in the use of the hardwired heaters (up 27.7%). Energy used on the light and power circuit (other than for heaters) increased (48.4%). The substantial increase of energy through the light and power circuit is possibly from the installation of a plug in heater that has not been recorded by this project.

Energy and comfort

Hot water use decreased by 10.1% which may be explained by the variable occupancy levels of the household. The energy used by the hot water system is considered high for a house with four occupants. As a comparison Case Study #02 – Nonie and family uses a similar amount of hot water and has nine occupants. Gayle and Dennis have a number of high needs occupants, and people who would often be in the house, including a very small child, an adult with down syndrome and another adult with the need for specialised electrical medical equipment.

Temperature was only very occasionally measured as going near to dew point in winter, which correlates with householder accounts.

While the house has poor heating efficiency, Gayle and Dennis manage to keep the inside rooms nearly 10 degrees above outside temperatures. To do this they use two heat pumps in the kitchen/living areas on a regular basis in winter, which helps to explain the high energy use.

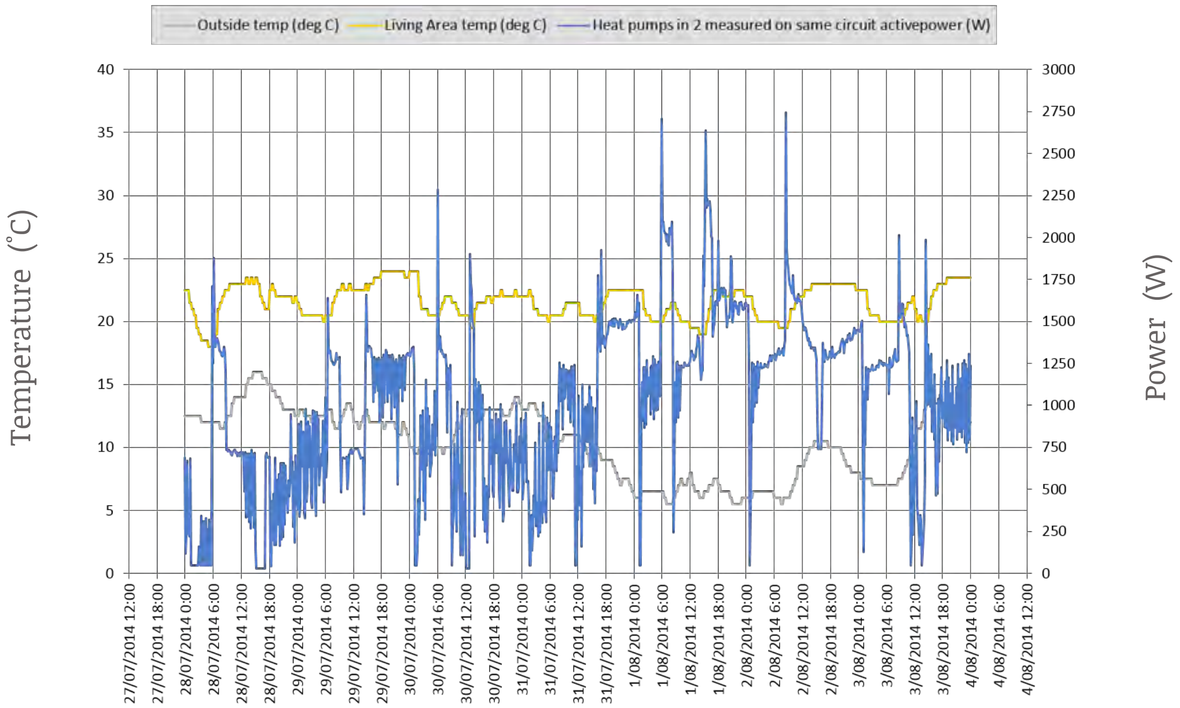
I've got a Downs daughter who doesn't like to wear clothes so she's got to stay... she's terrible, she just sits in a summer nightie and she won't put a dressing gown on, nothing, so we've got to keep her room warm.

(Before Interview 24/05/2014)

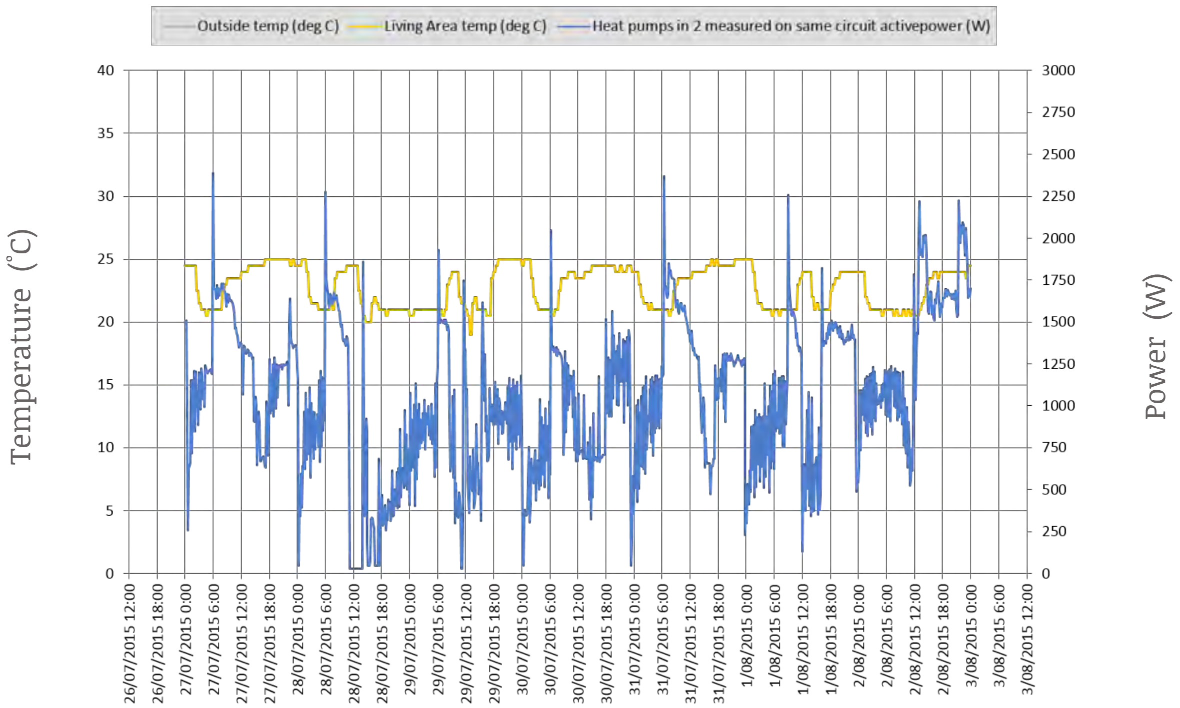
Yeah. It's draughty. Sometimes I see the curtains move, moving through the wind.

(After Interview 08/09/2015)

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Gayle and Dennis were concerned about energy use in their home because of,

> The money. As I said I think it's ridiculous just to keep warm, for god's sake.
> *(Before Interview 24/05/2014)*

The household increased their energy use between 2014 and 2015. Interestingly they believed that their bills had decreased. This may have been because they managed to get ahead in their payments.

As Gayle explained,

> The last bill we got the Hydro owed us over $1200 so... Couple of years ago I was behind and I was paying $189. I still pay $180 something and then all of a sudden instead of me owing them they owe me. And the last bill they owed me over $1200... *(After Interview 08/09/2015)*

Personal and community change

Gayle and Dennis live with their adult daughter who has Down syndrome and their teenage granddaughter. In 2015 they began looking after their new born grandchild during the day.

Technologically aware and skilled, Dennis had spent considerable time and effort establishing energy use routines, organising the technology he thought was best and planning for the future. He intended to install solar panels when they could afford them. Gayle was at home a lot and had significant health issues. At times each week she needed to use medical equipment for treatment, which not only used electricity but also limited her movements in and out of the house.

Managing the needs of everyone in the house and allowing people to get comfortable in their own way clearly influenced energy use in the home. Gayle talked about the difficulty of managing a house with high needs occupants. As she explained,

> You've got the Downs daughter. She'll sit in the lounge room, but she'll sit on the floor. Of all places to sit. It's a cold draft that comes through. I'm cold. I'm cold, you know. So you boot the heater up. If she sat in a chair and that, you know. They're very, you know, the both of them. *(After Interview 08/09/2015)*

Personal and community change

Gayle used the heater according to her needs on any given day but was aware that her daughter and granddaughter didn't heat all that efficiently.

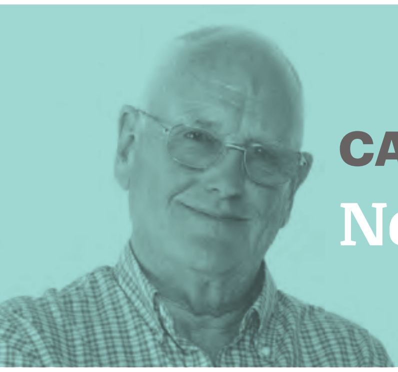
> Look, I'm cold, I want to be hot, so I just change it. I don't like wasting heat though and, as you know, Janice's got a heater in her room, but if she'd leave her door open she wouldn't need a heater in her room. She won't do that. Jacqui's got that invalid heater in her room. But then she sits in there with the door open, but it's still cold, so yeah.
>
> *(After Interview 08/09/2015)*

Gayle and Dennis felt strongly connected to their community. They felt that there were people that they could ask for help. Another of their daughters was a local Energy Champion and they knew they could always go to their neighbourhood centre if needed.

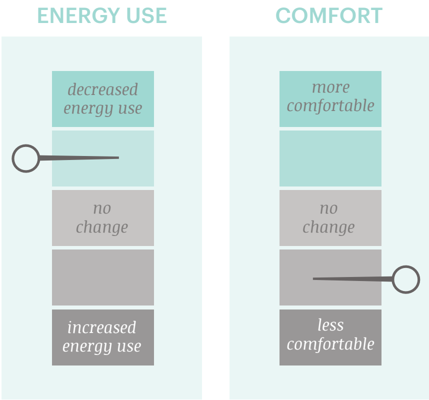
> [Our daughter is] involved, was involved a lot with the, you know, community centre and the family child centre and--but I know where they are and I know if I needed anything I'd only have to go there so, you know. *(After Interview 08/09/2015)*

Despite these connections, Gayle and Dennis' clear awareness and some evidence they shared discussions about the Energy Champion role with their daughter. While the Energy Champions did change the lightbulbs for Gayle and Dennis (which blew after a very short time), there is little evidence to suggest that discussions with the daughter led to any change. This lack of apparent uptake of ideas a may have been because: they lived with other householders who did not (or could not) change their energy use practices; Dennis was already practical and didn't really learn anything new from his Energy Champion daughter; or because their house was very busy and dynamic which made it hard to make changes or to make time.

Overall Gayle, Dennis and their family increased their power bills and increased the temperature in their home. Thermally their home performs poorly so they use two heat pumps to keep warm. They are knowledgeable about energy efficiency, well connected to the community and related to an Energy Champion, but could not manage to reduce their energy use.



CASE STUDY 16
Norm and partner



OWNER WITH MORTGAGE*		FREESTANDING ONE STOREY	WOOD FIRE + HEAT PUMP

Occupants | Own or rent | Bedrooms | House type | Heating

What did we do?

COMMUNITY CAPACITY BUILDING

[If I could] I'd sell [this house] and go somewhere else and get one that was more updated. One with a better set up, probably more glass in it so you get more light and more use of the energy. And I'd probably – I've often thought of it but it's a waste of time in a place like this but with solar panels.
(Before Interview 09/07/2014)

What was the result?

Norm and his wife saw very little change to both their comfort levels and their energy use. They continued to heat the house to a very high degree with the wood heater and occasionally used the heat pump in the shoulder season.

The only way Norm could have improved the performance of his house was to knock it down and start again – prohibitively expensive.

✔	Energy use reduced by 0.8kWh (4.2%) from 20.55kWh/day to 19.69kWh/day.
✘	Energy costs increased by ~$100 per year.
✘	Time spent in comfort zone decreased from 40% to 29.9% (90.8% of their time above the comfort zone of 24°C in the living).
✔	Displayed improved confidence that he could find information on energy efficiency and thermal comfort.
~	*Electrical heat efficiency not relevant in winter as wood fire the main source of heat and no other data available.*
~	Average temperature in the living area was 33°C.

* rent-to-buy scheme

Existing physical conditions of the house

Living room on west received a little bit of northern sun. Most northern sun blocked by entry deck. Very small windows on the north. Eastern and northern sun blocked by sheds and deck roof.

Very poor solar orientation, blocked northern sun and a lack of insulation, among other things, means this house performs thermally very poorly.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Block veneer, concrete block, tile roof, suspended timber floor (carpet and vinyl).
Insulation	None.
Windows	Single glazed, old wooden frame
Window coverings:	Vertical blinds and light curtains.
Access to sun	Very small window on north side.
Heating	Wood heater (winter), heat pump (spring and autumn).

Changes to the home

Other changes to the home:

- Norm installed a new draught stopper on his back door as the old one was broken.
- Norm and his wife stopped using the heat pump so much in winter, but may have used it more during the shoulder seasons.
- Norm's wife was very sick during some of this period and felt the cold more, especially after her chemotherapy treatment.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Norm and his wife live in a house that they almost own outright. They bought the place when the opportunity arose using the rent-to-buy scheme. Since they bought the place Norm has made as many changes as possible to improve the thermal comfort and energy efficiency. These changes have included: replacing the solid wood front door with glass panels to allow more direct sunlight into the house; draught proofing the doors and doorways; and building an outside living area on the northern side of the house. Norm explained that given the poor design of the house (badly orientated, small windows etc.) there was nothing more he could do. If they could afford to he would just sell the place and move to somewhere more comfortable. Norm was clearly incredibly frustrated by the poor design of the house.

While the house is poorly designed, the wood heater enables Norm and his wife to heat the house to unusually high temperatures (in winter 90% of the time the living room is above 24°C).

They often use the heat pump during the shoulder seasons (spring and autumn) and we picked up some use in the winter season. Norm's wife was quite sick during the after period and this may have changed the way that electricity was used in the house.

Norm himself had energy use requirements and managed a back injury through hot showers but there was some reduction in the after period. Norm and wife also looked after their grandson on occasion which would have affected energy use.

The Energy Champions visited Norm and his wife on several occasions, Norm explained how good this was for social reasons and for general information exchange. They did not attend any Get Bill Smart events.

Average daily energy use and heating efficiency during winter conditions

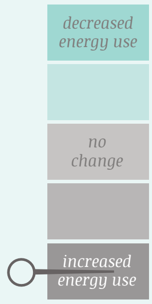
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0
T 41 Heating (hard wired heating)	2.52	3.86	1.34	53.0%
Total Heating	2.52	3.86	1.34	53.0%
Other Light and Power (T31)	9.67	8.27	-1.40	-14.5%
Hot Water	8.35	7.56	-0.80	-9.5%
Total Household Electricity	20.55	19.69	-0.86	-4.2%
House Heating Efficiency (degree-hours/kWh/day)	7.16	5.06	-2.11	-29.4%

Average daily temperatures and time in comfort zone during winter conditions

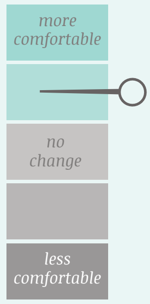
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	31.3	23.1	9.1	18.1	40.0%
After	33.3	24.0	9.1	19.5	29.9%
Difference between before and after	2.0	0.9	0.0	1.4	-9.7%

CASE STUDY 17
Sarah and family

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HARDWIRED RESISTIVE

What did we do?

COMMUNITY CAPACITY BUILDING

Don't move into this house.

(After Interview 24/09/2015)

What was the result?

Sarah was annoyed at having to live in this house because it was hard to heat, draughty and moist. The heater was ineffective. Despite her husband's construction skills and knowledge of energy efficiency, renting meant they were unable to make any effective changes to their home.

✗	Energy use increased by 11.57kWh/day (23.7%) from 48.81 – 60.38kWh/day.
✗	Energy costs increased by ~$300 per year.
✓	Time spent in comfort zone increased from 6.4% to 10.4%.
✗	Heating efficiency decreased from 0.15 to 0.14 (6.7%) – efficiency is very low.
✓	Sarah displayed improved confidence that she could find information on thermal comfort.
✗	Self-reported moisture and mould remained. Measures support this report with temp reaching dew point in winter in living room with 85% humidity peak.
✗	Despite attempts to draught proof, draughts remained problematic.

Existing physical conditions of the house

The house is a 40-50 year old standalone suburban house on a slightly larger block. It sits with its long axis north/south and therefore mainly receives east/west sun. It has all day solar access, but few windows are to the north. It is single storey but has a split level, so heat can flow from the living room on the lower level up to the bedroom area on the upper level. The house is constructed of weatherboard cladding with timber frame walls, a corrugated iron roof and concrete block plinth/skirt. The long axis of the house is north to south. The living room is on the south east corner and sits in open plan with the dining on the southwest. The living only receives morning sun. Overall the house has solar access for most of the day. Bedrooms are to the east and north. Heating is provided by a hard wired resistive heater in the living area and a plug in column heater for the bedroom area.

Despite having good curtain coverage, the age, poor orientation, draughtiness, moisture issues and a lack of effective insulation leads to a POOR thermal performance.

Insulation	In ceiling (loose fill rock) only.	POOR
Windows	Single glazed, timber frames, no pelmets.	POOR
Window coverings	Throughout house, medium to heavy weight curtains.	TO STANDARD
Under floor space	Suspended floor, underfloor enclosed with concrete block skirt, no insulation.	POOR
Mould and moisture	Very moist house (wipe down to dry off), mould in the bathroom, use absorbent beads near windows. Temp reached dew point in winter in living room with 85% humidity peak.	VERY POOR
Other conditions of note	Persistent draughts despite DIY draught-proofing.	POOR

Changes to the home

Other changes to the home:

- Sarah's husband (a builder) draught-proofed bathroom and toilet doors and covered vents around house.
- Added a second fridge (for beer for others helping them build their own house).
- Brother came in a caravan to visit and plugged into electricity.

GET BILL SMART UPGRADES

Not relevant for this participant.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	17.70	18.42	0.72	4.1%
T 41 Heating (hard wired heating)	10.88	16.42	5.54	50.9%
Total Heating	28.58	34.83	6.26	21.9%
Other Light and Power (T31)	7.21	10.31	3.09	42.9%
Hot Water	13.02	15.24	2.22	17.1%
Total Household Electricity	48.81	60.38	11.57	23.7%
House Heating Efficiency (degree-hours/kWh/day)	0.15	0.14	-0.01	-6.7%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	13.1	16.1	10.3	4.3	6.4%
After	13.2	16.1	9.7	4.9	10.4%
Difference between before and after	0.0	0.0	-0.6	0.6	4.0%

Referring to the tables and graphs presented, changes were observed in energy use and comfort. Overall electricity use increased by 23.7%. Total heating increased by 21.9% (from 28.58kWh/day to 34.83kWh/day). Over this time there was a significant increase in the use of the wired in electric resistive heater (up by 50.9%) and a slight increase in the use of the plug in heater (up by 4.1%). This extra heating likely caused the increase in the comfort zone, but was not enough to increase average temperatures. Heating efficiency decreased by 6.7%, going from 0.15 – 0.14; both ratios are low and show ineffective heating.

[John] has put, under the bathroom and toilet door where there was this big, huge gap, so he's nailed a piece of wood along the floor so once the door closes the air can't get through but we can feel, still feel draughts coming through. *(Before Interview 22/6/2014).*

Average temperatures of the living rooms and bedrooms remained constant with the living room temp at 13.1°C (up .01 of a degree) and the bedroom temperature remaining at 16.1°C. The house was only in the comfort zone for 10.4% of the after period which was an increase of 4% (up from 6.4%).

This level of time in the comfort zone is low and indicates a poor thermal environment.

The comfort zone increase coupled with constant and decreased average temperatures indicates that average temperature fluctuated more in the after period (with higher and lower temp extremes). Within this fluctuation there was probably a little more time in slightly warmer temps and slightly more time in the comfort zone. The before and after graphs show variation in heating practices, but similar temperature ranges being achieved.

Interestingly in this house the bedroom temperature stays warmer than the living room. This is unusual, but aligns well with qualitative understanding: Sarah's baby had sleeps during the day with the door closed (and heater on), the bedroom likely had better solar gain, and Sarah was trying to maintain warm places for her children. Supporting the higher bedroom temperatures the after period column heater use shows relatively constant use. In addition graphs show changes in column heater energy patterns in the after period. This may have been due to a new heater replacing the old or use of a thermostat. The distinction in temperatures also highlights the underperformance of the living area, even when a heater is on. This position of the living room at the south of the house and the stack effect created by having the bedrooms at a higher split level would also diminish living room performance (as heat will escape to bedrooms area).

Energy used on the light and power circuit (with heating use removed) increased by 42.9%. It is likely that this increase is due to the installation of a second fridge (put in to help keep 'thank you' beer for people helping them build their own home). During GBS monitoring Sarah's brother visited with his caravan. He plugged into the general light and power circuit and would have also contributed to this increased use.

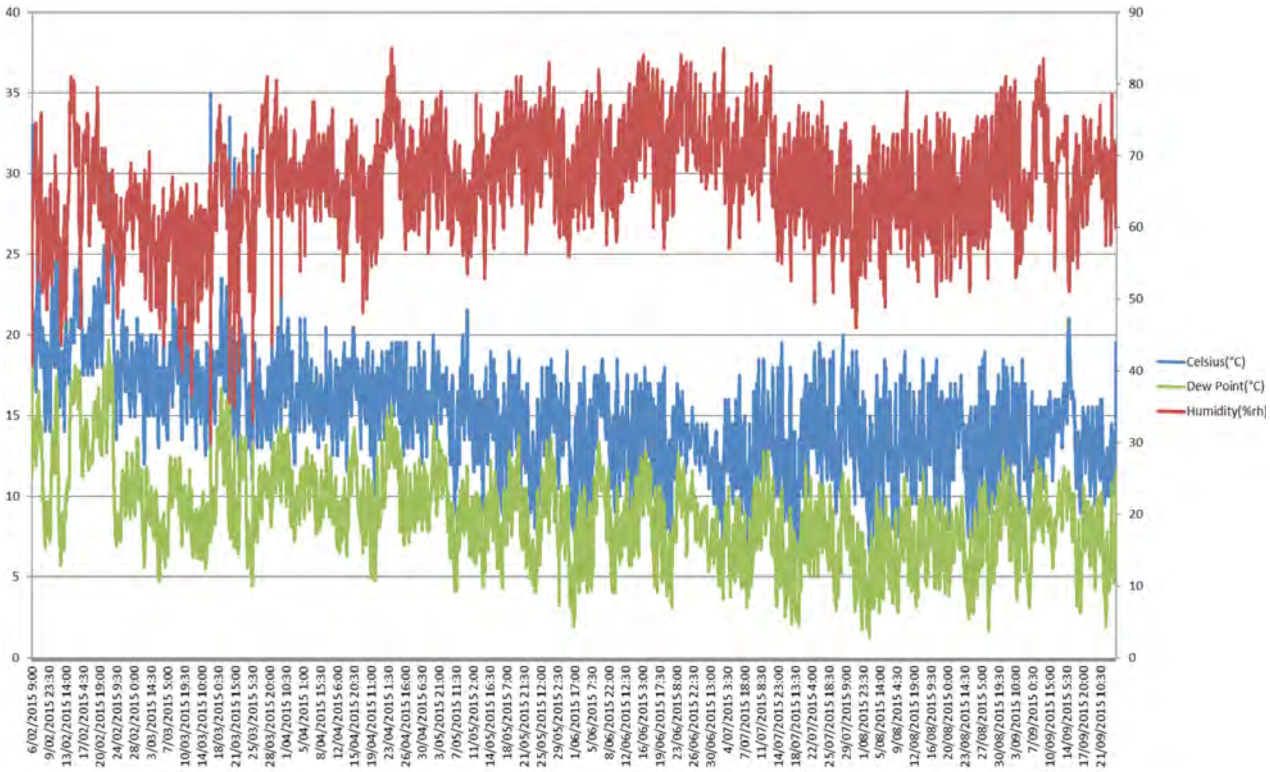
Hot water use increased by 17.1%. This is likely due to the long visit by Sarah's brother and the subsequent increase in showering.

Despite Sarah's use of absorbent beads near windows, she described the house as very moist and said she wiped down to dry off windows. There was mould in the bathroom. Temperatures reached dew point in winter in living room with an 85% humidity peak which supports Sarah's accounts.

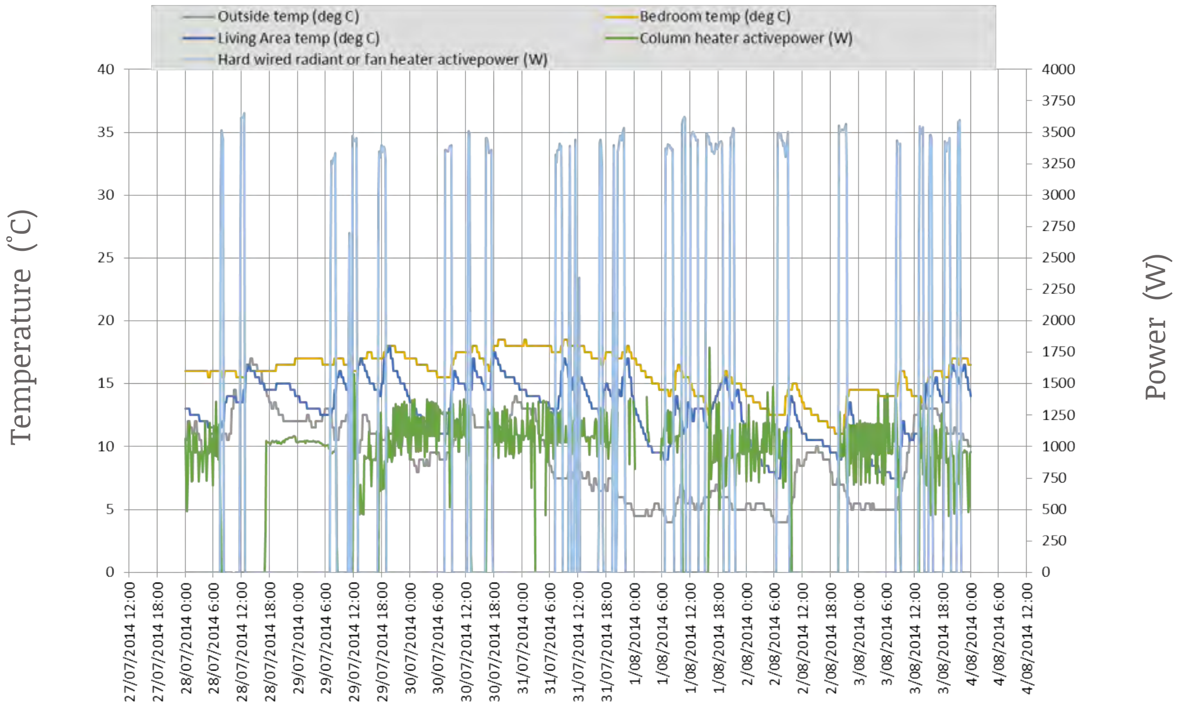
I've asked about this, for [the landlord] to fix this [living room] heater or replace it, because it only half-works and it's chewing the power. The real estate keeps saying that he just reckons he can't afford it, so we basically have to just freeze.

(After Interview 24/09/2015)

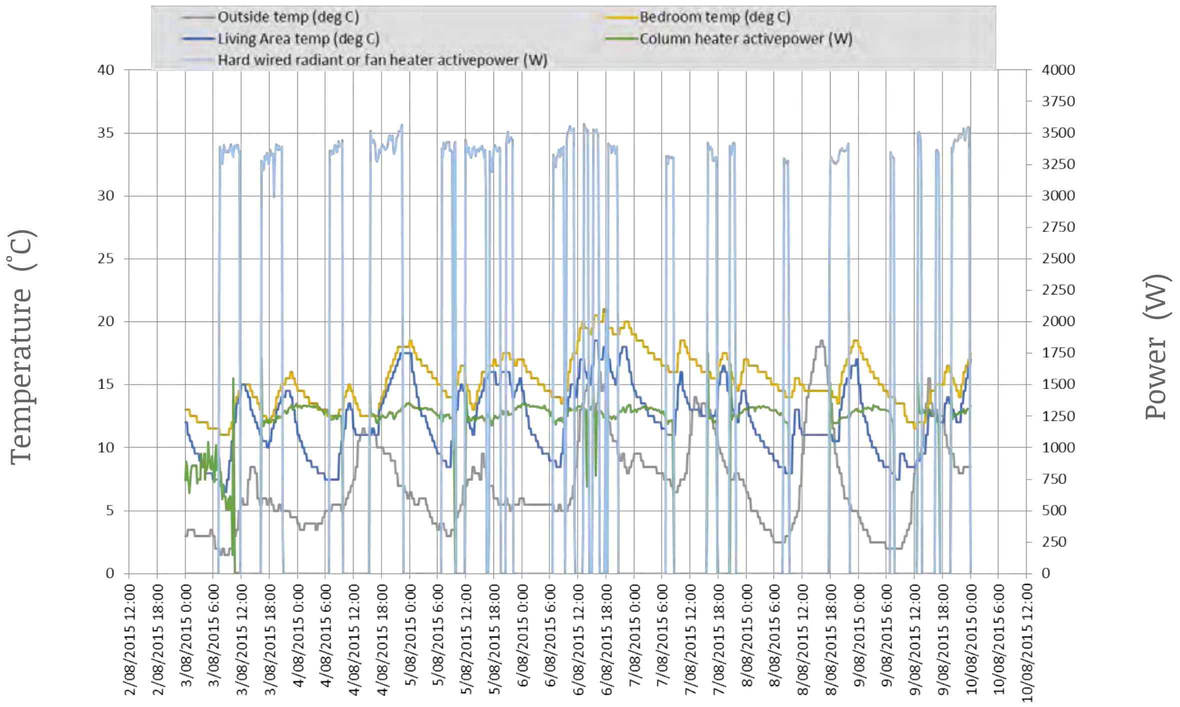
Temperatures, humidity and dewpoints example (living room sensor) recorded Feb to Sept 2015



Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Sarah and her family were worried about the amount of money they spent on power. Sarah explained that,

> We put on $70 a week but then by the weekend, we have to go and put another 50 on to take us through to... the Tuesday. *(Before Interview 26/05/2014)*

Over the course of this project Sarah's energy bills increased by approximately $300 per year, from $2,268 to $2,577. Given her increased power usage this is not surprising.

Such an increase in energy use was stressful, as Sarah said,

> It's quite stressful, trying to find the money for that and there are bills and...
>
> *(After Interview 24/09/2015)*

Personal and community change

Sarah and her family have rented their house for about four years. During this time they have attempted to improve the energy efficiency and thermal comfort of their home. Sarah's husband is a builder and did install some wooden draught stoppers on the bottom of the doors and over gaps. This may have helped a little but Sarah explained that the draughts still come through. They also used blankets to trap heat into certain parts of the house.

The living room was warm enough in certain places but Sarah explained the limitations of the heater saying it was,

> Just enough if you're going to sit in here, but it won't heat up the kitchen or even out near the front door, just where you're sitting right here. *(After Interview 24/09/2015)*

Sarah and her husband John have noted many things that they themselves could do to the house. Given John's professional skills they could make many quality changes around the home. Sarah explained that they did not have a good relationship with their landlord which had limited their ability to maintain a comfortable home. She said,

> We're not even allowed to hang pictures on the wall, which is really weird, and we've sent in a list of stuff, can we do this ourselves? Because my husband's a builder, it will make the house look better for the owner, but he just refuses to get back to us.
>
> *(After Interview 24/09/2015)*

Sarah explained that she and John had considered trying to buy the house they were renting but decided against this. Instead, they were building their own home. As a part of the process of building their own place, Sarah and John installed a beer fridge to provide drinks to people who were helping them with the building on their property.

Personal and community change

This new house will have solar panels and rainwater tanks, indicating a level of awareness and care about resource use and efficiency. Sarah explained that her husband was really very interested in energy efficiency.

Given that Sarah is at home a lot during the day with her young children she spends very little time in the comfort zone (10.4%). Sarah found that the kids were sick a lot during the winter and felt that the constant moisture in the rooms,

> That would add to their sickness [because] mould's not good for you to breathe in.
> *(After Interview 24/09/2015)*

By closing the doors to the bedrooms of the house during the day Sarah managed to maintain some level of comfort in the living areas. Yet as she explained,

> When the kids come home, and I want to warm their rooms up, so I open their bedrooms around three, and the cold air that just tumbles out of their rooms is unbelievable.
> *(After Interview 24/09/2015)*

Sarah did not attend any of the Get Bill Smart community events. She explained that she was too busy looking after children and studying. Sarah was friends with one of the Energy Champions and so acknowledged she had access to information through her.

Throughout the project Sarah's sense of community and the resources available to her remained the same – a somewhat neutral sense of community. Sarah and John were integral to their church community in the neighbouring suburb. Sarah felt that she and her husband were the 'go to' people in the community rather than the people who had to seek help or advice. She said,

> Our track record is we offer advice, people come and ask us, and we offer advice, we suggest, but they still just potter along in their own little bubble, as you say, so we don't see the point [asking other people for advice]. *(After Interview 24/09/2015)*

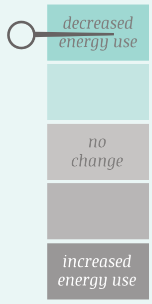
Overall Sarah and her family were uncomfortable in this house and were annoyed that it was hard to heat, draughty and moist. Poor orientation of the living room and the split level design of the house made it hard to manage. Despite her husband having construction skills and knowledge of energy efficiency, renting meant they felt unable to make any effective changes to their home.

CASE STUDY 18

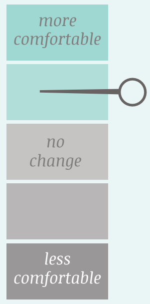
Susie and family

(comparing houses before and after move)

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER	(089) → (725)	FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

> Down at my other house I used to go home and I used to crawl into bed because it was a cold house and watch TV where here I don't. The big difference was the first night I moved in here I had my sister down and she would normally have seven blankets on her bed down at the old house. The first night she was here she slept with one doona.
>
> *(House 725 After Interview 21/9/15)*

What was the result?

Moving house greatly improved Susie and her family's comfort and reduced their bills. House 725 (the second house) required half the electricity and had a heating efficiency 304.6% better then house 089. Using less than half the heating and on a cheaper tariff in a house that looked nicer and had access to more sun helped Susie and her family to feel so much better about life.

- ✔ Energy use halved with the move going from 70.6 to 35.03Kwh (a 35.63kWh, 50.4% change).
- ✔ Self reported energy costs reduced by ~$1000 per year.
- ✔ Time spent in the comfort zone slightly increased from 43.9% to 49.3%.
- ✔ Heating efficiency increased from 0.12 to 0.47 (a changed of 0.36, 304.6%)
- ✔ Displayed improved confidence she could access information on energy efficiency if needed.
- ✔ Draughts were greatly reduced in the new house reduced.

Existing physical conditions of the house

House 1: 089 – This house somewhat maintained but needed work. Despite Susie hanging curtains, this house had a lot of its solar access into the living areas cut off, and little thermal resistance. The house also had no effective living room heater. Overall this house performed at a very poor to poor level.

House 2: 725 – This house has little thermal resistance in the walls but has ceiling insulation, some solar access and a heat pump that provides effective heat. This house feels much more comfortable to Susie than the one she lived in previously. Overall this house is poor to near standard.

House 1: 089	
Type	Stand alone, suburban.
Age	40-49 years.
Construction	Weatherboard cladding, timber frame, corrugate metal roof, suspended timber floor (1 m high) (vinyl and carpet cover), brick underfloor skirt.
Insulation	Unknown (likely none).
Windows	Single glazed, timber frame.
Window coverings	Lace + curtains and vertical blinds.
Access to sun	Car port on north and tree on west so morning and midday solar access, living room on west with a little northern sun; dining and kitchen to north but afternoon sun cut off.
Heating	Plug in radiant bar (dining), radiant (living), plug in column (hallway), column (bedroom), electric blankets. Had an old oil heater but was $700 to fill it and the oil only last about 2.5 weeks so cost prohibited its use.

House 2: 725	
Type	Stand alone, suburban.
Age	40-49 years.
Construction	Brick veneer, timber framed, tile roof, suspended floor enclosed with brick (carpet and tiles).
Insulation	Ceiling only.
Windows	Single glazed, aluminium frame.
Window coverings	Curtains in living and dining after home visit.
Access to sun	Dining with a deck to the north, living to the west with clear solar access to the north.
Heating	Heat pump (living), plug in radiant (hall).

Changes to the home

Other changes to the home:

– Moved house (from 089 to 725) seeking a more comfortable and nicer house.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Susie lived with her two young children. When we first met them they lived in house 089 which was hard to heat and uncomfortable. Susie felt embarrassed by how run down the house looked. Her new house looked and felt better. Susie had been quite depressed in her original house and the move to 725 had significantly improved her mental health; it was easier to live in, warmer and more affordable.

The data provided in this case is a comparison of Susie's before information for 089 and her before information for 725. Susie did have exposure to the GBS community events and did attend at least one.

All heating in 089 house was plug in electric. Susie felt that the house let her down in terms of comfort. In the new house all heating was wired in and included a heat pump. Susie used much less energy to heat the 725 house so total heating reduced by 30.83kWh/day (a reduction of 57.8%).

Despite the significant benefits from moving, when Susie first moved into house 725 she was frustrated that there was no door between the laundry and the rest of the house. Without a door draughts and cold air flowed through into the living space and this was exacerbated by the heat pump. Susie's frustration reveals her understanding of thermal comfort management in the home. Susie approached the landlord to change the door but he was not interested. It was clear that Susie would have made further changes to the home if she had the money and/or owned the place herself.

Keeping kids warm so that their asthma did not flare was a priority for Susie. It was also important for her own health, "if I'm not comfy then I'm grumpy. I get shivery and then I throw up" (725 interview 21/09/2015).

Pay as you Go electricity in house 725 also helped Susie feel more in control than in 089.

Susie was well networked in the community with friends she could talk with about thermal comfort and energy efficiency. She had previously attended some Get Bill Smart activities (before moving into house 725) and felt confident that the Energy Champions would be able to answer any questions she might have. Susie was also good friends with several other participants in the program and they were all able to share their experiences.

Note that after this comparison Susie's energy reduced a little more with the home energy helper visits from SLT (see Case 10).

In 089 Susie spent a lot of time in bed with electric blanket on and she was on a payment plan to cope with her high bills.

In 725 there are new ways to keep warm in the living room – the kids would comfortably snuggle on the couch near the heat pump.

Susie's experience is a fantastic example of how significantly the quality of housing can affect physical and mental health.

Overview

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	53.37	0.00	-53.37	-100.0%
T 41 Heating (hard wired heating)	0.00	22.53	22.53	–
Total Heating	53.37	22.53	-30.83	-57.8%
Other Light and Power (T31)	7.57	5.35	-2.23	-29.4%
Hot Water	9.72	7.16	-2.57	-26.4%
Total Household Electricity	70.66	35.03	-35.63	-50.4%
House Heating Efficiency (degree-hours/kWh/day)	0.12	0.47	0.36	304.6%

Average daily temperatures and time in comfort zone during winter conditions

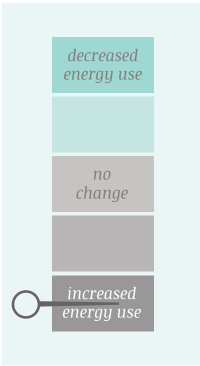
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	16.0	18.0	10.8	6.2	43.9%
After	20.6	17.0	8.2	10.6	49.3%
Difference between before and after	4.6	-1.0	-2.6	4.4	5.5%

CASE STUDY 19

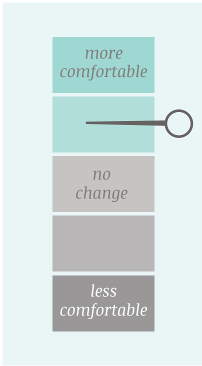
Selena and family

(comparing houses before and after move)

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER → OWNER WITH MORTGAGE		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

> Not at this point because we've switched over to PAYG, it seems so much cheaper. I don't know whether it's because we've become more conscientious of it but I mean we're just paying under $50 a week whereas we used to get big bills at the other house.
>
> *(After Interview 091 25/09/2015)*

What was the result?

Selena and her family moved from renting house 091 to purchasing house 726. While the move gave them housing security and more control over what they did to the home, they also found themselves dealing with significant moisture and mould issues in the new home.

- ✗ Energy use increased by 13.85kWh/day (49.6%) from 27.92kWh/day to 41.77kWh/day.
- ✓ Time spent in the comfort zone increased from 20.2% to 27.2%.
- ✗ Heating efficiency decreased from 0.80 to 0.79 (1%).
- ✗ Displayed decreased confidence that she could find information on thermal comfort and remained unsure she could access information on energy efficiency if needed.
- ✗ Problematic levels of moisture and mould.

Existing physical conditions of the house

House 1: 091 – Due to orientation of the house and blocking of the north/east sun with a deck, the lack of insulation, single glazing and poor window coverings, this house has poor thermal performance.

House 2: 726 – From the evidence from the householder and observation of the poor thermal performance of the building materials this house performs at a very poor level. The suspended timber floor is just above ground and as a result significant moisture is likely coming up from below. This moisture has led to problematic levels of mould in the bedrooms.

House 1: 091	
Type	Stand alone, suburban.
Age	40-49 years.
Construction	Brick veneer, tile roof, suspended timber floor (polished timber floor, carpet) (1m), old chimney.
Insulation	None.
Windows	Single glazed, aluminium frame.
Window coverings	Curtains (medium in living, bedroom, lace elsewhere).
Access to sun	Living room positioned to the west (north west window/south west window) open plan with kitchen/dining to the north, north east deck with roof (cutting out sun).
Heating	Heat pump.

House 2: 726	
Type	Stand alone, suburban.
Age	30-39 years.
Construction	Weatherboard, corrugated metal roof, suspended timber floor (polished floorboards, tiles, carpet), old brick chimney, small block skirt around underfloor.
Insulation	Possible ceiling.
Windows	Single glazed, wood frame.
Window coverings	Curtains (heavy), venetians (kitchen).
Access to sun	Main living access to northern sun, all day sun, long axis is east west.
Heating	Heat pump.

Changes to the home

Other changes to the home:

- Moved house (from 089 to 725) seeking a more comfortable and nicer house.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Selena and her partner were in their late twenties with two young children (under 4).

With the move to a new home, Selena and her family significantly increased their energy use (by almost 50%). Most of this increase is through hot water (which increased by 58.1% from 11.31kWh/day to 17.89kWh.day) and the Other Light and Power Circuit (65% increase from 8.59kWh/day to 14.16kWh/day). The increase in hot water use is most likely due to the second house (726) having a much older and less efficient hot water system. As seen in case #30 a faulty hot water system can contribute significantly to energy use. With no changes to work or household occupants, faulty hot water is a possibility.

It is unclear why Other Light and Power increased so much. This may be due to increased energy use associated with a house move and the beginnings of small home improvements, changes to appliances, family visitors or other reasons.

In moving to the new house (726) Selena and family also shifted to the Pay As You Go Billing system. Selena found this helpful for maintaining control over their energy use. Interestingly she explained that her bills had decreased, however it seems unlikely that this is the case, rather the change in billing style helped her management practices.

Selena and her family were incredibly physically active and some of the most fit and healthy people in this study. This would have helped her significantly to feel warm in houses that perform thermally very poorly.

Average daily energy use and heating efficiency during winter conditions

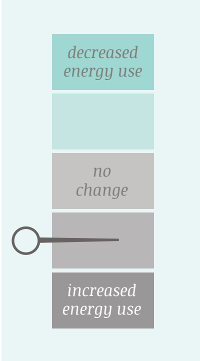
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	8.01	9.71	1.70	21.2%
Total Heating	8.01	9.71	1.70	21.2%
Other Light and Power (T31)	8.59	14.16	5.58	65.0%
Hot Water	11.31	17.89	6.57	58.1%
Total Household Electricity	27.92	41.77	13.85	49.6%
House Heating Efficiency (degree-hours/kWh/day)	0.80	0.79	-0.01	-1.0%

Average daily temperatures and time in comfort zone during winter conditions

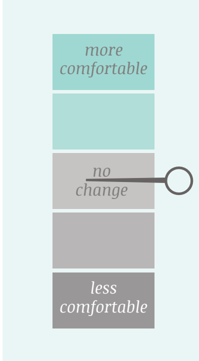
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.5	13.8	9.2	6.4	20.2%
After	17.0	15.1	8.4	7.7	27.2%
Difference between before and after	-0.4	1.3	-0.8	1.3	6.9%

CASE STUDY 20
Queenie and family

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

> Yeah, not really interested [in attending events], I just don't really have the time, with four kids, one on the way, it's pretty crazy.
>
> *(After Interview 09/09/2015)*

What was the result?

Thanks to the installation of carpet, Queenie and her family felt warmer in their home at lower temperatures. Despite this the family used more energy and heating costs increased. This is likely due to a shift in how the family used the heat pump – they went from turning it off when not in use to only turning it down.

- ✗ Energy use increased by 3.28kWh from 44.4kWh/day to 47.68kWh/day (7.4%).
- ✗ Energy costs increased by ~$320 per year (from $2,352 – $2,672).
- ✗ Time spent in comfort zone decreased from 75.1% to 74.7% (this remained excellent).
- ✗ Heating efficiency decreased from 0.84 to 0.62 (25.7%) – this is comparatively higher than others in study.
- ✓ Displayed improved confidence that she could find information on energy efficiency and thermal comfort.
- ✓ Self reported decrease in draughts.

Existing physical conditions of the house

Queenie and her family lived in a tiled, brick veneer, timber framed house with suspended floors (covered with tiles and later carpet). The house is approximately 30 years old. A stand alone suburban house sitting on a standard sized block, the house receives sun all day. The living/kitchen area sits to the north receiving sun most of the day. Bedrooms sit to the south of the house and so receive either eastern or western sun.

The family don't know if there is any insulation in ceiling. Heating in this house is provided by a heat pump in the living area.

Overall the living area position provides good solar access, but a lack of insulation means the house still only provides a poor level thermal performance.

Insulation	Unknown in ceiling, none elsewhere.	VERY POOR
Windows	Single glazed, aluminium frames, no pelmets.	POOR
Window coverings	Blinds (medium weight).	NEAR STANDARD
Under floor space	Suspended floor 0.2-0.8m, underfloor enclosed with brick wall, no insulation.	POOR
Mould and moisture	Self-reported increase in moisture (survey), however self-reported decrease in moisture (interview). Measures taken show temperature does not reach dew point when heating so moisture likely only on cold surfaces (eg windows) at specific times. Indoor winter humidity is not very high, so not likely to encourage further surface condensation.	
Other conditions of note	Overall well maintained. Draughts in the house.	

Changes to the home

Other changes to the home:

- The landlord carpeted the tiled living/dining area at Queenie's request.
- Queenie stopped paid work as she was expecting her fifth child.
- The family began to leave the heat pump on all the time as Queenie was told by someone that this was more efficient.

GET BILL $MART UPGRADES

Not relevant for this participant.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	11.11	14.78	3.68	33.1%
Total Heating	11.11	14.78	3.68	33.1%
Other Light and Power (T31)	19.75	13.12	-6.63	-33.6%
Hot Water	13.54	19.77	6.23	46.0%
Total Household Electricity	44.40	47.68	3.28	7.4%
House Heating Efficiency (degree-hours/kWh/day)	0.84	0.62	-0.22	-25.7%

Average daily temperatures and time in comfort zone during winter conditions

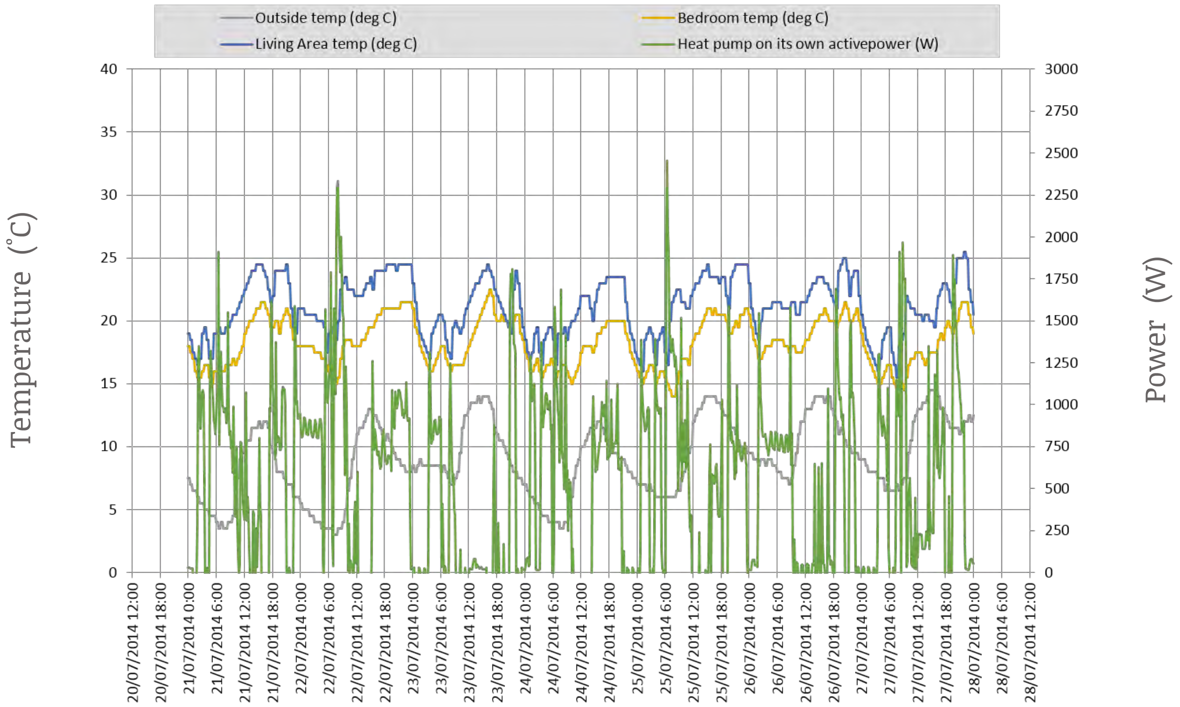
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	21.3	18.7	10.7	9.3	75.1%
After	20.5	17.9	10.0	9.2	74.7%
Difference between before and after	-0.8	-0.7	-0.7	-0.1	-0.4%

Referring to the tables and graphs presented, changes were observed in energy use and comfort. Total Household Electricity increased by 7.4% (from 44.40kWh/day to 47.68kWh/day). This increase was primarily due to more use of the heat pump (up 33.1%). Queenie explained that she left the heat pump on at all times as she had been told this was more cost effective and energy efficiency (please note using a heap pump in this way is not necessarily more efficient). Housing heating efficiency was reasonable when compared to others in this study because of the use of a heat pump, but declined from 0.84 to 0.62 (25.7%) in the after period as more heating was used.

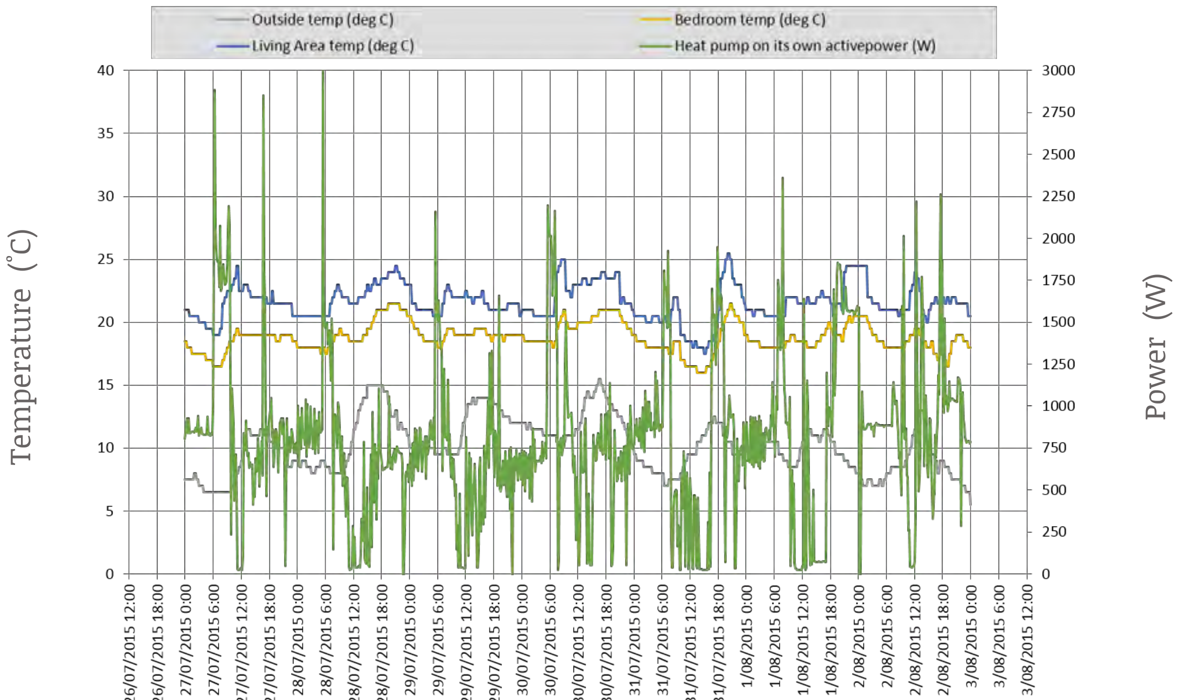
Time spent in the comfort zone minimally decreased from 75.1% to 74.7%. Time spent above the comfort zone (above 24°C) in the living area also declined from 10.7% to 6.5% of the time. The after time in the comfort zone is still very good as it would mean the house on average stayed above 18°C for about 18 hours a day. Average differences between the indoor temperatures and outside were consistently 10°C (warmer) in the living and ~7°C (warmer) in the bedroom. This temperature difference is reasonably high when compared to other detailed study houses.

Queenie reported that the family felt warmer at a lower heat now that the tiles had been covered by carpet. Average temperatures in the after period were a little lower (living average reduced by 0.8°C and the bedroom by 0.7°C) but overall heating energy increased. Despite slight changes in average temperatures, the before temperature graphs show a change in temperature dynamics. In the before period, in the living room, there tended to be large temperature swings and the temperature would rise and drop sharply when heating was turned on

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy and comfort

and off. There were frequent periods above 24°C and frequent periods below 17°C. This changes in the after period. There is less regular occurrence of sudden temperature drops and more comfortable temperatures were sustained for longer periods. The after graph also shows the bedroom is borrowing more of the heat from the living area.

Humidity and temperature measures taken show temperature does not reach dew point in the rooms measured. Indoor winter humidity is not very high (heat pumps tend to dry the air somewhat), so would not worsen surface condensation. So it is likely that moisture reported by Queenie is only on cold surfaces e.g. windows) at specific times. Certainly the difference between indoor and outdoor temperatures is enough to have encouraged surface condensation on windows.

Energy used on the Other Light and Power circuit decreased by 33.6% (from 19.75kWh/day to 13.12kWh/day, -6.63 kWh/day). At the same time, hot water use substantially increased from 13.54kWh/day to 19.77kWh/day (46%, 6.23kWh/day). It is difficult to tell why hot water use increased. It may have been due to changed patterns such as Queenie being home more and children staying in the shower for longer (her daughter loved a long shower).

Yeah. I mean, in the cold the kids will just whinge because they're cold. But the hot makes them grumpy if they can't cool down.

(Before Interview 10/05/2015)

Oh, yes, this winter was a lot warmer because we had the carpet.

(After Interview 09/09/2015)

Energy affordability

Queenie carefully monitored her energy use. She noted that on occasion the cost of electricity was a problem, saying:

"I know, like, the last couple of weeks I've had to like go up to my mums to borrow money to put power on and that's only because we've had… two birthdays a day apart – we struggled. Other than that, we don't do it generally, but it can come to the point where we have to borrow.

(Before Interview 10/05/2015)

Queenie's electricity bills increased by $320 per year, which matches with her increased energy use. When we spoke with her the second time, Queenie actually thought that her bills had gone down. The data collected from the energy supplier suggests this is not the case. Queenie was someone who paid her electricity bills via Pay As You Go. Queenie would have been able to see weekly peaks and troughs, but would not have had an overall tally of use over the year. It is possible that her extra energy use was not that noticeable because the extra cost came from occasional spikes in the regular use.

Interestingly, as with a number of other houses, Queenie and her family used a noticeable chunk of their energy on heating the water of tropical fish tanks. Queenie had noticed the extra use of energy each time a new fish tank had been set up. She rated it as a high energy user, under the heat pump, when she spoke with us. This highlighted how pets could be prioritised in homes too.

Queenie spoke often of living with her partner along with her four children, but did not mention her partner in GBS surveys. Queenie and the family had moved into this house because their old house had been too cold and was not effectively heated. They found this house much better. The family had an excellent relationship with their current landlord who, at Queenie's request, replaced ('freezing') tiles with carpet in the living areas.

Queenie left her heat pump on all the time as she was told by someone she trusted that turning it on and off was likely to cost her more money (it is worth noting here that this is not necessarily true). Queenie carefully managed home comfort explaining that:

To keep it warm in the winter I found if I shut my blinds about half past three it would stay warmer, then if . . . it was a really cold day I just would not open them. And same with the summer, like, if it was too hot I'd keep them down. But days like today I've got them all open, my heat turned down and it's not cold in here. *(After Interview 09/09/2015)*

Queenie liked to make sure that she kept the home reasonably warm (not too hot or too cold) as her children's, especially her daughter's health was affected by temperature. She said:

My daughter suffers epilepsy, so that sets her off a lot if she gets too hot. *(After Interview 09/09/2015)*

As a result, keeping the house at a good temperature was a priority.

Queenie felt that having carpet had really changed how warm her house was:

Yeah, it [the heat pump] gets put down to like 17 or something overnight. Depending on the weather, like, today I think I've got [the heat pump] down on 15. If it's a cold, cold day we'll have it on maybe 22. We used to have it up near 30 with the tiles.
(After Interview 09/09/2015)

With the installation of carpet, the room is likely to heat up faster once the heater is turned on as the tiles will not be soaking up the heat. While this may not affect air temperatures (which we measured), it could affect physiological comfort when touching the surface of the floor.

In her before and after surveys Queenie reported consistently high levels of confidence that she lived in a strongly connected community. She also thought that there were people within the community who could help her with thermal comfort and energy efficiency.

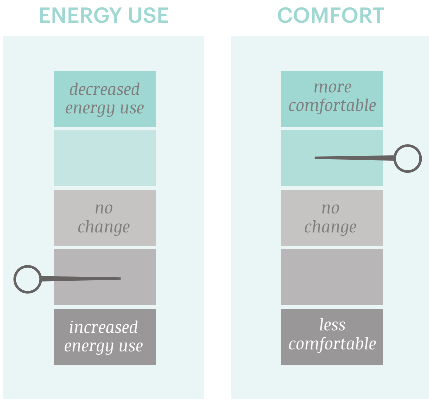
Queenie was unable to attend any of the Get Bill Smart workshops because she was busy looking after her four children. Despite a lack of attendance, she demonstrated increased awareness of power use and energy efficiency in her home which she said came from being part of the GBS research.

Yeah, I'm more aware and I'm more careful, I suppose, about what I'm doing, yeah. Since I've been doing this, and it just made me think, oh, especially with girls in the shower and stuff, you know, hot water.
(After Interview 09/09/2015)

Queenie informed us she is best friends with a woman who received upgrades through GBS. She also met local Energy Champions when they knocked on her door. She did not engage much with the Champions explaining that she already had the sensors in' (that she was part of the GBS project already and being monitored). She did not know that the Champions had other tips to offer. It is interesting that increased awareness has not yet translated into a decrease in energy. Queenie also listened to other people she knew and because of this had taken on the problematic advice about the heat pump.

Queenie and her family were close to the median of energy use for the Clarendon Vale no upgrade group of households but they were above average and above median for the project overall. Queenie felt confident in her management of the house. She listened to others about home management advice. The house was at temperatures that kept her children healthy but which meant the house was above 18°C for 3/4 of the day. The family's energy use increased over the GBS project period. There were times when Queenie had to ask her mum to help pay energy bills.

CASE STUDY 21
Frank and family



HEAT PUMP	OWNER WITH MORTGAGE		FREESTANDING ONE STOREY	HEAT PUMP
Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

COMMUNITY CAPACITY BUILDING

What was the result?

Frank was a competent handyman around the home and was constantly working to improve the performance of the house.

Thanks to a higher income than many in this study and a greater capacity to make change, Frank and his family enjoyed relatively high levels of comfort.

Frank attended some community engagement activities but saw himself as attending as a mentor rather than someone needing information.

✗	Energy use increased by 2.82kWh (7.1%) from 39.71kWh/day to 42.53kWh/day.
✓	Energy costs reduced by ~$125 per year ($1,971-$1,846).
✓	Time spent in the comfort zone increased from 56.3% to 61.4%.
✗	Heating efficiency decreased from 0.70 to 0.63 (8.9%) – remains good.
✓	Displayed improved confidence that he could find information on energy efficiency if needed.
✓	Self-reported draughts reduced.
✓	Self-reported reduction in moisture and mould.

[To reduce power we'd need to] Get rid of teenage kids! ... They use more power than Harvey Norman does!

(After Interview 09/09/2015)

Existing physical conditions of the house

Skylights in the kitchen, laundry and bathroom enabled natural light into the house and reduced the need for lighting.

A large deck at the back of the house (south east) also contributed to the liveability of the home (used as a space for clothes drying, cooking and socialising).

The orientation of the house, the higher levels of insulation and Frank's capacity to make changes to the house mean that this home performs thermally much better than most others in this study. We consider Frank's house as near to standard.

Type	Stand alone, suburban, standard block.
Age	50-59 years.
Construction	Weatherboard, timber framed, corrugated metal roof, under floor enclosed with brick, suspended timber floor (.9m above ground), (carpet, timber, cork).
Insulation	Well insulated ceiling with batts, polystyrene floor insulation under living spaces.
Windows	Single glazed timber frames, retrofitted double glazing in bedroom.
Window coverings	Lightweight vertical blinds.
Access to sun	All day access to sun, living room access to sun, eastern sun coming in to living room, well oriented.
Heating	Heat pumps (living, bedroom).

Changes to the home

Other changes to the home:

- Frank had retro-fitted double glazed windows into his daughter's north facing bedroom.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Frank and his family live in a well maintained house. Frank utilised his construction skills to make the home a comfortable place to live. Frank had built high quality double glazed windows for his daughter's bedroom and had insulated both the ceiling and the accessible parts of the floor.

Frank's professional skills and a slightly higher family income means that he had a higher capacity for creating a comfortable and efficient home than others in this study.

Frank and his family increased their total energy use by 2.82kWh/day (7.1%). Most of this increase can be attributed to greater use of the heat pumps (and subsequent increase in time spent in the comfort zone) which may have been used more due to the colder winter. The heat pumps were left on 16°C all day and all night.

Power use on the Other Light and Power circuit decreased. Frank was constantly retrofitting and changing energy use practices in the home which may have contributed to this change.

Frank and his family were well connected in the community. Frank contributed a lot of time to the local men's shed and felt that he had helped to train some of the Energy Champions in energy efficient retro-fits in the home. Frank's wife had also begun to participate in activities at the men's shed and was also quite knowledgeable.

Frank attended several Get Bill Smart community events. He said he attended in order to support the Energy Champions and while he didn't learn anything he said that they were enjoyable social events.

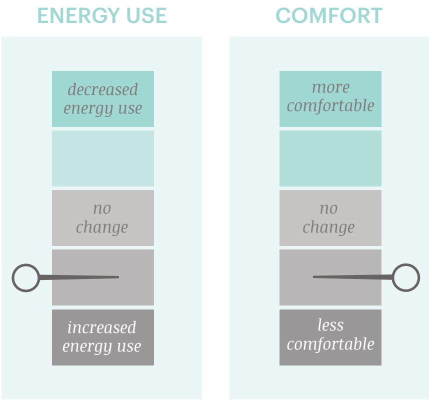
Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	14.19	17.75	3.57	25.1%
Total Heating	14.19	17.75	3.57	25.1%
Other Light and Power (T31)	9.33	8.12	-1.22	-13.0%
Hot Water	16.18	16.66	0.47	2.9%
Total Household Electricity	39.71	42.53	2.82	7.1%
House Heating Efficiency (degree-hours/kWh/day)	0.70	0.63	-0.06	-8.9%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	22.6	15.4	9.0	9.9	56.3%
After	23.0	17.4	8.5	11.3	61.4%
Difference between before and after	0.4	2.0	-0.6	1.4	5.2%

CASE STUDY 22
Stacey and family



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

> The real estate. The door used to whistle. All my windows. I'd say they must have had security things up on the windows or maybe even fly nets, because all the bottom, they've all got a hole that you can just about fit a 20 cent piece in. So you get all the dust and stuff from the... *(After Interview, 9 Sep 2015)*

What was the result?

Stacey and her family increased their energy use while at the same time decreased the time they spent in the comfort zone.

While at first glance it appears that Stacey reduced her heating, tables show that she increased the temperature the house was heated to. In the after period she spent more time above the comfort zone of 24°C.

Stacey hung new curtains and actively zoned areas of her house which contributed to her ability to stay warm.

✗	Energy use increased by 5.01kWh (11.4%), from 43.9kWh/day to 48.91kWh/day.
✗	Energy costs increased by ~$228 per year (from $2070 to $2298).
✗	Time spent in the comfort zone decreased from 50.1% to 44.1%.
✓	Heating efficiency increased from 0.49 to 0.60 (23.8%).
✓	Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.

Existing physical conditions of the house

The whistling made by the wind coming through the front door was unbearable and Stacey convinced her real estate to install draught-proofing. Despite significant improvement in curtain coverage and draught-proofing, the lack of insulation, poorly positioned living room and single glazing means this house continues to perform poorly.

Type	Stand alone, suburban.
Age	30-39 years.
Construction	Brick veneer, tile roof, suspended timber floor (carpet, vinyl).
Insulation	None.
Windows	Single glazed, aluminium frame.
Window coverings	Lace curtains and light curtains, improved to medium to heavy curtains throughout house.
Access to sun	Long access north west to south east, slightly blocked on the north east but otherwise all day sun, south corner living area.
Heating	Heat pump, electric blankets (5).

Changes to the home

Other changes to the home:

- Stacey had curtains that she finally got around to hanging.
- Door snakes used to stop draughts.
- At Stacey's request, real estate agent draught-proofed her 'whistling' front door.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Stacey and her children appear to have significantly changed their heater use over the course of the project. The time they spent in the comfort zone decreased (from 50.1% to 44.1%) while at the same time heating costs went up. On closer examination this is due to the increase in time Stacey and her family spent above the comfort zone of 24°C. The average winter temperature in their living room was ~28°C.

Living room temperatures increased significantly while bedroom temperatures increased only slightly. This suggests that Stacey and her family changed their zoning practices, closing doors to the living room, hanging blankets in doorways and using door snakes and draught stoppers. The draught-proofing on the doors would have also helped reduce heat loss.

Stacey explained that she had hung new curtains in the house. This would have contributed to the improved house heating efficiency – windows were the weak point of the home and thus coverings would be beneficial. Stacey noticed moisture on the bedroom windows and this is likely due to the high temperatures in the house rather than being a dew point issue. The high heat pump use is likely to be helping to keep humidity down. The significant increase in the house heating efficiency may also have been because some plug-in heating went through Other Light and Power without a heater sensor attached.

While Stacey liked to keep herself to herself, she was clearly an important person in the community with neighbours frequently dropping in to borrow items or ask for a favour. Stacey was well connected with the community and did have a home visit from one of the Energy Champions. Stacey said this was helpful but she did not attend any community events.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	1.66	0.67	–0.99	–59.6%
T 41 Heating (hard wired heating)	17.45	20.50	3.06	17.5%
Total Heating	19.10	21.17	2.07	10.8%
Other Light and Power (T31)	13.50	15.76	2.27	16.8%
Hot Water	11.30	11.97	0.67	5.9%
Total Household Electricity	43.90	48.91	5.01	11.4%
House Heating Efficiency (degree-hours/kWh/day)	0.49	0.60	0.12	23.8%

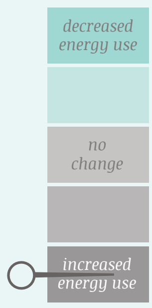
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	24.6	18.6	12.3	9.3	50.1%
After	28.4	19.1	11.0	12.8	44.1%
Difference between before and after	3.8	0.5	–1.3	3.5	–6.0%

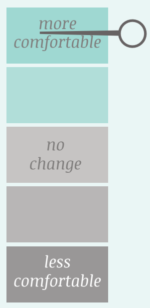
CASE STUDY 23

Monique and children

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	HARDWIRED RESISTIVE

What did we do?

COMMUNITY CAPACITY BUILDING

I just rug him up more, and put the heaters on; there's not really much more you can do, give him an asthma pump. I mean, maybe you could heat up less if he wasn't sick, possibly, maybe.

(After Interview, 9 Sep 2015)

What was the result?

Monique had high energy bills but did spend a significant amount of time in or above the comfort zone. While she did not have much financial capacity to change her home, she drew on the resources available from community organisations and her existing relationship with an Energy Champion. As a result she did make some changes to the comfort of her home through zoning, draught-proofing and a new hot water cylinder.

✗	Energy use increased by 7.41kWh/day (9%), from 82.75kWh/day to 90.16kWh/day.
✓	Energy costs reduced by ~$220 per year (from $3056 to $2836).
✗	Time spent in the comfort zone decreased from 76% to 64.8% (but time above 24°C increased in living room from 22% to 44% of time).
✓	Heating efficiency increased from 0.21 to 0.22 (2.1%) but remains fairly low.
✓	Displayed improved confidence that she could find information on thermal and energy efficiency if needed.
✗	Draughts remained problematic.

Existing physical conditions of the house

The back door has a gap underneath it of about 3cm. This contributes significantly to draughts. The house has a poor thermal performance due to single glazing and aluminium frames, limited solar access from the north, lack of effective insulation and draughts.

Type	Stand alone, suburban.
Age	30-40 years.
Construction	Brick veneer, timber frame, tiled roof, concrete floor (carpet, tiles).
Insulation	Ceiling only (batts) – unknown quality.
Windows	Single glazed, aluminium frame.
Window coverings	Curtains throughout house (heavy and lace), none in kitchen or bathroom.
Access to sun	House runs north/south axis, morning sun to living room, close neighbour on the north west, kitchen/dining west side of house.
Heating	Hard-wired radiant and fan (living), hard-wired radiant (hall).

Changes to the home

Other changes to the home:

- Sealed around the front door (by real estate agent).
- New hot water cylinder (old one was leaking).
- Windows sealed.
- Talked with the kids about saving money by reducing energy use – there is now a new household routine around this.
- Shower timer from Energy Champions.
- Hung a blanket between open dining/kitchen and living area.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Monique kept her house warm in order to help her son, who had problems, with asthma. In summer, however, the house was too hot, and she and the kids would go into the bathroom to cool down and eat icy poles. She had good community connections and used other services, such as Anglicare's kids' camps program. Her energy bills had been very high; they had been based on estimates only by the power supplier.

Monique was proactive about energy efficiency and attempted to act on the information she was given. She said her first port of call in looking for information would be Google, but one of her cousins was an Energy Champion, and she came around with a box of goodies and gave her advice. Monique also had another organisation provide advice to her about the house and as a result asked the landlord to fix the draughts around the windows. Given that she had been in the house a long time and was a 'good' tenant the landlord was happy to help.

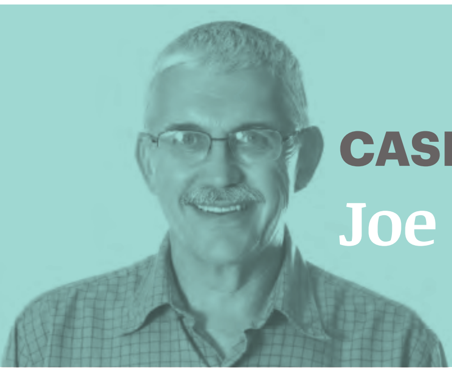
During the GBS project, Monique increased her heating use by 11.4%. She thought this might be because she had been working from home more and also because the winter had seemed a lot colder than usual. Monique's time in the comfort zone decreased from 76% to 64%, however this was because of a substantial increase in time spent above 24° (from 22% of time to 44%). The average temperature in the living room in mid-winter was 23.9° which is very close to the upper edge of the comfort zone and comparatively high for this study. A new hot water cylinder probably contributed to the small reduction in hot water usage. Monique also made use of the shower timer to encourage her kids to have shorter showers. There is also some evidence that Monique changed her zoning practices between the sensor swap.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	61.84	68.86	7.02	11.4%
Total Heating	61.84	68.86	7.02	11.4%
Other Light and Power (T31)	12.00	12.51	0.50	4.2%
Hot Water	8.91	8.79	-0.12	-1.4%
Total Household Electricity	82.75	90.16	7.41	9.0%
House Heating Efficiency (degree-hours/kWh/day)	0.21	0.22	0.00	2.1%

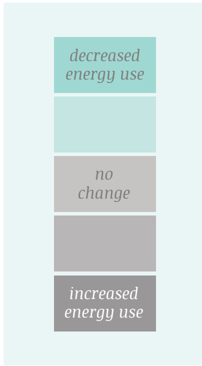
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	22.5	20.7	8.5	13.1	76.0%
After	23.9	23.2	8.7	14.9	64.8%
Difference between before and after	1.4	2.5	0.1	1.8	-11.2%

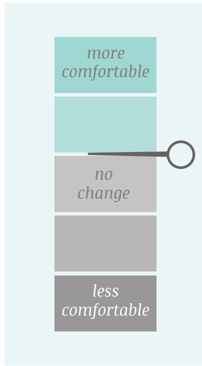


CASE STUDY 24
Joe and Beth

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER WITH MORTGAGE		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

What was the result?

Joe and Beth's house had poor thermal performance and they lived outside the comfort zone for significant lengths of the day.

Joe and Beth had access to thermal comfort and energy information through a daughter who was an Energy Champion.

It seems that Joe and Beth were not particularly interested in learning from her or participating in the program beyond the basic study. This couple had significant health problems during the project and it is likely that there simply was not the capacity to engage in any kind of education or change processes in their home.

✗	Self reported increase in energy use. (GBS was not able to conduct in-house electrical monitoring here.)
~	Time spent in the comfort zone remained fairly constant moving from 23.4% to25.8% (a 2.4% change). They also spent 26.1% of time in living above comfort zone which then reduced to 8.7% above comfort zone.
~	Heating efficiency could not be calculated from this participant.
✓	Displayed improved confidence that they could find information on thermal comfort and energy efficiency if needed.
✗	Draughts and moisture remained problematic. Moisture levels medium and mould in bedroom and bathroom.

Researcher: did [the Power Ranger] talk to you about any of the stuff [energy efficiency activities and ideas] that went on at all?

Joe: She told me- she told me about a few things. I can't remember exactly what was said now.

(After Interview 7/9/15)

Existing physical conditions of the house

Temperature near dew point at intermittent points June to Sept in the living area (but with a peak of 65% humidity). This may be due to the moisture coming from the kitchen, which is open plan with the living area. The bedroom had intermittent points where temp near dew point with peaks of 75% humidity. Temp in the bedroom low in winter. Mould reported in the end bedroom (had to move the bed) and bathroom.

Joe and Beth's house's single glazing and limited insulation, and mould issue lead to it having a poor thermal performance. The heat pump did assist somewhat to improve performance.

Type	Stand alone, suburban.
Age	30-39 years.
Construction	Brick veneer, timber frame, tile roof, suspended timber floor (1.0m off ground) (carpet, vinyl) , solar panels.
Insulation	Ceiling batts (2009).
Windows	Single glazed, aluminium frame.
Window coverings	Lace and curtains (medium) in dining, curtains/venetian blinds (bedrooms).
Access to sun	All day access to sun, main living room on north west but no north window (only afternoon sun).
Heating	Heat pump (living).

Changes to the home

Other changes to the home:

- No changes made.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Joe and Beth were the parents of one of the Energy Champions. They had lived in the house for many, many years and had regular practices of zoning, heating only the areas they used.

Joe and Beth noted damp windows at the back of the house and continued to have medium levels of mould and moisture.

Energy use in the house was affected by Joe being ill and the presence of grandchildren in the home.

Joe and Beth had strong networks in the area and would have been able to access information on energy efficiency and thermal comfort if needed. That they didn't utilise these networks indicates both their long term residence in the home and their established domestic patterns and also reflects their poor health; they simply did not have the capacity to make changes and continue to work and pay the bills.

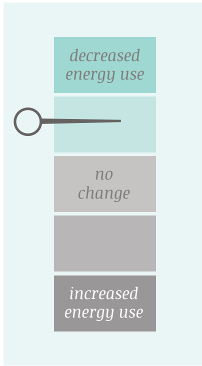
Prior to the second interview, Joe and Beth hung curtains in their home that they had had sitting around for some time.

Average daily temperatures and time in comfort zone during winter conditions

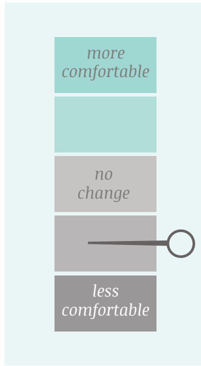
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	20.8	11.4	11.3	4.8	23.4%
After	19.4	10.0	10.8	3.9	25.8%
Difference between before and after	-1.4	-1.4	-0.5	-0.9	2.4%

CASE STUDY 25
Nancy and partner

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
2	OWNER WITH MORTGAGE	4	FREESTANDING TWO STOREYS	WOOD FIRE

What did we do?

COMMUNITY CAPACITY BUILDING

Oh yeah, I'm very methodical with information.

(After Interview, 8 Sep 2015)

What was the result?

Nancy and her partner have decreased their energy use and decreased the time they spend in the comfort zone. Given that they use a wood heater to heat the home these two things are not necessarily related. It is unclear why their energy use declined. Nancy has been very ill and she and her husband are always looking for ways to improve the home – it is likely this has led to a dynamic energy use within the home.

✔	Energy use decreased by 0.65kWh/day (2.9%), from 22.66kWh/day to 22kWh/day.
✔	Energy costs reduced by ~$6 per year (from $1244 – $1238).
✘	Time spent in the comfort zone decreased from 50.5% to 44.7%.
~	Given the wood heater, heating efficiency is not accurately measured for this home.
✔	Displayed improved confidence that she could find information on energy efficiency and remained confident that she could access information on thermal comfort if needed.

Existing physical conditions of the house

Nancy and her partner had installed solar panels and solar hot water so that in the future as they got older they would have smaller electricity bills. This house was well maintained and had good solar access. However, in summer, despite insulation in the ceiling and sisalation in the walls, the upstairs rooms of the house were very hot and the single glazed aluminium frames and the lack of insulation in the older part of house meant the thermal performance of the house was poor and was particularly problematic in summer.

Type	Stand alone, suburban.
Age	30-40 years.
Construction	Brick veneer, timber suspended floor, floorboards (tiles, carpet), corrugated metal roof.
Insulation	Ceiling, sisalation in upper walls.
Windows	Single glazed, single tinted, aluminium frame.
Window coverings	Vertical blinds/thick curtains throughout, venetian blind (kitchen).
Access to sun	All day sun to living room/kitchen/sun, hedge on the north blocked some sun.
Heating	Wood heater

Changes to the home

Other changes to the home:

- New curtains.
- Changed many light bulbs to LEDs.
- Ecoswitch that Nancy got from the newsagent in a small country town.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Nancy and her partner were in control of how they managed their home and were careful forward planners. They had chosen to install solar panels and solar hot water so that in the future, they would have reduced electricity bills. They were also contemplating installing a heat pump or another kind of electric heater because Nancy's husband was increasingly less able to keep up with the demands of a wood fire (currently their wood supply came from a second property and so there was lots of work involved). If they had the money, Nancy said they would also put in under-floor insulation.

Nancy had a strong local community, although a serious illness had prevented her from attending any Get Bill Smart activities. However, an Energy Champion had knocked on her door and she said this had made a difference to her level of energy consciousness.

The data showed that the average indoor temperature in the home fell by about 1°, although it remained within the comfort zone. The time spent in the comfort zone overall also fell, although it remained relatively high at 44.77%, and time spent above the comfort zone reduced as well. The reason for the 7.7% reduction in other light and power usage is not clear, although it may be related to the solar panels.

Average daily energy use and heating efficiency during winter conditions

	Before	After	Change	Change
	(kWh/day)	(kWh/day)	(kWh/day)	(%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	0.00	0.00	0.00	0.0%
Total Heating	0.00	0.00	0.00	0
Other Light and Power (T31)	14.36	13.26	–1.10	–7.7%
Hot Water	8.30	8.75	0.45	5.4%
Total Household Electricity	22.66	22.00	–0.65	–2.9%
House Heating Efficiency (degree-hours/kWh/day)				

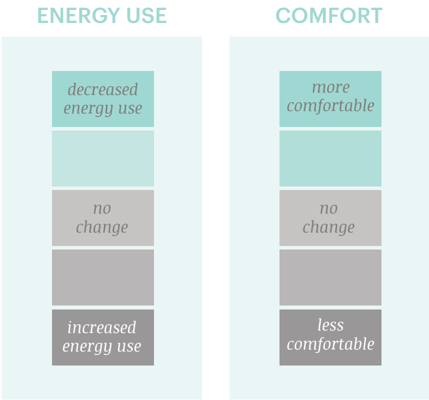
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	22.7	17.4	11.6	7.6	50.5%
After	21.8	16.6	10.8	7.5	44.7%
Difference between before and after	–0.9	–0.9	–0.8	–0.1	–5.8%

CASE STUDY 26

Robert and partner/ Selena and family

(2 families using the same house consecutively)



Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

What was the result?

Robert and partner and Selena and family both occupied this house at different times.

They had very different energy use and very different thermal comfort. Robert's household was rarely in the comfort zone and used very little energy. Selena's household was sometimes in the comfort zone and used significantly more energy. The comparison of different people in this home shows how poorly the house performed in terms of thermal comfort and energy efficiency.

Moisture and mould was a huge problem for both households.

- ~ Energy use changed from 13.08kWh/day to 41.77kWh/day.
- ~ Time spent in the comfort zone changed from 3.8% to 27.2%.
- ~ Heating efficiency changed from 3.39 to 0.79.
- ~ Robert and partner were slightly more confident than Selena and family that they could find information on thermal comfort and energy efficiency if needed.
- ~ Draughts were problematic for both Robert and partner and Selena and family.

> I mean we're a bit concerned about how much moisture there is like whether it's going to start growing mould or not because in the bedroom it was quite you could actually see the wall. It was all glossy and shiny. That's not good.
>
> *(Robert, Before Interview 20/05/2014)*

Existing physical conditions of the house

From the evidence from the householders and observation of the poor thermal performance of the building materials this house performs at a very poor level. The suspended timber floor is just above ground and as a result significant moisture is likely coming up from below. This moisture has led to problematic levels of mould in the bedrooms.

Robert and his partner suspect that prior to them renting the house the landlords simply painted over the mouldy walls.

Type	Stand alone, suburban.
Age	30-39 years.
Construction	Weatherboard, corrugated metal roof, suspended timber floor (polished floorboards, tiles, carpet), old brick chimney, small block skirt around underfloor.
Insulation	Possible ceiling.
Windows	Single glazed, wood frame.
Window coverings	Curtains (heavy), venetians (kitchen).
Access to sun	Main living access to northern sun, all day sun, long axis is east west.
Heating	Heat pump.

Changes to the home

Other changes to the home:

- This house went from being occupied by a young couple (renters), to being occupied by a couple with two young children (owners with a mortgage).

GET BILL $MART UPGRADES

Not relevant for these participants.

Overview

It is interesting to look at how one house performs with two different occupants. Robert and his partner were in their early twenties. They were both new to the area and found it hard to integrate into the community. Both spent significant amounts of time at home studying.

Selena and her partner were in their late twenties with two small children. They were also relatively new to the area and had found it difficult to connect with the community. Selena and the kids spent significant time at home.

While both households were at home for many hours of the day, their energy use differed substantially. Selena and her family reported spending more than twice as much on electricity than Robert and his partner; ~$50 per week compared with ~$20 per week. While some of this can be attributed to the extra people in the home, it also reveals the different priorities, capacities and management strategies of the householders.

Robert and his partner were often at home during the day but they would be in the small bedroom with blankets, computers and occasionally a small plug in heater. The computers generated some heat in the small space and it was easy to contain the warmth. Selena would have had much more trouble containing the heat as her two young children could not just be kept in one small room all day.

Both households made use of blankets and rugs.

Selena and her family spent considerably more time in the comfort zone (27.2%) than Robert and his partner (3.8%). This is reflected in energy use. That both households spent such little time in the comfort zone suggests both incredibly poor thermal performance of the house and low financial capacity of householders.

Selena's household also used considerably more hot water than Robert's. It may be that this increase is not just an increase in household numbers but a change in the way hot water is used. For example Selena's family may have taken more baths. The hot water system may also have deteriorated.

The house as occupied by both households often reached dew-point in the living and bedroom areas. Humidity ranged between 40-90% in the living room and 50-95% in the bedroom. This suggests moisture was coming up through the floors. Both households noted the significant mould problem and found moisture difficult to manage.

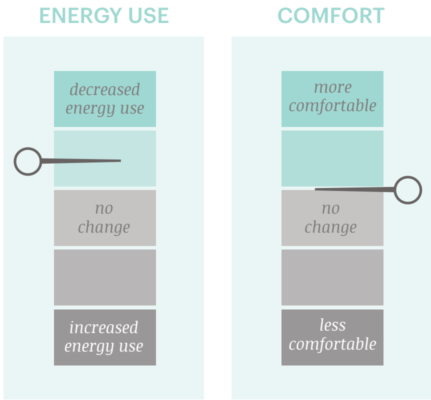
Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.46	0.00	-0.46	-100.0%
T 41 Heating (hard wired heating)	0.68	9.71	9.03	1325.0%
Total Heating	1.14	9.71	8.57	750.2%
Other Light and Power (T31)	6.28	14.16	7.88	125.4%
Hot Water	5.65	17.89	12.24	216.6%
Total Household Electricity	13.08	41.77	28.69	219.4%
House Heating Efficiency (degree-hours/kWh/day)	3.39	0.79	-2.60	-76.7%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	12.8	12.9	9.0	3.9	3.8%
After	17.0	15.1	8.4	7.7	27.2%
Difference between before and after	4.3	2.2	-0.5	3.8	23.4%

CASE STUDY 27
Pam and family



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HEAT PUMP

What did we do?

COMMUNITY CAPACITY BUILDING

> When we moved in, the curtains to keep the draughts out the doors were already up, to keep the heat in. Yeah, so we didn't have to do a lot here, actually, which was really good. It already had the draught stoppers along the bottom of the doors.
>
> *(After Interview 21/09/2015)*

What was the result?

Pam and her family moved into their house in search of a warmer more functional home (see Case Study 14 for previous household experience). The family was much happier in the new home and while the house doesn't actually perform particularly well, thanks to the heat pump they can live relatively comfortably.

Pam's understanding of key energy efficiency and comfort features had helped her choose the new house.

- ✔ Energy use decreased 63.21 to 57.87kWh by 5.34kWh (8.5%).
- ✔ Time spent in the comfort zone slightly increased from 80.0% to 82.0%. This is a high level of time in comfort zone.
- ✔ Heating efficiency increased from 0.32 to 0.35(8.2%).
- ✔ Displayed improved confidence that she could find information on thermal comfort if needed.

Existing physical conditions of the house

The position of the living area, single glazing and the high uninsulated suspended floor over the garage creates an uncomfortable indoor winter environment.

While the physical house is in better condition than many in the area, it still performs at a poor level.

Type	Stand alone, suburban.
Age	30-40 years.
Construction	Brick veneer walls, corrugate metal roof, floor (height), unused chimney.
Insulation	Unknown, suspected none.
Windows	Single glazed, aluminium frame.
Window coverings	Vertical blinds, blinds and curtains.
Access to sun	Northwest to south east long axis, living to west with afternoon sun access. 1 shed north west blocks a little sun (to kitchen).
Heating	Heat pump in living, radiant fan in hall.

Changes to the home

Other changes to the home:

- No changes.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Pam and her family moved into this house in search of a more comfortable home. So confident was she that the house would be functional that she turned down the GBS in home education and upgrade.

The house worked well and Pam explained that they felt comfortable in winter with the heating on. Pam's family spent 82% of their time in the comfort zone (a slight increase from 80%). While time in the comfort zone increased, overall energy use decreased. House Heating Efficiency decreased by ~8% from 0.32 to 0.35.

Use of the heat pump decreased by 16% (from 22.1kWh/day to 18.44kWh/day) while use of the plug in heater increased from 6.12kWh/day to 9.2kWh/day (50.3%).

All other energy decreased.

Pam and her family were energy conscious and were careful in how they zoned and heated their home. This was a household who had previously received an in home education and upgrade as a part of the GBS project. As a result they were likely to have retained some knowledge of energy efficient practices. Indeed, Pam spoke directly about energy features in regards to the new house.

This was not a house that performed well but it did perform better than Pam's previous home. The family was comfortable for a good period of time and felt confident in their management practices. They did also manage to reduce their energy consumption over the after winter period.

Pam did not attend any community run GBS events as she was pregnant and then had a new born baby as well as looking after her other children.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	6.12	9.20	3.08	50.3%
T 41 Heating (hard wired heating)	22.10	18.44	-3.66	-16.5%
Total Heating	28.22	27.64	-0.58	-2.0%
Other Light and Power (T31)	21.15	17.42	-3.73	-17.7%
Hot Water	13.84	12.81	-1.03	-7.4%
Total Household Electricity	63.21	57.87	-5.34	-8.5%
House Heating Efficiency (degree-hours/kWh/day)	0.32	0.35	0.03	8.2%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	20.4	18.4	10.3	9.1	80.0%
After	20.8	18.4	10.0	9.7	82.0%
Difference between before and after	0.4	0.0	-0.3	0.5	2.0%

Cases 28–39

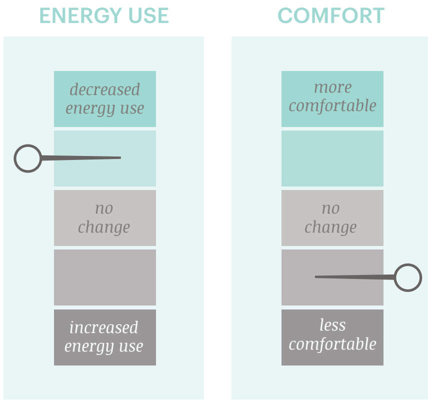
HOME ENERGY UPGRADES

GBS support activities for these cases were:

1. Home energy upgrade/ education visits by experienced home energy helpers.

Houses in this case group were all living in suburbs of the Greater Hobart region. None of these households had homes in the suburbs of Clarendon Vale and Rokeby and none of these households were directly exposed to community capacity building activities held.

CASE STUDY 28
Gabrielle and daughter



	RENTER		FREESTANDING ONE STOREY	HARDWIRED RESISTIVE + HEAT PUMP
Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

IN HOME EDUCATION & UPGRADES

> I'm always thinking, turning lights off when they're not being used, and yeah, just being careful I guess.
>
> *(After Interview 31/08/2015)*

What was the result?

Gabrielle and her daughter reduced their energy use and costs but their thermal comfort also decreased.

Gabrielle's household was dynamic over the project as her mother came to visit for long periods, the sensors were moved around the house and she recovered from a broken leg.

Gabrielle felt that little changed as a result of her participation in the project but the tips were helpful reminders of what she could do around the home.

✓	Energy use reduced by 1.60kWh/day (10.2%) from 15.71kWh/day to 14.1kWh/day.
✓	Energy costs reduced by ~$195.
✗	Time spent in the comfort zone decreased from 12.6% to 7.5%.
✗	Heating efficiency decreased from 0.40 to 0.34.
~	Maintained confidence that she could find information on thermal comfort.
~	Maintained lack of confidence that she could find information on energy efficiency.
✗	Self-reported moisture levels increased (medium – high) and mould appeared. Home Energy Helpers reported mould issue in bedroom. Occasional high humidity measured (higher in bedroom).
~	Draughts reduced but remained problematic.

Existing physical conditions of the house

Gabrielle and her daughter live in one story suburban stand alone house that is approximately 60 years old. The house receives sunlight, with best access in the morning. The living area is on the north east and mainly receives sunlight from the northeast through a window. The house is timber framed with weatherboard cladding, has a corrugated iron roof and a suspended timber floor (covered with carpet, vinyl and tiles).

The house has thin loose fill insulation in the ceiling. Heating is provided by a fan heater, electric blankets (2) and a heat pump.

In winter without heating the house is reported as never comfortable with draughts. With little insulation and only some solar access this house has poor thermal performance.

Insulation	Loose fill thin ceiling only.	POOR
Windows	Single glazed, old timber frames, pelmets.	NEAR STANDARD
Window coverings	Curtains and venetians. Backing on curtains in living.	NEAR STANDARD
Under floor space	Timber suspended 1.0m high, enclosed with block, no insulation.	POOR
Mould and moisture	Self-reported medium moisture levels in living area reported and some mould appeared in the bedrooms in the after period. Intermittent points where temp comes near or would reach dew point. Winter humidity in bedroom got to 90% and in living to 80% which is very likely to cause condensation on cold surfaces.	POOR
Other conditions of note	Noticeable draughts. Generally uncomfortable indoors.	POOR
	Generally maintained to a reasonable standard.	

Changes to the home

Other changes to the home:

- Gabrielle bought a plug in heater to take chill off bedrooms and so her mother was warm when visiting.
- Gabrielle called a plumber to turn the hot water down.
- Gabrielle bought 2 electric blankets July 2014.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Small fridge thermometer
- ✔ Draught proofing of windows
- ✔ Stay Warm education booklet
- ✔ Lights changed
- ✔ Eco-switch
- ✔ Shower timer
- ✔ Door snakes

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.06	0.13	0.07	110.3%
T 41 Heating (hard wired heating)	5.95	4.35	-1.60	-26.8%
Total Heating	6.01	4.48	-1.53	-25.4%
Other Light and Power (T31)	4.75	5.16	0.41	8.7%
Hot Water	4.95	4.46	-0.49	-9.8%
Total Household Electricity	15.71	14.10	-1.60	-10.2%
House Heating Efficiency (degree-hours/kWh/day)	0.40	0.34	-0.07	-16.7%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.2	11.6	12.0	2.4	12.6%
After	13.6	11.2	10.9	1.5	7.5%
Difference between before and after	-3.6	-0.4	-1.1	-0.9	-5.1%

Referring to the tables and graphs presented, changes were observed in energy use and comfort. Overall electricity reduced from 15.71 to 14.10kWh/day which was a 1.60kWh/day saving (10.2%). Both before and after total energy use is much lower than average or median use in the Greater Hobart upgrades group. The percentage change in electricity use is higher than the average but less than median for this same group.

House heating efficiency decreased by 16.7% from 0.40 to 0.34. This decrease was caused by changes to the way Gabrielle was using her heaters and where they were positioned. The change in heater use is apparent on the example before and after graphs when compared.

Time spent in the comfort zone also decreased, from 12.6% to 7.5% (-5.1%) with no time spent above 24°C meaning Gabrielle and her daughter spent little time above 18°C during winter. The average temperature of the living room in the after period was 13.6°C, a drop of 3.6°C when compared to the before period. The bedroom temperature remained at ~11°C.

The before/after data shows there was a change in heating practices which was likely inspired by the cold temperatures Gabrielle and her daughter are living in. Living room heat pump use decreased slightly from 5.95kW/day to 4.35kWh/day (a decrease of 26.8%). In addition, Gabrielle bought 2 electric blankets in July 2014 and then also got a plug in heater to use in the hallway (to warm bedrooms) and to keep her mother comfortable when visiting. The before graph shows that the bedroom tracks with, or even below, outside temperatures and that the only room kept warm is the living area (using the heat pump). The temperature in the bedroom tracking with outside temperatures indicates very poor thermal resistance in the house. In the after graph while part of each day in the living and the bedroom still tracks just above outside, the bedroom temperature is now being heated for part of the day as is the living room. In the after graph heating in the living room is not being sustained for as long as it was in the 2014 winter and both the bedroom and living are going through cycles of peaks and troughs.

The before period heating was likely affected by the fact that Gabrielle had a broken leg at that time and was spending a lot of time in the at home in the living room. Gabrielle's concern over her mother being ill when at her house motivated changes in the after period.

Sensors were installed on the electric blankets and registered as the (0.7 kWh/day, 110%) increase in plug in heating. The Get Bill Smart team was not aware of the new plug in heater, and it is therefore only registered as part of the Other Light and Power, which increased 0.41 kWh/day.

The light on one of the temperature and humidity sensors bothered Gabrielle's daughter and so Gabrielle moved the sensor to a different room. This means the data collected on temperature in the bedrooms will not necessarily correlate to use in the daughter's bedroom, but does give an idea of how cold these rooms can get.

On her mother's advice Gabrielle employed a plumber to lower the thermostat on her hot water heater. Hot water decreased by 9.8%, from 4.95kWh/day to 4.46kWh/day (a reduction of 0.49kWh/day).

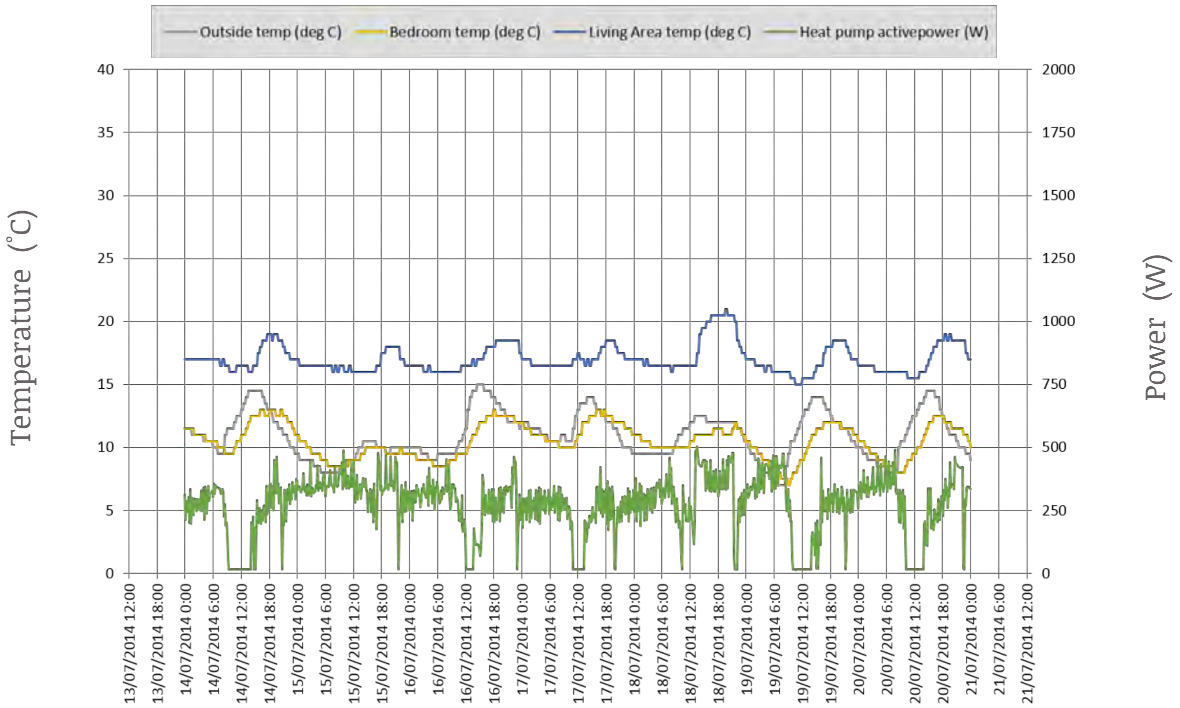
Condensation appeared to be a developing problem in the house. Gabrielle originally reported medium moisture levels in the living area and later reported increased moisture levels and some mould in the bedroom. HEHs visiting during the upgrade also reported mould in the bedroom. Measurements taken in the living and bedroom show there were intermittent points where temp came near, or reached dew point. While these were only intermittent points, winter humidity in bedroom got to 90% and in living to 80% in the after period. This high level of humidity was controlled for periods in the living room by the use of the heat pump. Humidity levels of around 80%–90% can cause surface condensation even when the measured air temperature does not reach dew point. Single glazing is most vulnerable, but walls and ceilings can also become wet. Indeed living room winter humidity was better constrained in the before (2014) winter because of the way the living room heater was being used at the time.

Changes to room use, movement of the unmonitored plug in heater and the moved bedroom sensor have made it harder to capture the heating and temperature patterns in this house. However, it is clear that Gabrielle changed her patterns of heating and lived in a cold thermal environment in a house that had little heat resistance.

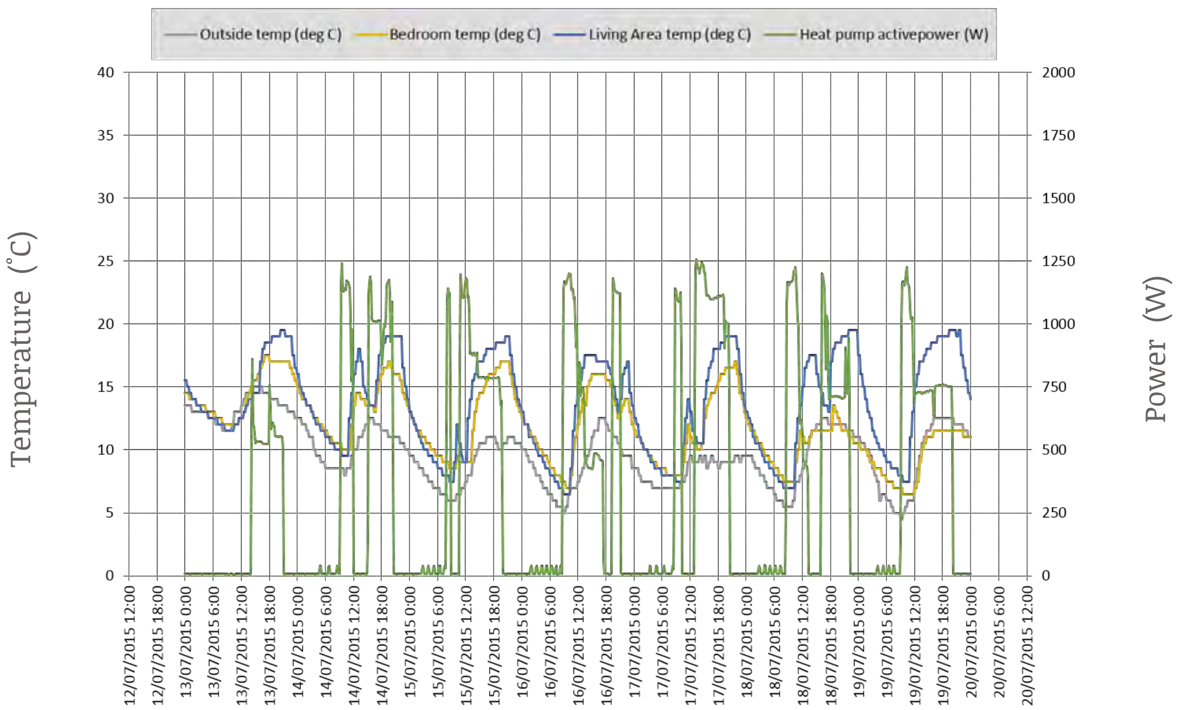
> We had my mum over in, I think July... What I was doing was having this heater on and closing off the lounge room door. But the rest of the house was absolutely freezing, and when mum came over, she actually got an upper respiratory tract infection. *(After Interview 31/08/2015)*

> [With the heater we are] comfortable in the lounge room, because we close the door off, but uncomfortable in the rest of the house. *(Before Interview 20/05/2014)*

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Personal and community change

As a single mother Gabrielle had a limited income and was very conscious of her energy use. When we first met she said,

> I must admit, I'm a bit, not paranoid, but concerned when I do put the heater on, like sometimes I've got to have it on all day and I'm just thinking, what's going to happen when the next bill comes through? I mean it's got an economy cycle and that to it but it's just when money's tight, you know, you do get concerned.
>
> *(Before Interview 20/05/2014)*

Billing data from the electricity retailer indicates that Gabrielle reduced her annual energy bills by approximately $195 per year.

The second time we spoke to Gabrielle she was still concerned about her bills but felt that she was on track with her energy usage saying,

> My bill, I think the last one was about $200 and something.... I think it's pretty good. Yeah because what did they say, you know how they have a one person household, two person, stuff like that. I think ours was like equivalent to a one person household or something *(After Interview 31/08/2015).*

Gabrielle's bills decreased as expected by her decreased energy use.

Personal and community change

When we met Gabrielle she had recently broken her foot. She and her daughter were new to Tasmania and did not have established networks. Gabrielle's mother visited to help out with her broken foot, staying for long periods of time at intervals over the course of the GBS project.

Given her restricted mobility, Gabrielle was likely to have felt the cold more than usual and this may have informed how she heated her home in the before period. Gabrielle did not feel she had full control of the thermal comfort and energy efficiency of her home and thought the house was poor performing. She connected illnesses they had to their cold house. Certainly, the house was cold, with temperatures often sitting under 18°C. Being ill would have, in turn, affected how they managed the home. We saw Gabrielle trying to adjust winter heating practices in the after period to try and improve comfort. She also bought electric blankets and a plug in heater to heat the other end of the house.

Prior to the visit by the Home Energy Helpers Gabrielle was energy conscious not only because she needed to be financially, but for environmental reasons as well. She said,

> We all play a part don't we, in the big global impact.
>
> *(After Interview 31/08/2015)*

Personal and community change

While Gabrielle had some upgrades to her home as a part of the Get Bill Smart project, she did not feel like much had changed afterwards. She noted that the draughts had improved slightly but were still problematic. In fact she removed some of the draught proofing around the doors because it made the door catch as it opened and closed.

While the upgrades did not make a huge difference to the home for Gabrielle, she felt the HEHS had helped to reinforce her prior awareness and consciousness around energy efficiency and thermal comfort. She said,

> There was a few sort of handy hints, which sort of I guess helped a bit. *(After Interview 31/08/2015)*

Gabrielle pointed out that other needs could get in the way of efficient behaviours. She knew, for example, that closing the curtains helped to keep the heat in, but explained that it was also important to her that the room was light. She said,

> I mean I know I should have the curtains closed, because the heats going out with that, but I like to have light in. *(After Interview 31/08/2015)*

Gabrielle's sense that there were people in her community who could help her with energy efficiency and thermal comfort declined over the course of this project. This decline may have been due to her increased isolation for the period she was stuck inside with her broken foot and the persistent discomfort she felt in her house even after the Home Energy Helper visit.

When we first met, Gabrielle noted that many people in her street had lived there a long time and as such were a bit wary of newcomers. Her status as a renter she felt also affected how welcome she was in the community.

She explained,

> The trouble is too, when you rent sometimes they don't want to... [They think] oh they're going to shift out sometimes too. *(Before Interview 20/05/2014)*

Gabrielle noted in the after period that she had not made a huge effort recently to engage with the community but that this was something she planned to do. She said,

> I don't know, I guess I just sort of more or less keep to myself, I don't reach out to the community. *(After Interview 31/08/2015)*

Gabrielle was keen to live in a warmer house but was limited by her rental status and her income. Prior to the GBS project she was already attempting to improve energy efficiency and keep her energy bills low. The design of her house was such that it was difficult to heat and felt very draughty.

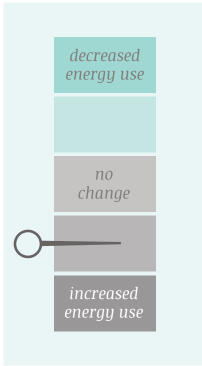
While Gabrielle herself did not get a huge amount out of her participation in Get Bill Smart, she recognised it might be of great value to others saying,

> I just think it's a great program. I think it could definitely help a lot of people in lower income households. And it's just a way of making people aware of how to save energy and be more energy efficient. *(After Interview 31/08/2015)*

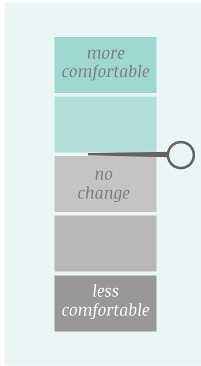
CASE STUDY 29

Patricia

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	RENTER	4	FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + WOOD FIRE

What did we do?

IN HOME EDUCATION & UPGRADES

> It makes it harder to breathe [when it is cold]. That some nights, you know, I'm fully dressed and I have two dressing gowns on too, [but this has] improved.
>
> *(After Interview, 07/09/2015)*

What was the result?

Patricia used minimal energy to heat her home and her home performed very poorly. As a result she was very uncomfortable for most of the time.

While temperature data collected shows minimal changes to comfort, Patricia was very clear that she felt more comfortable after the home upgrade visit.

✗	Energy use increased by 1.75kWh/day (18.5%), from 9.48kWh/day to 11.23kWh/day.
✓	Energy costs reduced from by ~$35 per year (likely due to reduced tariff).
✗	Time spent in comfort zone remained at 1.1% (self-reported increase in comfort).
~	Heating efficiency increased from 13.33 to 18.29, but this only looks good because Patricia went from NEVER heating to only occasionally heating. These figures are NOT indicative of a good house performance.
~	Confidence that she could find information on energy efficiency and thermal comfort remained low.
✓	Self reported moisture levels decreased.

Existing physical conditions of the house

The position of the living area, single glazing, aluminium frames and lack of insulation, along with Patricia's practice of leaving a door slightly open for her animals, means this house has a very poor thermal performance. However the thermal performance was improved slightly by an upgrade.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Concrete blocks, tile roof, suspended timber floor (carpet).
Insulation	Unknown (suspect none).
Windows	Single glazed, aluminium frame.
Window coverings	Vertical blinds (added curtains to living and bedroom during project).
Access to sun	Some morning and afternoon sun however living room only receives late afternoon sun.
Heating	Has wood heater which smokes too badly to use, rare use of a plug-in heater, electric blanket.

Changes to the home

Other changes to the home:

- New curtains around the house.
- Curtains in doorways to retain heat.
- A new plug-in electric heater in living area.

GET BILL $MART UPGRADES

- ✔ Draught-proofing of doors
- ✔ Small fridge thermometer
- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklet
- ✔ Hot water valve cosy
- ✔ Ecoswitches (2)
- ✔ Lights changed
- ✔ Curtains
- ✔ Shower timer
- ✔ Door snakes

Overview

Patricia is in her 60s and lives with her dogs, cats, birds and chickens. The animals are very important to Patricia and she manages her home with their comfort in mind. She leaves the doors open slightly so the cats can come and go and sacrifices her own well-being in order to afford the cost of pet ownership.

Prior to the Get Bill Smart upgrades Patricia was extremely cold. Her wood heater is dysfunctional as it leaks large amounts of smoke into the house and thus it goes unused. Patricia now occasionally uses a new plug in heater in the living room because she has learnt to zone off areas to contain the heat. As a result she occasionally is slightly warmer. The Home Energy Helpers managed to significantly improve Patricia's draught problems which she has noted has helped her comfort levels.

The energy use table below highlights how little Patricia heated her home. The average indoor and outdoor temperatures are only a couple of degrees above the average outdoor temperatures. Patricia is spending 99% of her time in temperatures below 18°C. Indeed, the average indoor temperature for the living room in mid-winter remained at 11.7°C.

Patricia did not feel that there were people in her community whom she could talk to about thermal comfort and energy efficiency. Similarly she did not feel she lived in a strongly connected community. Both these measures did improve slightly over the course of the project.

Patricia sits well below both the median and the average in terms of energy use for both the group receiving Home Upgrades and Community Capacity Building, and all participants in the project.

Average daily energy use and heating efficiency during winter conditions

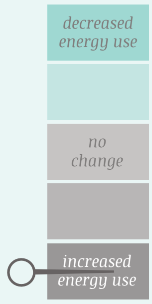
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.21	0.14	–0.07	–32.4%
T 41 Heating (hard wired heating)	0.00	0.00	0.00	0.0%
Total Heating	0.21	0.14	–0.07	–32.4%
Other Light and Power (T31)	5.91	6.79	0.88	14.9%
Hot Water	3.35	4.29	0.94	28.0%
Total Household Electricity	9.48	11.23	1.75	18.5%
House Heating Efficiency (degree-hours/kWh/day)	13.33	18.29	4.96	37.2%

Average daily temperatures and time in comfort zone during winter conditions

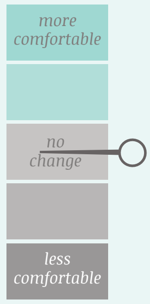
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	11.7	11.0	8.6	2.8	1.1%
After	11.7	10.7	8.6	2.6	1.1%
Difference between before and after	0.0	–0.4	0.0	–0.2	0.0%

CASE STUDY 30
Yvette and Gerard

ENERGY USE

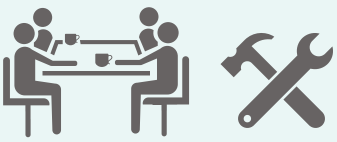


COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
2	OWNER	3	FREESTANDING ONE STOREY	HARDWIRED RESISTIVE + HEAT PUMP

What did we do?



IN HOME EDUCATION & UPGRADES

> And we put these shutters down too. They keep a lot of the cold out. And the warmth in and, yeah. And they're good in summer too. When it's roasting hot we put them down sort of two-thirds of the way and it keeps a lot of the heat out as well.
>
> *(After Interview, 2 Sep 2015)*

What was the result?

Yvette and Gerard managed their home for energy efficiency and thermal comfort as well as they could, given the physical limitations of the house.

Gerard's health issues influenced the way they heated their home and their capacity to make use of sunlight.

Their energy use increased primarily due to an increase in hot water usage – likely due to an increasingly faulty hot water system.

- ✗ Energy use increased by 9.8kWh (21.1%), from 34.81kWh/day to 44.61kWh/day.
- ✗ Energy costs increased by ~$232 per year ($2157 – $2389).
- ~ Time spent in the comfort zone remained constant at 14.7-14.1%.
- ~ Heating efficiency remained constant at 0.85-0.86.
- ✓ Displayed improved confidence that they could find information on thermal comfort if needed.
- ✓ Draughts reduced (some to none).

Existing physical conditions of the house

The position of the living area, single glazing and the need to keep curtains and blinds closed means this house performs at a poor level. Temperatures in the home are able to reach dew point and this is likely to the house being closed up to keep internal spaces dim coupled with the open plan living/kitchen space. Use of the heat pump however seems to have kept humidity to only 75% which is lower than many houses in this study.

Type	Stand alone, suburban.
Age	30-39 years.
Construction	Brick veneer, corrugated iron roof, suspended timber floor (vinyl, carpet).
Insulation	Ceiling (cellulose, old), some floor insulation (batts, kitchen/living).
Windows	Single glazed, aluminium frame.
Window coverings	Lace curtains, curtains (living room – medium weight), venetian blinds, external shutters.
Access to sun	Long access north to south, sheds on north and west mean only morning sun.
Heating	Heat pump (living), plug-in heater (study), wired-in heater (shed), electric blanket (2).

Changes to the home

Other changes to the home:

- Installed three internal draught stoppers on doors (prior to the upgrade).
- Replaced some energy efficient lights with original globes.
- Yvette and Gerard bought a new fridge in Jan 2015 when their fridge of twenty years broke.

GET BILL $MART UPGRADES

- ✔ Draught-proofing of doors
- ✔ Stay Warm education booklet
- ✔ Hot water valve cosy
- ✔ Lights changed
- ✔ Shower timer
- ✔ Door snakes
- ✔ Small fridge thermometer

Overview

Yvette and Gerard had lived in their home since it was built in 1980. Retired now, they spent a lot of time at home in the living room, Yvette's craft room or Gerard's shed out the back.

Gerard had a chronic illness that affected how they managed their home. Key symptoms included sensitivities to both light and cold. As a result Yvette explained that they rarely opened the curtains in the living room in order to keep a comfortable home environment for Gerard. Similarly they felt it was important to maintain a warm living space to keep Gerard comfortable.

Yvette and Gerard spent 14% of their time in the comfort zone (temperatures between 18°C and 24°C). The average peak winter temperature of the living room was 19.2°C. Yvette explained that they used the heater when they needed to but also made an effort to use blankets and warm clothing before resorting to heating.

The House Heating Efficiency is quite good at ~0.85. The multiple layers of window coverings – curtains, blinds and external shutters – would have improved the thermal resistance of the living area. The insulated nature of the shutters may also have helped to reduce window condensation which was noted as only being a minor problem.

Hot water use increased significantly (by 60%). When we first spoke to Yvette she explained that their hot water system was just about to blow up. Detailed energy use data shows the hot water turning on and off again and unusual high frequencies indicating that it is likely faulty.

Gerard was a handyman and during times of better health had insulated underneath the open plan living area with batts. While it would have been a financial squeeze, he wanted to insulate the ceiling of the house but was physically no longer able to do so.

Yvette and Gerard appreciated the home upgrades but did change some of their light bulbs as they found the energy efficient ones too dim.

Yvette and Gerard were involved in the local community but did not think that there were people they could ask about energy efficiency or thermal comfort. They said that they would talk to their daughter, get an electrician or look on the internet.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.93	0.57	–0.36	–39.0%
T 41 Heating (hard wired heating)	5.24	6.88	1.64	31.2%
Total Heating	6.17	7.44	1.27	20.7%
Other Light and Power (T31)	15.07	15.40	0.32	2.1%
Hot Water	13.56	21.76	8.20	60.5%
Total Household Electricity	34.81	44.61	9.80	28.1%
House Heating Efficiency (degree-hours/kWh/day)	0.86	0.85	0.00	–0.1%

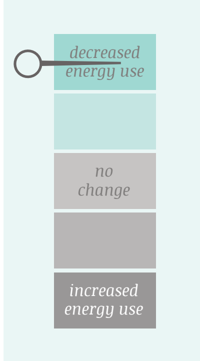
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.3	13.0	10.3	5.3	14.7%
After	19.2	13.1	9.8	6.4	14.1%
Difference between before and after	0.9	0.1	–0.6	1.1	–0.7%

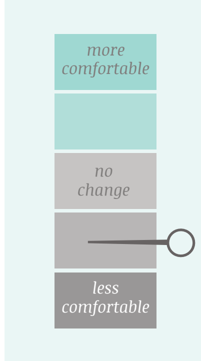
CASE STUDY 31

Hazel

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	HARDWIRED RESISTIVE + HEAT PUMP

What did we do?

IN HOME EDUCATION & UPGRADES

> Oh yes, yes, I am more up with it now. You know, I just was power's power, but now I can see how you can save. See because I've also got a new shower thing, so that's saving too.
>
> *(After Interview 31/08/2015)*

What was the result?

Hazel decreased her energy use partially as a result of the in home education and upgrades and partially due to the departure of her daughter and grandson who had been living with her.

Hazel was pleased to have regained control of energy use in her home and found the educational components of the program useful for managing the heat pump.

- ✔ Energy use decreased by 10.94kWh/day (36.5%) from 29.97kWh/day to 19.40kWh/day.
- ✔ Energy costs reduced by ~$317 per year ($1439-$1122)
- ✘ Time spent in the comfort zone decreased from 19.4% to 13.3%.
- ✘ Heating efficiency decreased from 0.71 to 0.64 (10%).
- ✔ Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
- ✔ Draughts reduced.

Existing physical conditions of the house

The position of the living area, single glazing and the high uninsulated suspended floor over the garage creates an uncomfortable indoor winter environment.

While the physical house is in better condition than many in the area, it still performs at a poor level.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Brick veneer, tile roof, suspended timber floor (carpet), under house garage.
Insulation	Ceiling (batts).
Windows	Single glazed, aluminium frame.
Window coverings	Vertical blind, pelmets.
Access to sun	All day sun, living room on the east corner and kitchen on north corner, skylight in the hallway.
Heating	Heat pump, wired panel heater, electric blanket.

Changes to the home

Other changes to the home:

- Hazel has begun to turn her heat pump off overnight (unless it is below 10°C).
- Hazel's daughter and adult grandson moved out.

GET BILL $MART UPGRADES

✔ Insulation	✔ Shower timer
✔ Draught proofing of doors	✔ Door snakes
✔ Hot water pipes insulated	✔ Small fridge thermometer
✔ Hot water valve cosy	
✔ Water saving shower head	
✔ Lights changed	

Overview

When we first met Hazel she shared her house with her daughter and adult grandson. Her family had moved in with her following relationship breakdowns. Hazel found living with her family difficult as they were less aware of the cost of energy use as they were not contributing to bills and as a result were more likely to leave doors open and appliances on.

With the departure of her family members Hazel's bills decreased along with her energy use. Noticeably her hot water use reduced by 64% from 10.36kWh/day to 3.64kWh/day. Other Light and Power use also decreased substantially by almost 40%. There may have been an unmonitored electric plug in heater on this circuit.

Worth noting is that Hazel's heater use increased. This may be because she felt more comfortable heating her home knowing her bill would be generally less. The increase was only slight so this may have also been due to the colder winter.

Hazel was fairly energy conscious prior to participation in the project. She was nervous about the cost of her electricity bills saying that when these were too high she had to reduce how much she spent on groceries. Hazel used a plug in turbo oven for her cooking which helped keep costs down.

Hazel did not spend very long in the comfort zone. Indeed despite an increase in heater use, her time in the comfort zone decreased from 19.4% to 13.3%. This also suggests someone was using an unmonitored plug in heater in the house in the before period.

Average daily energy use and heating efficiency during winter conditions

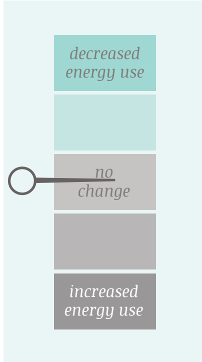
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.07	0.09	0.01	18.8%
T 41 Heating (hard wired heating)	7.85	8.21	0.36	4.6%
Total Heating	7.93	8.30	0.37	4.7%
Other Light and Power (T31)	11.68	7.10	-4.58	-39.2%
Hot Water	10.36	3.64	-6.72	-64.9%
Total Household Electricity	29.97	19.04	-10.94	-36.5%
House Heating Efficiency (degree-hours/kWh/day)	0.71	0.64	-0.07	-10.0%

Average daily temperatures and time in comfort zone during winter conditions

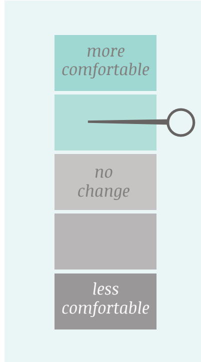
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.1	12.7	9.2	5.7	19.4%
After	16.0	11.7	8.5	5.3	13.3%
Difference between before and after	-1.1	-1.0	-0.7	-0.3	-6.1%

CASE STUDY 32
Hamilton and Isabel

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

IN HOME EDUCATION & UPGRADES

Hamilton thinks he and Isabel are pretty careful with their energy consumption so he wasn't sure it would be easy to reduce energy use further 'how it is, is how it is'. They are already managing it carefully, so couldn't think what they could do to reduce it. *(After Interview 2/9/15)*

What was the result?

Hamilton and Isabel's home was of a better quality than many others in this project. They managed their household budget tightly and kept an immaculate house. They learned a lot from the upgrades and education, and reported a significant improvement in their comfort levels due to draught-stopping. Hamilton was very interested in the technical side of the upgrade and had plans to further improve their thermal comfort and energy efficiency once they had the money.

~	Energy use decreased by 0.19kWh (0.9%), from 21.71kWh/day to 21.52kWh/day.
✔	Energy costs reduced by ~$76 per year (from $1306 to $1230).
✔	Time spent in comfort zone increased from 31.2% to 34.2%.
✘	Heating efficiency decreased from 1.68 to 1.45 (14.1%).
✔	Displayed improved confidence that they could find information on thermal comfort if needed.
✔	Draughts reduced.

Existing physical conditions of the house

Overall, the house performs near or to standard, helped by insulation in ceiling and walls and solar gain in the living room. Single glazing aluminium windows and single glazing were recorded as giving some discomfort.

Type	Stand alone, suburban.
Age	5 – 9 years
Construction	Brick veneer, corrugated metal roof, concrete floor (carpet and tiles)
Insulation	Ceiling and walls (batts)
Windows	Single glazed, aluminium frame.
Window coverings	Curtains (medium)
Access to sun	Living room faces north but close eastern neighbour, so mainly midday and afternoon sun.
Heating	Heat pump (living), hard-wired panels (hall, kitchen), electric blanket.

Changes to the home

Other changes to the home:

- Replaced down-lights with LEDs

GET BILL $MART UPGRADES

✔ Draught proofing of doors	✔ Door snakes
✔ Hot water system insulated	✔ Small fridge thermometer
✔ Hot water pipes insulated	✔ Stay Warm education booklet
✔ Hot water valve cosy	✔ Ecoswitches (3)
✔ Lights changed	
✔ Shower timer	

Overview

Hamilton and Isabel's home was of a better quality than many in the GBS project, and performed near or standard. However, Hamilton and Isabel learned a lot from the project. They were very grateful for their upgrade and receptive to the education — it triggered a lot of ideas for them about how they could improve the thermal comfort and energy efficiency of their home. The installation of draught-proofing, especially on the internal door to the garage, had made a massive difference and was much more effective than their previous use of door sausages. They also thought the Ecoswitches were great.

They had installed LEDs in place of down-lights themselves, because LED lights used less electricity and emitted less heat.

Hamilton in particular was interested in the technical side of the upgrades and had a number of ideas about what he could do with his new knowledge.

He was thinking of installing pelmets and other draught-proofing to reduce the cold in the living room, and floor insulation to block the cold that he thought was coming up through the floor. However, lack of money was the biggest barrier to making significant changes.

Hamilton and Isabel said their hot water supply ran out less these days, and the data confirms there was a 14.5% reduction in hot water heating, likely partly because of insulation upgrades made to the hot water system. Their use of light and power also decreased somewhat, likely due to the switch to LED bulbs.

Heating use increased (and efficiency decreased), but this may be due to the longer, colder winter during the study period; Hamilton said that this year, he and Isabel had used the heater more than usual over winter. There was still some moisture on the windows at times.

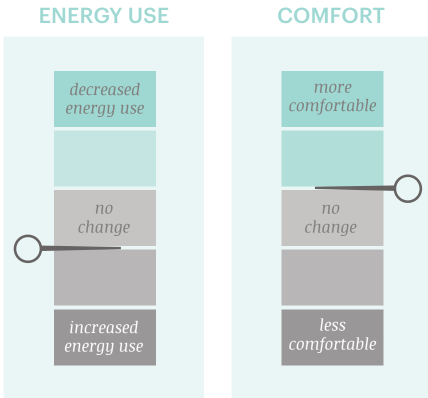
Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.05	0.05	–0.01	–12.5%
T 41 Heating (hard wired heating)	5.01	6.50	1.48	29.5%
Total Heating	5.07	6.54	1.47	29.1%
Other Light and Power (T31)	9.47	8.85	–0.62	–6.6%
Hot Water	7.17	6.13	–1.04	–14.5%
Total Household Electricity	21.71	21.52	–0.19	–0.9%
House Heating Efficiency (degree-hours/kWh/day)	1.68	1.45	–0.24	–14.1%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.4	14.9	8.1	8.5	31.2%
After	19.2	14.8	7.5	9.5	34.2%
Difference between before and after	0.8	–0.1	–0.6	0.9	3.0%

CASE STUDY 33
Ingrid



OWNER		FREESTANDING ONE STOREY	PLUG-IN ELECTRIC

Occupants | Own or rent | Bedrooms | House type | Heating

What did we do?

IN HOME EDUCATION & UPGRADES

Because you see, when it's cold I go to bed. I got the TV in there and I switch my blanket on and that's it. That's all I can do, you see. That's how I save electricity and the [electric] blanket doesn't really use much.

(After Interview 01/09/2015)

What was the result?

Ingrid did not feel that much had changed around her home. She continued to live in a cold house and use minimal energy. Ingrid maintained meticulous records about her energy use, there was very little she could have done to reduce use further. Ingrid slightly increased her energy use as she became more sensitive to the cold.

- ✗ Energy use increased by 0.96kWh (17.1%).
- ✗ Energy costs increased by ~$192 per year (self-reported bill increase).
- ✓ Time spent in the comfort zone increased from 0.8%–0.9% – this time is still incredibly low.
- ✓ Heating efficiency increased from 1.67 to 1.78 (6.6%).
- ✓ Displayed improved confidence that she could find information on energy efficiency.
- ✓ Self-reported moisture levels decreased (medium – none).
- ✗ Self-reported draughts remained present.

Existing physical conditions of the house

Ingrid lived in a standalone suburban house on a standard sized block. Approximately 55 years old, the house is constructed of rendered brick veneer, with a corrugated metal roof and a suspended timber floor (with carpet and vinyl). With a square house plan and siting on a slope it is well positioned for all day solar access. The living room (most used) sits on the east corner of the plan and receives morning sun. Another living area sat on the north corner of the house but was not used very often and the curtains were generally closed in that area.

Heating is provided by living room column/fan heater, an electric blanket, a small fan heater. There is a fireplace that is never used.

Overall this well maintained house has poor thermal performance because of a lack of insulation, single glazing, thin curtains, window draughts and the lack of solar gain to the most commonly used sitting room.

Insulation	Ceiling only (batts).	POOR
Windows	Single glazed, aluminium frames, pelmets.	POOR
Window coverings	Thin curtains and lace.	VERY POOR
Under floor space	Suspended floor 0.4-1.5m off ground, underfloor enclosed with brick, no insulation.	POOR
Mould and moisture	Temp intermittently reaches dew point in living and bedrooms. Humidity peak in winter is 85%.	POOR
Other conditions of note	Well maintained. Draughts.	

Changes to the home

Other changes to the home:

- Ingrid replaced her curtains as the old ones fell apart when washed.

GET BiLL $MART UPGRADES

- ✔ Temperature turned down on hot water system
- ✔ Door snakes
- ✔ Draught proofing of doors
- ✔ Small fridge thermometer
- ✔ Hot water system insulated
- ✔ Stay Warm education booklet
- ✔ Hot water pipes insulated
- ✔ Lights changed
- ✔ Shower timer

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.79	0.81	2.7%
T 41 Heating (hard wired heating)	0.00	0.00	0.00
Total Heating	0.79	0.81	2.7%
Other Light and Power (T31)	2.51	3.59	43.1%
Hot Water	2.30	2.16	-6.1%
Total Household Electricity	5.61	6.57	17.1%
House Heating Efficiency (degree-hours/kWh/day)	1.67	1.78	6.6%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Kitchen Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	11.1	10.9	9.7	9.7	1.3	0.8%
After	10.5	10.1	8.8	8.8	1.5	0.9%
Difference between before and after	-0.6	-0.8	-0.9	-0.9	0.1	0.1%

Referring to the tables and graphs presented, changes were observed in energy use and comfort. Total Household Electricity average per day increased by 0.96 kWh/day from 5.61 to 6.57 (17.1%). Both before and after consumption was very low.

Housing heating efficiency was high at 1.67 before and 1.78 after. This was because Ingrid used minimal heating, rather than her heaters being super-efficient. In uninsulated houses such as these the more heating used means the less efficient the heating efficiency will become.

Ingrid also noted that she kept at least some windows open, even during winter, to ensure fresh air. This is shown through the very low temperatures recorded in Ingrid's house. The indoor temperature of Ingrid's house tracked very closely with the outside temperature (approximately only 1.5.°C above outside). This means the house was uncomfortably cold most of the time. For most of the time (99.2-99.1% of time) the temperature levels in the house were below the comfort zone of 18-24 degrees. Ingrid reported feeling cold a lot of the time.

Total heating increased by 2.1% (from 0.79kWh/per day to 0.81kWh/per day). At the same time Ingrid's Other Light and Power use increased by 43.1% (from 2.51kWh/per day to 3.59kWh/per day). Ingrid noted at the After Interview that she had begun to use a new plug in heater that was not recorded by this project. Also contributing to the increase in power use on this circuit may have been the purchase of a new stove. Ingrid explained that her old stove had been replaced because it did not work. Ingrid may have begun to cook more and the new stove may have used more energy as well.

Energy and comfort

Hot water use decreased by 6.1%. Ingrid noted that the Home Energy Helpers had given her a hot water upgrade which likely contributed to this reduction.

Example temperature graphs showing before and after the GBS visit highlight some key points. Indoor and outdoor temperature consistently track near each other before and after. On occasion the outdoor temperature spikes, this may be due to a problem with the sensor but may also be something being laid over it for a short period (it was on a shelf). The after graph shows slightly increased temperatures inside and this is likely due to Ingrid's increased use of a non-monitored plug in heater. She did confide in our second interview that she had found the cold much harder to bear in the 2015 winter and had 'cracked' and used the heater a little more.

Ingrid's use of the electric blanket is visible in both the before and after graphs. As discussed in the interviews with her she turns the blanket on sometimes as early as 4pm when the temperatures in her house are getting colder. She also uses the electric blanket in the early mornings.

Both before and after graphs show occasional spikes in the use of the living room heater. It is likely that at these times she had guests as she explained in her interviews that this was the only time she usually used the heater. Ingrid reported that she never heated the bedroom and the graphs confirm this as the bedroom generally tracks outside temperatures.

Moisture problems in the house reportedly reduced, but measure show that temperature intermittently reaches dew point in living and bedrooms in before and after with humidity peaks in winter at 85%. This may mean Ingrid deals with some surface condensation issues. The living room humidity patterns are like many people's bedrooms humidity (due to the lack of heating). Ingrid's airing of the house is likely what keeps the moisture under control.

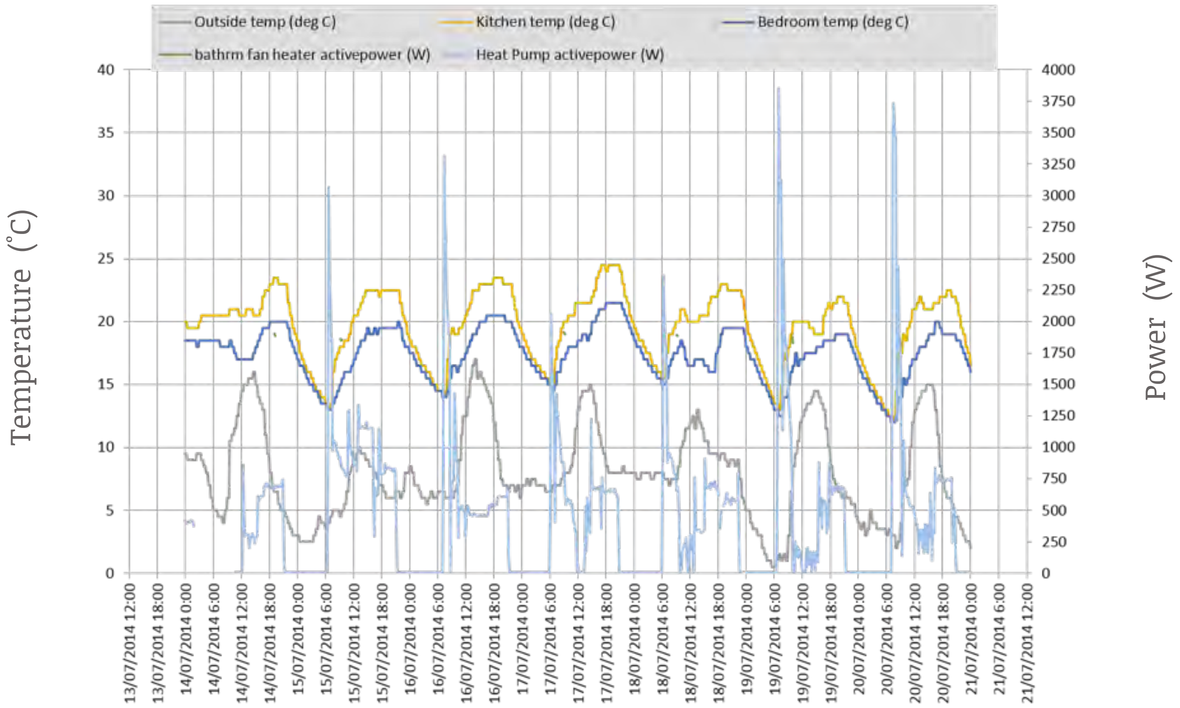
I have to improve the comfort of home because I can't reduce it. You see this, you see where it is. I don't use–I mean with $1.50 a day, I think that's the lowest that anyone can. And I can show you that it's only a $1.50 a day.

(Before Interview 19/05/2014)

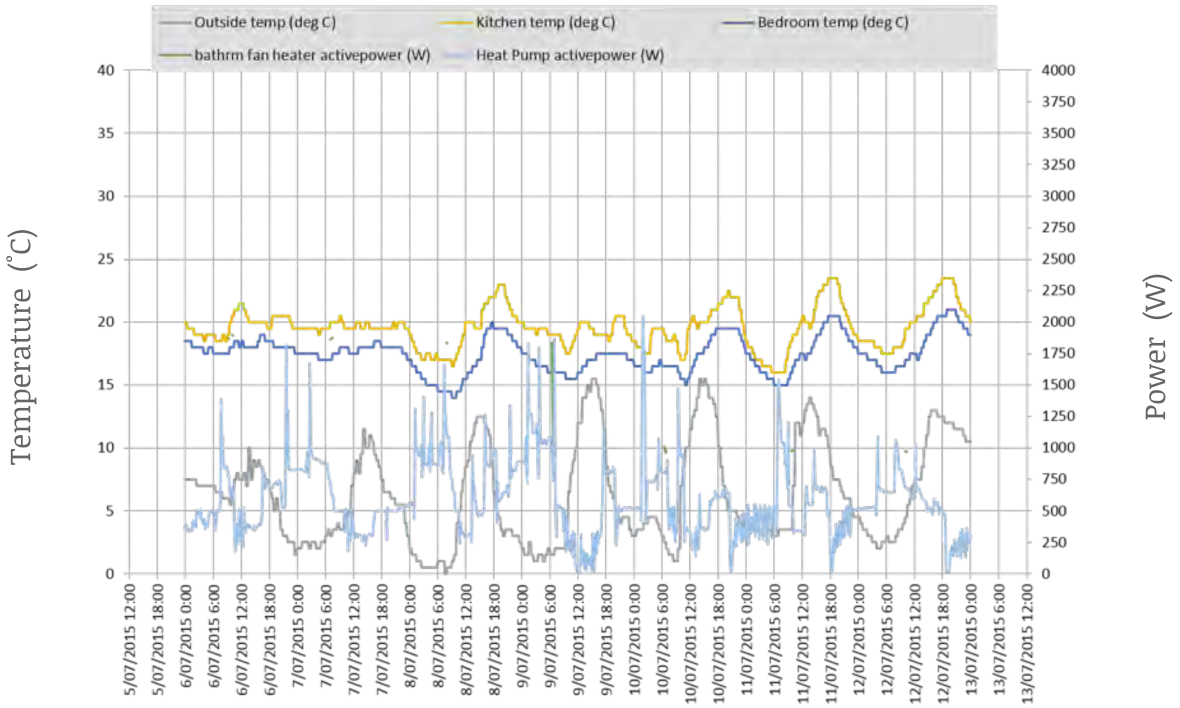
Yes I would like that my house to be more comfortable. But I am too scared to put the heaters on because all the costs you see. Because there's too many costs involved you see. The house insurance went up by $99 in one year so I rang them up and they said they have to because they had all these bushfires in Victoria and we all have to pay for it.

(After Interview 01/09/2015)

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Ingrid was extremely careful with her energy use and monitored her costs very closely. So concerned was she about the costs that she explained:

> Sometimes you like to don't go to bed so early you see and you just think, ah I'd better go, use too much electricity and then you go [to bed] you see.
>
> *(After Interview 01/09/2015)*

Ingrid's energy use increased and according to her records her bills also increased by ~$16 per month. This was different to the billing data from the supplier which indicated she had reduced costs by $67 per year. Ingrid's records were meticulous and these differences in cost may have been due to problems with some of the billing data.

Personal and community change

Ingrid lived alone in a house that she and her husband had built over 50 years ago. Her house was immaculately kept and very carefully managed. Ingrid knew that she spent approximately $1.50 per day on energy and had detailed records of all her household bills. She explained that she was conscious of the energy use because of the cost:

Yes, financial reasons. You see it's Pay As You Go. When I have money I put it in and then, I can show you the book. The first day I came here in this country, I use the book, and I have it every money, everything, and I put it in. This is the second book now. You see every year…. You see, what I have to spend, how much electricity I use. You see '12, '11, '13 and it goes on and on, and this is this year. *(Before Interview 19/05/2014)*

Ingrid's house was very cold. It was uninsulated brick veneer and was hard to heat up. She used such minimal energy that she was almost never within the comfort zone.

While Ingrid lived alone she had was a part of a functional community network. When the research team visited, her neighbours came out to make sure she was safe. Ingrid also explained her involvement with the community, she cut the hair of one man who lived nearby, made craft for local charities and looked out for her neighbours.

Ingrid was a very self-sufficient person who was unwilling to complain about the discomfort in her home. She explained,

> Yeah. I mean, you do what you can you see. So it's all right. I am not a person who complains. I do my own thing. *(After Interview 01/09/2015)*

In keeping with this independent streak Ingrid also explained that she did not want to seek help from the community to make her home more comfortable she said,

> I be my own person, you see. I don't like to ask, I think what I can and what I do is right. *(After Interview 01/09/2015)*

An example of this was her strategy of putting old Christmas cards in the cracks in the window frames to stop the draughts.

It is worth noting that Ingrid wanted to assist the greater Get Bill Smart project, but was quite annoyed by some of the interventions. For example installation of monitoring equipment in her meter box made the meter box door much harder to close. This was a problem for Ingrid as she regularly checked her energy use.

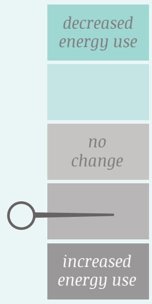
While Ingrid was very stoic about her frugal lifestyle, in our second visit to her home she opened up more about the stresses and difficulties of living in such a cold and uncomfortable house.

Overall the thermal performance of Ingrid's house was very poor. This was exacerbated by her need to keep the windows open for fresh air. It was Ingrid's impressive stoic nature that allowed her to manage when she couldn't afford to pay more for energy, for example she would simply go to bed with the electric blanket (and a good book) at 4pm when it began to get cold. Ingrid was the lowest energy user and had the coldest house of all participants in this study.

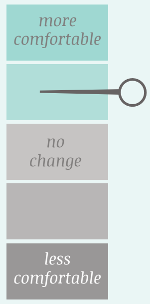
CASE STUDY 34

Cassie and partner

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

IN HOME EDUCATION & UPGRADES

> I chose a pretty good block. I mean I get sun in here don't I? Through that window, sun in that window.
>
> *(Before Interview 26/05/2014)*

What was the result?

Cassie and partner's overall household energy use increased along with the time she spent in the comfort zone (of 18°C to 24 °C) and above the comfort zone. The increase in energy use Cassie reported as being from extra heating used because her partner had a serious illness and needed to be kept warm.

- ✗ Energy use increased by 1.45kWh/day (7.1%) from 20.43 – 21.88 kWh/per day.
- ✗ Energy costs increased by approximately $281 per year ($905–$1,186).
- ✓ Time spent in the comfort zone increased from 68.8% to 72.9%.
- ✗ Heating efficiency decreased from 0.91 to 0.84 (7.5%).
- ✓ Maintained a high level of confidence that she could find information on energy efficiency and comfort.
- ✓ Self-reported moisture levels remained the same (low) and mould was eradicated. Temperature did not reach dew point. Humidity max only 70%.

Existing physical conditions of the house

Cassie and her partner live in a small standalone house on a small suburban block that is part of a retirement lifestyle complex. It was built in 2011. The long axis of the house is southwest to northeast. The house has a carport on the northwest and a close neighbour also on the north west but still receives morning and midday sun. The living room is on the north corner of the house and is open plan with a dining area, which is on the east corner – these areas catch sun from the east and the north. The house is constructed of prefabricated vinyl weatherboard cladding, a suspended floor (with carpet and vinyl), a corrugated iron roof, and fibre cement skirt. The house is insulated to 2011 standards and so wall and floors and ceiling are insulated. Heating is provided by a heat pump in the living room, a fan heater in the bathroom and an electric blanket.

Overall, despite the single glazing and limited window covering, the insulation, airtightness, and solar gain in critical spaces this house performs to a NEAR STANDARD.

Insulation	Ceiling (batts), walls (batts and wrap), floor (polystyrene with reflective foil).	TO STANDARD
Windows	Single glazed, aluminium frames, no pelmets.	NEAR STANDARD
Window coverings	Vertical blinds all through.	POOR
Under floor space	Suspended floor, underfloor enclosed with fibre cement sheeting, insulated.	TO STANDARD
Mould and moisture	Temperature never near dew point problems. Humidity in winter peaks at 65 and 70%.	TO STANDARD
Other conditions of note	New house, well maintained.	
	Heat pump hot water system.	

Changes to the home

Other changes to the home:

- Cassie ran her heat pump at 27°C, rather than the usual 19°C as her partner was very sick.
- Cassie and her partner also used the electric blanket more regularly.
- The couple's occupancy patterns changed due to long hospital stays for Cassie's partner.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Small fridge thermometer
- ✔ Hot water valve cosy
- ✔ Stay Warm education booklet
- ✔ Lights changed
- ✔ Hot water pipes insulated
- ✔ Shower timer
- ✔ Door snakes

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (%)
T 31 Heating (plug in heating)	1.06	1.13	7.2%
T 41 Heating (hard wired heating)	9.67	11.32	17.0%
Total Heating	10.73	12.45	16.1%
Other Light and Power (T31)	6.68	6.66	-0.3%
Hot Water	3.03	2.78	-8.4%
Total Household Electricity	20.43	21.88	7.1%
House Heating Efficiency (degree-hours/kWh/day)	0.91	0.84	-7.5%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	20.1	17.8	9.2	9.8	68.8%
After	20.5	18.2	8.8	10.5	72.9%
Difference between before and after	0.4	0.3	-0.3	0.7	4.1%

Referring to the tables and graphs presented, changes were observed in energy use and comfort. Total Household Electricity increased 1.45kWh/day from 20.43kWh/day to 21.88kWh/day (7.1%). Total heating increased by 16.1% from 10.73kWh/day to 12.45kWh/day. This increase was primarily due to increased use of the heat pump, but plug in electric heaters also went up. Cassie explained that her heating use had increased primarily because her partner had been very sick during the after period and required substantially more heating.

Time in the comfort zone was high in the before data (68.8%). This time increased to 72.9% over the project. There was also an increase in the time spent above a 24°C average in the living room — from 0.3% to 4.9% of the time. This means that a lot of the time in the after period Cassie and her partner were targeting heating to somewhere between 18°C and 24°C. Cassie reports of using higher heater temperatures and the increase in time heating above the comfort zone correspond. Cassie reported that in the after period they had been setting the heat pump to 27°C rather than their usual 19°C.

Cassie's hot water use decreased by 8.4% (from 3.03kWh/day to 2.78kWh/day). This may have been due to the time her partner spent in hospital. Hot water heating was provided by a heat pump-hot water system, which is a reverse cycle air conditioner heater and is typically 4 times more efficient than a standard electric storage hot water system. Energy used for hot water heating was very low overall before and after.

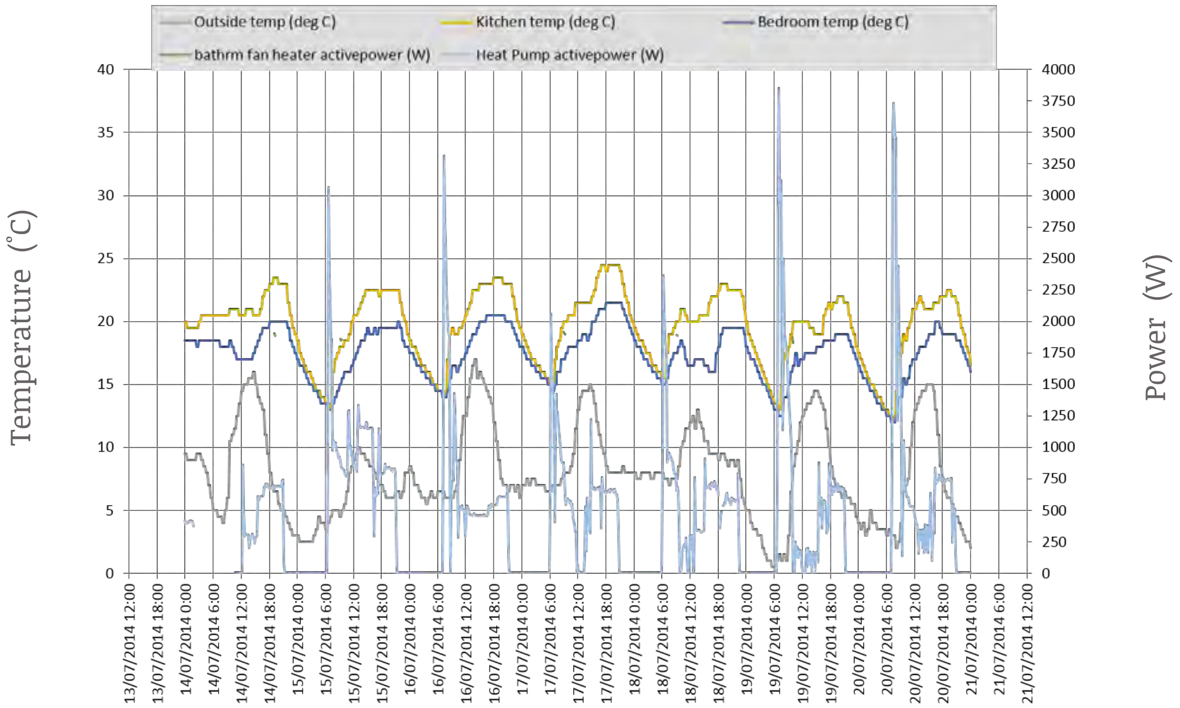
Energy and comfort

There was no issue with temperatures reaching dew point in this home and humidity peaked at 70% in winter. This great performance was in large part due to the well-insulated building shell and the use of the heat pump/air conditioning, which dries out the air.

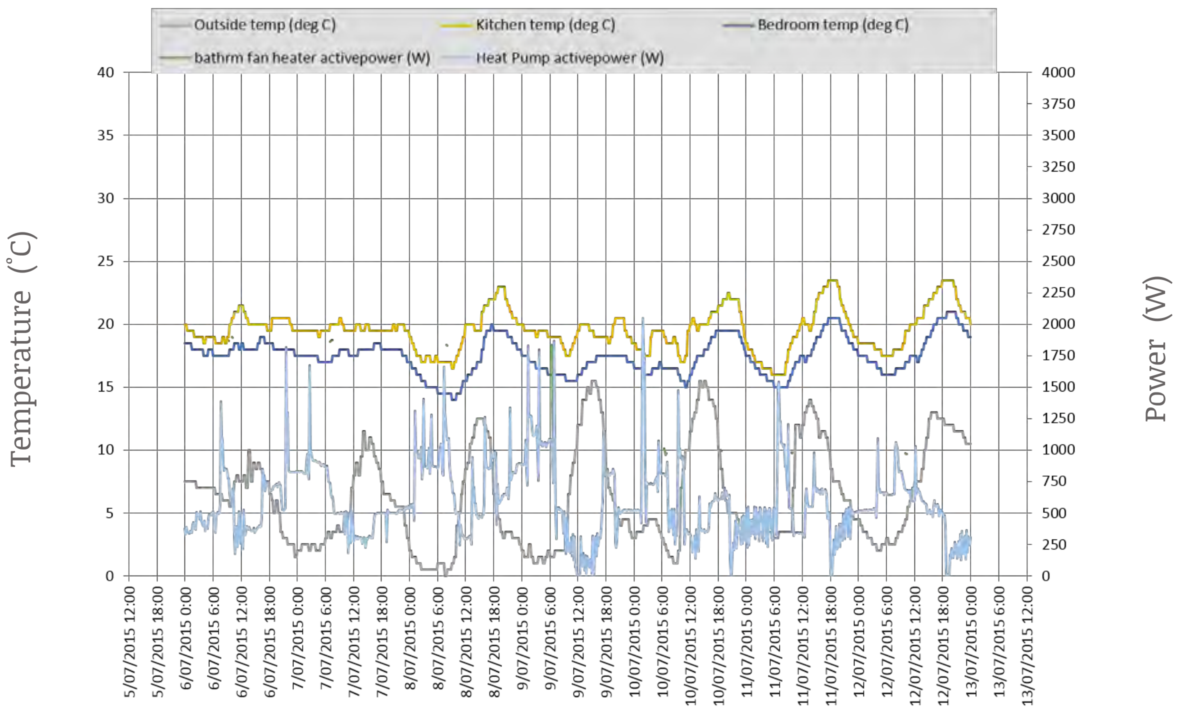
Cassie's house was reasonably efficient. While efficiency decreased (from 0.91 – 0.84), her house was relatively effective at maintaining heat. This is primarily due to its 5 star energy rating (the house was built in 2011), its living room orientation and the presence of good insulation. Overall energy use in this house sits just under the greater Hobart upgrades group average energy use. Cassie intentionally chose this house because of its position in the landscape and the solar gain to the house. She noted a good level of sun and how pleased she was to have bought in a good position.

> Just vertical blinds to get the sun in the winter and to keep it out in the summer for coolness. I very seldom have a jacket on like I have today, only I've put that on because of the door being opened but normally I wouldn't have that on. *(Before Interview 26/05/2014)*

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Cassie was very careful with her energy use and was concerned about her bills. When her partner got sick she was conscious of changing her heating practices to keep the house warmer for him. She was quite concerned about what this would mean for her bills as the heater was run much higher and doors were left open. She was pleased to note that the increase in bills was less than anticipated and she was able to keep her partner warm without additional financial stress:

> Yeah, well see I haven't kept the bedroom doors closed or anything, because I think, well he doesn't want to go from a hot room to a cold type of thing. So I was very pleased with [the bill]. I think it was about $20 more than last year. It was only a smidgen on the graph. Just a smidgen. *(After Interview 02/09/2015)*

Personal and community change

Cassie and her partner are in their 70s and live in a retirement lifestyle community. All the accommodation in this community was built to five star energy efficiency standards (required by law since 2003). Cassie's house has gained efficiency from being built under these standards. This is not always the case. In some instances, like for Nonie (case study #03), even recently built houses can perform poorly.

Cassie's house was relatively small and therefore easy to heat and maintain she also observed certain practices to ensure she was using heating effectively. She explained that

> When we go out through the day in the winter with the heater going, I do close the bedroom two doors and the bathroom door. So that helps the warmth in here, so you're not running the heater on as high as you would with the doors open.
>
> *(After Interview 02/09/2015)*

Cassie's partner moved in with her just after GBS monitoring on the house began. Cassie's partner became ill after GBS Home Energy Helpers had visited and the couple found the house was more comfortable for him if they increased the heating. She was worried that this would dramatically increase her electricity bills but noted being pleasantly surprised that although it was more expensive it was not as bad as she had anticipated. We have found in other cases that increasing heating for sick occupants can increases energy use much more than in this case. The effect of increase of heating here was limited by the efficient building shell and the efficient appliances in use.

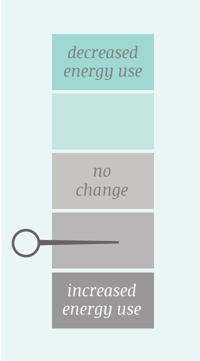
Cassie chose to live where she did so as to be relatively close to family. She made it clear that while she liked to live nearby friends and family she did not want friends living in the same street and tended to keep to herself.

While Cassie knew that the Get Bill Smart team could provide her with information on energy efficiency and thermal comfort she did not feel that there was anyone else in her community who could.

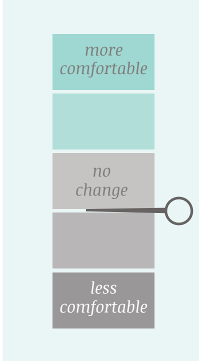
Cassie received an upgrade, but her house was reasonably new and was built to modern energy efficiency standards so Cassie reported there was little for Home Energy Helpers to do. Changes in energy use and heating were due to the illness of her partner.

CASE STUDY 35
Danielle and family

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING TWO STOREYS	PLUG-IN ELECTRIC + HEAT PUMP

What did we do?

IN HOME EDUCATION & UPGRADES

> Well just your lifestyle really, it's horrible to be too cold or too hot. And I'm just a Mrs Fix It person, I always just like to make sure that things are working and good, and it really is the cost of the bill that has motivated me to do the things like the curtains and light globes and that sort of thing. *(Before Interview 25/05/2014)*

What was the result?

Danielle improved her knowledge of energy efficiency and thermal comfort. She made some changes to how she used and heated her house and found the advice from Home Energy Helpers useful. Her power use increased but not significantly given that she began working from home between the before and after periods.

✗	Energy use increased by 7.2kWh (16.8%), from 42.97kWh/day to 50.18kWh/day.
✗	Energy costs increased by ~$168 per year (some data based on estimates from the supplier).
✗	Time spent in comfort zone decreased by 0.7% (from 17.5% to 16.8%).
✓	Heating efficiency increased from 0.39 to 0.41 (4.0%) – median for group.
✗	Displayed decreased confidence that she could find information on energy efficiency and comfort.
✓	Self-reported reduction in moisture (low – none).
✓	Danielle displayed an increased sense of community and a greater awareness that there might be people in her community who could help with energy efficiency and thermal comfort.

Existing physical conditions of the house

Danielle and her children live in a standalone suburban house that is approximately 40 years old. Her son lives in a bed-sit underneath the main house. The house is timber framed, with weatherboard-clad walls, a sheet metal roof, and suspended timber floors (with carpet and vinyl). Positioned with an east to west long axis and high on a steep hill, the house receives sun through the morning and the middle of the day. The bedsit is tucked under, so receives less sun. The upstairs living area sits on the east of the house and receives morning through midday sun.

Bedrooms to the west receive some afternoon sun. The kitchen is open plan with the living area. Heating is provided by a heat pump in the living, a fan heater in the bed-sit, a water bed heater in the bedroom and a column oil heater in the study (office).

With some solar access to the living area this house tends to capture critical warmth, but the lack of insulation still limits thermal performance to a poor level.

Insulation	Ceiling only, poor condition.	POOR
Windows	Single glazed, aluminium frames.	POOR
Window coverings	Vertical blinds (living and bedrooms), roller blind (kitchen), heavy curtains study.	POOR
Under floor space	Suspended timber floor with unit under, unknown insulation status.	POOR
Mould and moisture	Temp did not reach dew point and humidity under 75% all year. In winter in living humidity under 65%.	NEAR STANDARD
Other conditions of note	Generally well maintained house.	

Changes to the home

Other changes to the home:

- Danielle now works from home and has begun to use a plug in oil heater (with thermostat) in her home office.
- Following advice from the Home Energy Helpers, Danielle bubble wrapped the glass door between her lounge and foyer area.
- Danielle reduced showering because she knows it saves energy.
- Danielle decreased the temperature the heat pump is set to (now 22°C).
- The kitchen has a new stove.

GET BILL $MART UPGRADES

- ✔ Hot water valve cosy
- ✔ Small fridge thermometer
- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklet
- ✔ Lights changed
- ✔ Water saving showerhead
- ✔ Shower timer
- ✔ Door snakes

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	9.02	10.28	1.26	14.0%
T 41 Heating (hard wired heating)	7.24	6.75	-0.49	-6.8%
Total Heating	16.26	17.03	0.77	4.7%
Other Light and Power (T31)	19.35	26.58	7.23	37.4%
Hot Water	7.36	6.56	-0.79	-10.8%
Total Household Electricity	42.97	50.18	7.20	16.8%
House Heating Efficiency (degree-hours/kWh/day)	0.39	0.41	0.02	4.0%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.5	14.3	9.0	6.4	17.5%
After	16.9	14.6	8.3	6.9	16.8%
Difference between before and after	-0.6	0.3	-0.6	0.6	-0.7%

Referring to the tables and graphs presented, multiple changes were noted. Total Household Electricity increased by 16.8% (from 42.97kWh/day to 50.18kWh/day).

Total heating increased by 4.7% from 16.26kWh/day to 17.03kWh/day. This increase is likely related to Danielle working from home in the after period (a change from the before period). As she reported she tended to heat her office space with a plug in heater and not use the heat pump until she had finished work. The plug in heater was not mentioned to the GBS team until the end of the monitoring period and hence was not monitored. Increased use from this plug in appears in Other Light and Power where there was a big increase from 19.35 to 26.58kWh/day. Increase noted in the plug in heating of 1.26kWh/day is from increased use of the downstairs heater in the bed-sit.

> I wouldn't feel very good that, say, my daughter or her friends if they were here, I'd feel really bad for my kids really if they had to suffer being cold.
>
> *(Before Interview 23/05/2014)*

Energy and comfort

In the living area after the Home Energy Helpers visit Danielle reported that she turned the temperature of the heat pump down. The example before/after charts show this reduction as does the hard wired heating decrease of 6.8%. Example graphs also show the heat pump energy use moving up and down in the after period rather than staying at constant levels suggesting Danielle has gone from leaving it on to turning it on and off as needed.

Time spent in the comfort zone decreased from 17.5% to 16.8%. No time was spent above 24°C. Both the before and after percentages are low. Temp/humidity was measured in the living and a bedroom, not in the room Danielle set up as the home office. Temperatures there may have been substantially warmer than the averages recorded.

Bedroom temperatures seem to respond to the outside temperature but tend to stay a little warmer than outside (a regular distance from outside temperatures on the graph). This temperature buffer is likely due to the presence of a waterbed and the continual heating of the water which constantly holds the room temp slightly higher than outside.

> Life's too short to be down about things like a cold house. Like I said, we started working out, we go for an afternoon walk and you can always count on a good walk to warm you up even if it's freezing outside.
> *(After Interview 07/09/2015)*

Danielle's Other Light and Power increase of 7.23kWh/day (37.4%) is related to the plug in heater in the study but may also be attributed to a new stove that was installed partway through the project.

The heating efficiency of Danielle's house increased by 2.4%, from 0.0.39 to 0.41. This is a small difference and does not indicate the house's energy changes well because of the use of the plug in heater in the study.

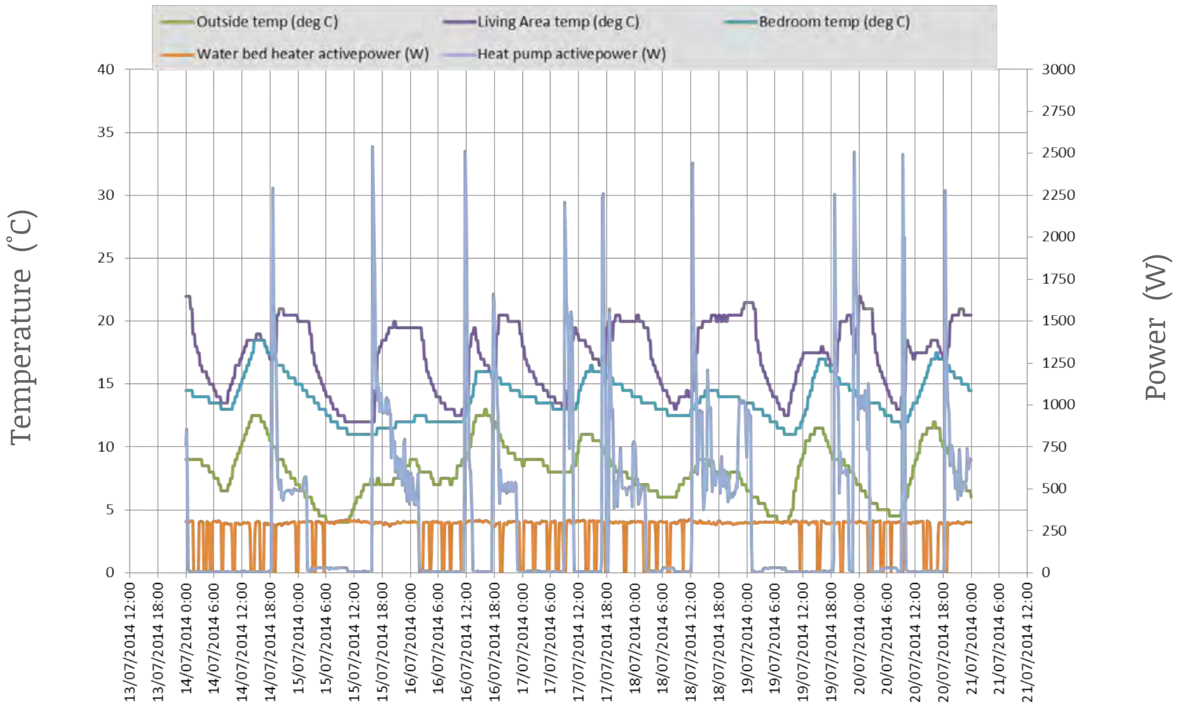
Consistent with Danielle's comments that she had reduced the number of showers she had, is the decrease in energy used by her hot water system (from 7.36kWh/day to 6.56kWh/day). GBS upgrades at her house involved measures that would have also helped to improve hot water use.

Measurements show moisture was manageable in this house. The living and bedroom area temperature did not reach dew point during winter and winter humidity peaked at 75%. Moisture was reported as a significant issue by Danielle. In the living area the heat pump limited humidity to peaks of 65%, indicating a reasonably dry living room.

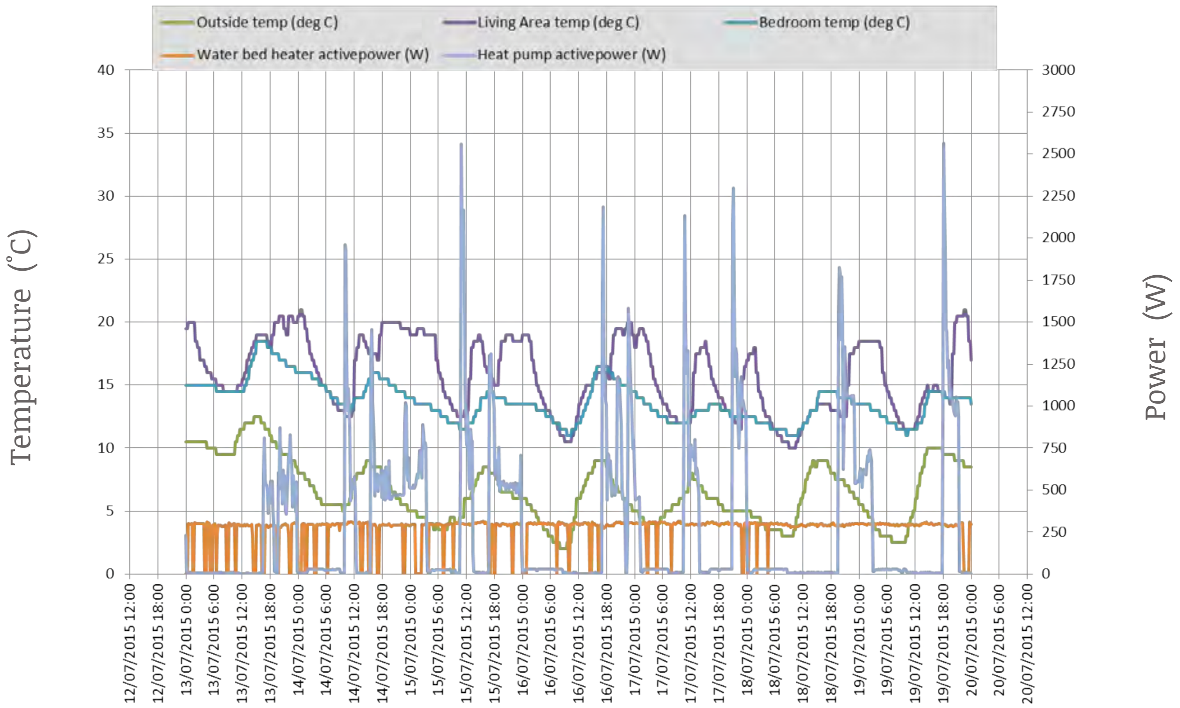
Much of Danielle's energy use and corresponding comfort is hard to monitor as she began heating an area in which we did not have sensors.

Temperature and energy use was also logged in Danielle's son's unit. His heater use went up slightly.3.16 to 4.51kWh/day and room temperature also went up so comfort slightly increased.

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Danielle was very careful with her power bills. Prior to the GBS program felt that she would like to reduce costs but wasn't sure how,

> Because my power bills are high so it just makes you really conscious of what you're doing, everything is electrical isn't it, for me cooking and preparing meals to making a coffee to my son's got computer equipment down there … I mean it's a shame it's like buying petrol isn't it, petrol's expensive but you can't live your life on how expensive petrol is and say we're not going there or not going there, so it's the same with power, you don't want it to affect your lifestyle.
>
> *(Before Interview 23/05/2014)*

After participation in the Get Bill Smart project Danielle's bills seem to have increased. The data we have from the energy supplier were based on estimates and so are likely to be inaccurate (the estimate was an annual increase of ~$164). Working from home will have contributed to this increase.

Despite the bigger bills Danielle felt a lot more in control explaining that,

> This is probably the first time that I've been up-to-date with my power bill, I haven't had to make a payment plan but then I've got my son contributing to that too. I've got his whole living area downstairs with fridge and microwave and his computer gaming stuff and he's got a heater downstairs which he's been using as well, but I only let him have it on one bar, so it's right next to him, might as well be in his jacket. *(After Interview 07/09/2015)*

Personal and community change

Danielle lives with her two children. Danielle's son is late teens and lives in the small bedsit underneath the house. In his room he has a radiant plug in heater, a fridge, a microwave and lots of computer gaming equipment. Danielle had limited success getting him to reduce his use. Because he uses so much power and often has the heater on very high, he now contributes to the power bill.

Danielle had a fantastic relationship with her landlady. Danielle had asked whether she could make some changes to the kitchen and the landlady was delighted with the final product. As a result Danielle felt valued and respected as a tenant and considered the rental to be very much her home. She explained,

> Up until a little while ago this bench here was like the other side, it had a really high wall on it and I asked my landlord could I do it because to let the light and the warmth, because it was like a freezing little icebox in here, and the heat would if anything go right up there. *(Before Interview 23/05/2014)*

The landlord was so pleased that she offered to pay Danielle's water bill.

In her after survey Danielle displayed an increased sense of community and a greater awareness that there might be people in her community who could help with energy efficiency and thermal comfort.

Even prior to the project Danielle was clearly proactive when it came to energy efficiency and comfort. She had a strong network of friends whom she was able to turn to:

> Like I had a friend here and he was telling me about how the heater, for example, I just said to him some people run these heaters 24/7 because they reckon it takes more energy to turn them on and off, and he said no, yours is a whatever he said it was, geared up that you can turn it on and off anytime and it doesn't matter, because I can't justify that blowing. *(Before Interview 23/05/2014)*

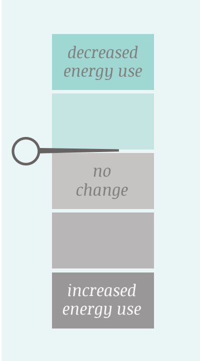
Danielle had also installed her own door seals, blocked off areas of the house with curtains and thought about how she used different appliances in the home. She used her strong network of friends to work through ideas and issues explaining,

> I discuss my power bill with a few of my friends, we can't believe what sort of power bills that they have also, so we discuss it and I've said to a couple of my friends ring up Aurora and get them to explain that cost. One of my friends has got one of those off-peak heat bank things in their hallway, costs her an absolute fortune but it's on off-peak, she can't understand it. *(After Interview 07/09/2015)*

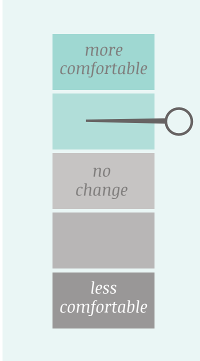
Danielle found the home energy education and upgrade helpful and had changed some of her habits as a result. Her power use increased but not significantly given that she began working from home between the before and after periods. The thermal performance of Danielle's house was poor but she made the most of the good sunlight.

CASE STUDY 36
Patti and son

ENERGY USE

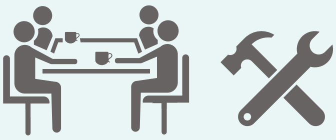


COMFORT



	 RENTER		 FREESTANDING ONE STOREY	 HEAT PUMP
Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?



IN HOME EDUCATION & UPGRADES

Oh, you know, no one told me anything that I didn't already know but I salute the fact that they were so relentlessly diligent, you know, running through the whole booklet and I mean I kept saying "Yep, yep, yep, yep," all over it, you know. But okay, everyone's not so…

(After Interview 01/09/2015)

What was the result?

Patti increased her energy use slightly, however due to electricity price decrease she actually saved money on her bills. With the increase in energy use her time in the comfort zone also increased.

Patti was confident in her ability to find information and make changes to her home and was limited only by her rental status and financial capacity.

✗	Energy use increased by 1.02kWh/day (8.9%) from 11.47kWh/day to 12.5kWh/day.
✓	Energy costs reduced by ~$67 per year ($660-$593)
✓	Time spent in the comfort zone increased from 18.4% to 21%.
✗	Heating efficiency decreased from 1.01 to 0.97 (4.5%).
✓	Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
✓	Draughts reduced.

Existing physical conditions of the house

Patti's house was in relatively poor condition. Despite acceptable orientation, thick curtains and multiple layers of carpet, he single glazing and lack of insulation contributed to poor thermal performance.

Type	Stand alone, suburban.
Age	40-49 years.
Construction	Weatherboard with timber frame, suspended timber floor (carpet, multiple layers of carpet in living, vinyl and tiles in bathroom/toilet/kitchen), corrugated metal roof, garage under living room.
Insulation	None.
Windows	Single glazed, timber frame.
Window coverings	Curtains (mostly heavy), pelmets (living and one bedroom).
Access to sun	All day access to sun in living room.
Heating	Heat pump.

Changes to the home

Other changes to the home:

- Patti upgraded her curtains to a heavier weight.
- Patti had multiple layers of carpet in the living room to which she continued to add during the course of the GBS project.

GET BILL $MART UPGRADES

- ✔ Draught proofing of doors
- ✔ Door snakes
- ✔ Hot water system insulated
- ✔ Small fridge thermometer
- ✔ Hot water valve cosy
- ✔ Stay Warm education booklet
- ✔ Hot water pipes insulated
- ✔ Water saving shower head Lights changed
- ✔ Shower timer

Overview

Patti had lived in her home for several years with her young son. When we first met she also had a boarder staying with her briefly.

Patti's overall energy use increased by 8.9% from 11.47kWh/day to 12.50kWh/day. The table below shows slightly increased energy use across the board. Heating and hot water increased the most in terms of kWh/day, while Other Light and Power increased more in terms of percentage.

When speaking with Patti in the After Interview she explained that while she had enjoyed the home education and upgrades she hadn't learnt much that she didn't already know. It did however make her feel confident in her own practices. Patti acknowledged that because she felt in control prior to the home visit and because that visit reinforced this message, she "might have been a bit more profligate with the heating just because of the psychological…" (After Interview 01/09/2015). This may explain the small generalised increase in energy use.

Heating efficiency decreased as is to be expected with increased heater use, however it remained very good. This is because of the hard work Patti put into managing her home.

Patti found the draught stoppers in her house frustrating as they necessitated the slamming of doors in order for them to close. She was however grateful for their presence.

Patti was very energy conscious and felt confident in her knowledge and ability to control her home which was only limited by her rental status.

Patti was active in her community although recently had felt somewhat isolated from her community due to some personality clashes. Patti was confident in her own ability to find information that she needed.

Average daily energy use and heating efficiency during winter conditions

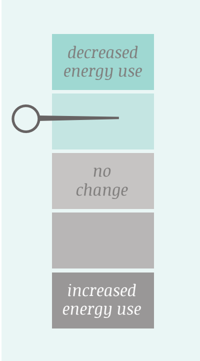
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	5.19	5.73	0.53	10.2%
Total Heating	5.19	5.73	0.53	10.2%
Other Light and Power (T31)	2.30	2.72	0.41	17.9%
Hot Water	3.98	4.05	0.08	2.0%
Total Household Electricity	11.47	12.50	1.02	8.9%
House Heating Efficiency (degree-hours/kWh/day)	1.01	0.97	-0.05	-4.5%

Average daily temperatures and time in comfort zone during winter conditions

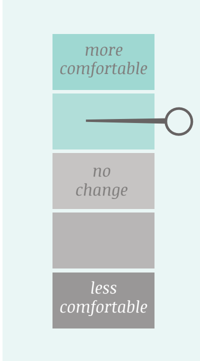
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	16.0	11.9	8.7	5.3	18.4%
After	16.1	11.6	8.3	5.5	21.0%
Difference between before and after	0.1	-0.3	-0.4	0.3	2.6%

CASE STUDY 37
Alice

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	RENTER	1	ONE STOREY TOWNHOUSE	HARDWIRED RESISTIVE

What did we do?

IN HOME EDUCATION & UPGRADES

> The cost, of course, cost, yeah, and comfort, yeah, both of course. I feel quite proud of being aware; I've lived all these years, because I'm in my 70s and I've lived all these years and I really haven't been aware, I realise that now. And all of this is important, very important
>
> *(After Interview, 1 Sep 2015).*

What was the result?

No major changes were made to Alice's house through the upgrade, but she did think she had learned a lot during the process. She had changed her practices at home and was proud of her new skills. Thermally the house was of a reasonable standard and so changes she made to her practices (heater use, zoning) had a noticeable impact.

✓	Energy use decreased by 1.32kWh (6.1%), from 21.69kWh/day to 20.37kWh/day.
~	Energy costs reduced by ~$1 per year (from $1015 to $1016).
✓	Time spent in the comfort zone increased from 7.6% to 11.1%.
✗	Heating efficiency decreased from 0.48 to 0.46 (4.9%).
✓	Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
✓	A recently built house with insulation and solar hot water.

Existing physical conditions of the house

This home is a one storey unit that was recently constructed with double glazing and solar hot water. Alice reported that the western sun in the living area could get far too hot in summer, but was good in winter. The temperature did not reach dew point indoors. The living room humidity stayed under 70%, but the bedroom moved from a peak of 80% (before) to 75% (after). Overall, despite poor window coverings and a difficult living room orientation, the insulation, double glazing and solar hot water mean this house performed to standard.

Type	Conjoined unit, one storey in townhouse complex.
Age	0-5 years.
Construction	Brick veneer and fibre board walls, corrugated metal roof, concrete floor on ground (vinyl and carpet cover), solar hot water.
Insulation	Ceiling (batts), walls (batts).
Windows	Double glazed, aluminium frame.
Window coverings	Metal venetians all through house, no pelmets.
Access to sun	Conjoined neighbour sits on north east, main living area receives afternoon sun.
Heating	Wired-in radiant heater, upright radiant plug-in.

Changes to the home

Other changes to the home:

- New curtains.
- Changed heating practices.
- Changed zoning practices in both winter and summer.

GET BILL $MART UPGRADES

- ✔ Lights changed
- ✔ Water-saving shower head
- ✔ Shower timer
- ✔ Door snakes
- ✔ Small fridge thermometer
- ✔ Stay Warm education booklet
- ✔ Hot water valve cosy

Overview

Alice was retired and lived happily in her conjoined unit with her dog. She had a strong sense of community and often visited her neighbours and the nursing home across her drive. She was a bit of a 'go-to' person, and had a good feel for how other people were managing energy use in their homes.

As a result of GBS, Alice felt a lot more in control and proud of herself for the changes she had made to her heating practices. The home energy helpers assisted her to think through zoning off unused, draughty parts of her house, and this gave her more freedom to move around rather than hide in one room. She also learned to effectively capture summer breezes, and to use her heater more efficiently (she felt she had been using it wrongly before). She now offers advice to others about energy use issues. She indicated that there are still some gaps in one of the doors that weren't sealed properly by the home energy helpers and these still admit draughts.

The solar hot water system in her home helps to keep her bills down. However, summer remains her biggest problem and so she has plans to invest in a screen door to help with this.

Average daily energy use and heating efficiency during winter conditions

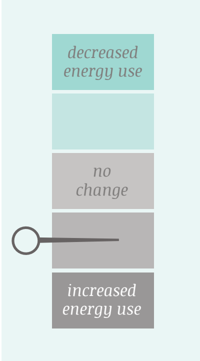
	Before (kWh/day)	After (kWh/ day)	Change (kWh/ day)	Change (%)
T 31 Heating (plug in heating)	3.07	0.52	–2.55	–83.1%
T 41 Heating (hard wired heating)	6.63	8.90	2.27	34.3%
Total Heating	9.70	9.42	–0.28	–2.9%
Other Light and Power (T31)	5.26	4.63	–0.63	–12.0%
Hot Water	6.73	6.33	–0.41	–6.1%
Total Household Electricity	21.69	20.37	–1.32	–6.1%
House Heating Efficiency (degree-hours/kWh/day)	0.48	0.46	–0.02	–4.9%

Average daily temperatures and time in comfort zone during winter conditions

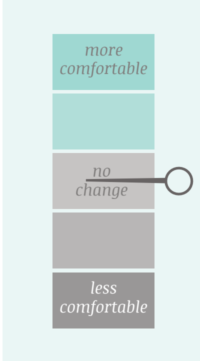
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	15.1	12.7	9.2	4.7	7.6%
After	15.2	12.3	9.4	4.3	11.1%
Difference between before and after	0.1	–0.4	0.2	–0.4	3.5%

CASE STUDY 38
George and Leina

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
2	OWNER WITH MORTGAGE	4	FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

IN HOME EDUCATION & UPGRADES

With the heat pump systems, we had one on the floor many years ago and it was more efficient than the one on the wall. Having said that, we chose on the wall because it gave us more room in the lounge room, it was just taking up a little bit of room. So therefore we had it put on the wall and I will say that there is a downward draught when it's on. If I had a bigger room I'd probably go back to the floor system again, but this way it gives us a bit more room.

(After Interview, 2 Sep 2015)

What was the result?

George and Leina reduced energy costs at the same time as increasing their energy use slightly. This is because energy prices went down and their increase in use was through the cheaper T41 power tariff. The upgrade was reported as helpful and despite already being aware of some suggestions made by the home energy helpers, they found the minor adjustments to the heat pump suggested were very useful and reduced heating draughts.

- ✗ Energy use increased by1.61kWh/day (5%), from 32.31kWh/day to 33.92kWh/day.
- ✓ Energy costs reduced by ~$271 per year (from $1894 to $1623).
- ✗ Time spent in the comfort zone decreased from 29.5% to 28.2%.
- ✗ Heating efficiency decreased from 0.33 to 0.1 (4.4%).
- ✓ Maintained confidence that they could find information on thermal comfort and reported improved confidence that they could access information on energy efficiency if needed.
- ✓ Draughts reduced.

Existing physical conditions of the house

Despite some insulation, the overshadowing from the house to the north and the eastern deck and the single glazing means that the thermal performance of this house is only poor to near standard level.

Type	Stand alone, suburban.
Age	50-59 years.
Construction	Brick veneer, tile roof, suspended timber floor (0.2m-0.4m off ground) (tiles, vinyl, carpet).
Insulation	Ceiling (batts), some walls (batts).
Windows	Single glazed, timber/aluminium frames.
Window coverings	Vertical blinds (kitchen and living), heavy curtains (living and bedrooms).
Access to sun	Northwest to southeast long axis, neighbouring house close to north corner, covered deck on north east of house, so little east and north sun, living room midday to afternoon sun.
Heating	Heat pump, radiant panel heater, electric blankets (2), hard-wired resistive circuit (garage – unmonitored).

Changes to the home

Other changes to the home:

- Daughter and grandson moved out.
- Started using small portable gas oven inside.

GET BILL SMART UPGRADES

✔ Ceiling insulation	✔ Small fridge thermometer
✔ Draught-proofing of doors	✔ Stay Warm education booklet
✔ Hot water pipes insulated	
✔ Lights changed	
✔ Shower timer	
✔ Door snakes	

Overview

George and Leina's household was very dynamic with changes in occupancy that led to fluctuations in energy use. In the before period the couple had an adult daughter and their grandchild stay with them. After the extra occupants left energy use actually went up a bit. Leina thought that they might have used more heating during 2015 because of the colder winter. Perhaps also there might have been some 'comfort creep' after the extra occupant left.

They had previously chosen to replace a floor-mounted heat pump with a wall-mounted heat pump to give them more floor space in their living room, although there were less happy with the effectiveness of the wall-mounted one.

Although George and Leina's energy use increased during the GBS project, their bills decreased. This was probably because of a reduction in energy costs and because their increase was mainly on the cheaper T41 heating tariff. Their heating efficiency and time in the comfort zone both reduced slightly, but the average temperature in both bedroom and living room increased slightly.

George and Leina found the physical changes made by GBS helpful, and even though they were already aware of some of the information provided, other information was helpful in assisting them to make minor changes (e.g. to heat pump use) that made them feel more comfortable. They now closed doors and windows when cold, and opened windows in closed-off rooms to keep the air fresh. They had recently started using a portable gas oven rather than an electric oven, and this may have related to the reduced Other Light and Power energy use.

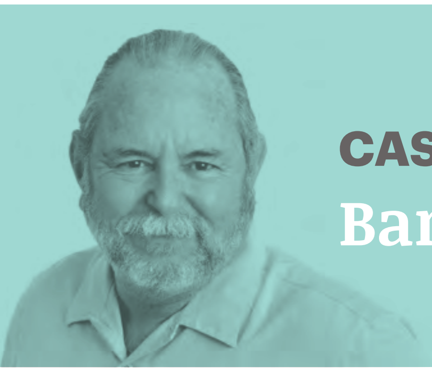
They felt more in control of their energy consumption, but said to improve this they would like to move to a smaller house. George and Leina also wanted solar power but said they could not currently afford it. Leina reported strong community connections, and said that there would always be new ideas and sources of help available. She would feel comfortable calling either GBS or Aurora for help.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	1.71	1.92	0.22	12.6%
T 41 Heating (hard wired heating)	14.71	16.17	1.46	9.9%
Total Heating	16.42	18.09	1.67	10.2%
Other Light and Power (T31)	9.02	8.65	–0.37	–4.1%
Hot Water	6.88	7.18	0.31	4.5%
Total Household Electricity	32.31	33.92	1.61	5.0%
House Heating Efficiency (degree-hours/kWh/day)	0.33	0.31	–0.01	–4.4%

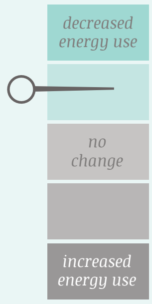
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.0	9.6	8.4	5.3	29.5%
After	17.9	9.9	8.3	5.6	28.2%
Difference between before and after	–0.1	0.3	–0.2	0.3	–1.3%

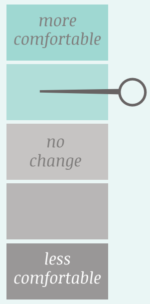


CASE STUDY 39
Barry and Mary

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	WOOD FIRE

What did we do?

IN HOME EDUCATION & UPGRADES

> The fridges would be the thing that would suck the power, there's not a lot I can do. We did ask [the Home Energy Helpers] about that and they said there was a thing you could do but it was a lot of mucking around and I thought "No we'll just continue on the way we're going". *(After interview, 2 Sep 2015).*

What was the result?

Barry and Mary experienced a minor improvement in their comfort levels and a small decrease in their energy use and electricity costs after the GBS home visit. The couple relied heavily on their wood heater for comfort in the home. During the GBS study period the couple had got solar power installed, but had had problems with the tariff rate they received and so weren't sure what benefit it would provide. The couple were involved in their community and had a caring attitude toward their neighbours but appeared not to need to ask for help from others much.

- ✔ Energy use decreased by 1.65 kWh (9.8%), from 16.81kWh/day to 15.16kWh/day.
- ✔ Energy costs reduced by ~$356 per year (from $1430 – $1074).
- ✔ Time spent in the comfort zone increased from 37.7% to 39.5%.
- ~ Given the wood heater, heating efficiency is not accurately measured for this home.
- ✔ Displayed improved confidence that they could find information on thermal comfort and energy efficiency if needed.
- ✔ Draughts reduced.

Existing physical conditions of the house

No moisture issues were measured in this home. Humidity peaked at a fairly low 65% in the living room in winter and, in the bedroom, at 75% before and 70% after. Draughts were a problem, likely amplified by heating from wood fire and balancing of temperatures across the house. While the reasonable curtain coverage and the use of radiant wood heat supported Barry and Mary's comfort, having the sun blocked for big chunks of the day, single glazing and only ceiling insulation led to the thermal performance of this house being poor.

Type	Stand alone, suburban.
Age	30-40 years.
Construction	Brick veneer wall, tile roof, suspended timber floor (0.5-2.0m off ground) (vinyl, carpet), photo voltaics on roof.
Insulation	Ceiling (batts, 5 years old).
Windows	Single glazed, aluminium frame.
Window coverings	Curtains with thermal backing plus lace in all rooms, one blind in kitchen and bathroom.
Access to sun	Overshadowed by neighbour and shrub close and uphill on north east so living (on eastern corner) only receives morning sun, kitchen and dining (open plan with living) receive midday and some afternoon sun but roofed deck on western side blocks lots of sun.
Heating	Wood heater with fan, electric blankets (2).

Changes to the home

Other changes to the home:

- New hot water cylinder.
- House sitters for a total of about 12 weeks overall (some in winter periods).

GET BILL $MART UPGRADES

- ✔ Hot water pipes insulated
- ✔ Stay Warm education booklet
- ✔ Hot water valve cosy
- ✔ Water-saving shower head
- ✔ Lights changed
- ✔ Shower timer
- ✔ Door snakes
- ✔ Small fridge thermometer

Overview

Barry and Mary are retired and live is a comfortable a well maintained home. Barry and Mary's overall energy use decreased because of a reduction in their hot water usage. They had a new hot water system installed in late 2014 which probably contributed to this. In the after period their time spent in the comfort zone increased, as did the average bedroom temperature, and the average living room temperature remained the same. Unusually, although Barry and Mary have a wood heater, they did not spend any time above the comfort zone cut-off point of 24° (wood heaters were normally heating to higher temperatures). This indicates they managed their wood heater outputs whenever they were using it.

Barry and Mary had had solar panels installed over the GBS study period. They had some trouble with the installation of these in relation to tariff charges (many others had similar issues with this at the same time). The solar panels affected the billing data, which means the apparent savings in energy costs are probably too high.

They were frustrated by the new light bulbs installed through GBS, which they reported as flickering (this was followed up on by SLT), and disliked the flashing of the sensor lights that recorded energy and temperatures. They were given advice about further changes by the home energy helpers, but decided that implementing them would mean too much trouble mucking around, and that they would just keep doing what they were already doing. They came from a strong church community which had an ethic of helping others who needed it.

Barry and Mary had house sitters in their home for two weeks during July 2014 and then at several other times throughout the study period, adding up to 12 weeks overall.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.31	0.41	0.10	31.1%
T 41 Heating (hard wired heating)	0.00	0.00	0.00	0.0%
Total Heating	0.31	0.41	0.10	31.1%
Other Light and Power (T31)	3.98	4.12	0.14	3.6%
Hot Water	12.52	10.63	–1.89	–15.1%
Total Household Electricity	16.81	15.16	–1.65	– 9.8%
House Heating Efficiency (degree-hours/kWh/day)	26.85	21.98	–4.87	–18.2%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.6	14.7	8.3	8.3	37.7%
After	18.5	15.7	8.2	8.9	39.5%
Difference between before and after	– 0.1	1.0	– 0.2	0.6	1.8%

Cases 40–51

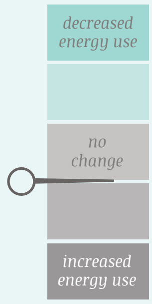
REPRESENTATIVE HOUSEHOLDS

There were no GBS support activities undertaken with these households. These households provided representative information and were not exposed to GBS activities.

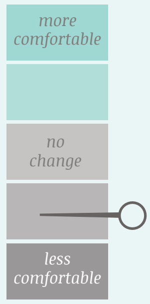
Houses in this case group were all living in suburbs in the Greater Hobart region. None of these households had homes in the suburbs of Clarendon Vale or Rokeby and none of these households were directly exposed to community capacity building activities held.

CASE STUDY 40
Naomi and family

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	WOOD FIRE + HEAT PUMP

What did we do?

REPRESENTATIVE GROUP

We're pretty frozen this year, because we haven't had any wood … I just put extra blankets and that on their beds. I've got two dogs that keep us warm. It's nice and warm in here, because that's basically on 25°C, but you walk around the rest of the house and it's freezing.

What was the result?

Naomi stopped using her wood fire due to cost. The temperatures in her house decreased to sit within the comfort zone of 18-24°C. While her comfort rating increased, this was mainly due to a reduced amount of overheating that was occurring due to the use of the wood fire. Naomi actually felt colder.

The radiant heat from the wood fire was important to Naomi's comfort and thus, while the air temperature of the comfort zones improved, Naomi reported feeling less comfortable. It is well understood that radiant heat is a more comfortable form of heat.

When Naomi stopped using a wood heater and the heat pump usage stayed roughly the same, but overall household heating increased and the temperatures dropped.

- ✗ Energy use increased by 2.2kWh (5.5%) from 40.01–42.21 kWh/day.
- ✓ Energy costs decreased by ~$300 per year (much of this due to no longer purchasing wood to burn).
- ✓ Time spent in the comfort zone increased from 56.9% to 80.1% (had been consistently above the comfort zone of 24 degrees in the before period).
- ✗ Heating efficiency decreased from 0.60 to 0.40 (34%) (due to the ceasing of use of the wood fire).
- ✓ Displayed improved confidence that she could find information on energy efficiency and comfort.
- ✗ Self reported moisture levels increased and mould noticed for the first time. Temperature not shown reaching dew point, but large temperature differences between inside and outside could cause significant condensation.

Existing physical conditions of the house

Naomi and her children rent a stand-alone suburban home. Sitting in the middle of a standard sized block the house is open to sunlight, The long axis of the house sits northwest to south west. The living room sits to the south and only receives some afternoon sun. The construction is weatherboard cladding with timber frame sitting on a concrete block skirt, roofed with corrugated iron with a timber suspended floor (covered in carpet and vinyl).

The house had no known insulation. Heating is provided by a wood fire and a heat pump in the living room and a radiant plug in heater in bathroom.

Due to the lack of available sunlight to the living area, the poor level of maintenance, the significant draughts and the lack of insulation this house is described as having very poor thermal performance.

Insulation	None known.	VERY POOR
Windows	Steel framed, single glazed, no pelmets.	POOR
Window coverings	Curtains of various weights.	NEAR STANDARD
Under floor space	Suspended timber floor .2-1.5m, underfloor enclosed with concrete blocks, no insulation.	POOR
Mould and moisture	Moisture levels reported to have increased, reported mould noticed for the first time.	POOR
Other conditions of note	House maintained in working order, but only just.	POOR
	Gaps under most doors and significant drafts.	POOR

Changes to the home

Other changes to the home:

- Blocked fan vent in bathroom with cardboard.
- Stopped draughts with rolled up towels.
- Used extra blankets and doonas.
- Hung curtains and sheets in doorways (kitchen and front door).
- Turned the heat pump down slightly.
- Stopped buying wood for the fire.

GET BILL $MART UPGRADES

Not relevant for this participant.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (%)
T 31 Heating (plug in heating)	2.88	6.58	128.7%
T 41 Heating (hard wired heating)	18.94	18.01	-4.9%
Total Heating	21.81	24.60	12.7%
Other Light and Power (T31)	9.65	7.99	-17.2%
Hot Water	8.55	9.63	12.6%
Total Household Electricity	40.01	42.21	5.5%
House Heating Efficiency (degree-hours/kWh/day)	0.60	0.40	-34.0%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	25.9	22.3	11.0	13.2	56.9%
After	21.7	18.8	10.5	9.8	80.1%
Difference between before and after	-4.2	-3.5	-0.5	-3.4	23.2%

Referring to the tables and graphs presented, multiple changes were noted. Total household energy use increased by 2.2 kWh/day, from 40.01kWh/day to 42.21kWh/day (5.5%). Total heating went from 21.8kWh/day to 24.6kWh/day, an increase of 12.7%. The use of the heat pump declined by 4.9%0.9kWh/day(4.9%), while plug in heating use increased by over 3.7kWh/day (128%).

Not captured in the data above is that Naomi stopped purchasing wood for their wood heater in the after period because it was difficult to source and she had been finding the wood was often green (other households also had these issues). Reducing the use of the wood fire saved her approximately $500 but increased the pressure on her electrical heating and caused a shift in heating practices. The extra plug in heating may have also been used to counteract the lack of radiant heat from the fire. Heating efficiency reduced by 34% (from 0.60 to 0.40). The reduction in heating efficiency is because the heat from the wood fire being used in the before period is not available in the after period. The electrical heating is being used approximately the same amount and providing approximately the same amount of heat, but the extra 'free' heat from the wood fire is not there in the after period.

Time spent inside the comfort zone (of 18-24°C) increased from 56.9% to 80.1%. The family had actually spent more time over 24°C (over the comfort zone) in the before period with the wood heater. During the after period they more frequently spent time in the comfort zone, rather than above it. As is shown in the table and charts, average temperatures did reduce somewhat. The living room was the only place where the temperature had an average comfort that exceeded 24°C in the after period. In the living room time spent above the comfort zone reduced from 75.5% to 9.2% of the time. In the bedroom time spent above the comfort zone reduced from 10.6% of the time to 0%.

Example charts show that in the before period bedroom and living room temperatures follow each other when the wood fire is on. The heat pump may have been used to blow heat down the hallway and perhaps to kick start the heating in the house while the fire was being lit. The after chart shows that the heat pump was used more continuously once the wood fire was no longer in use. The temperature is maintained at a more consistent but cooler level and there are no large spikes in temperature.

The example before/after charts also show how much the house responds to the outside temperature cycles. In the before chart this response is less visible as the heat from the wood fire is intense enough to partly overrides the outdoor cycles. This response to outside temperatures indicate poor thermal resistance in the building shell.

Naomi was a shift worker (and a student in the after period), so tended to need heating at irregular hours. Naomi had said that she had been more onto the teenager children about keeping the temperature of the heat pump down in the after period.

Hot Water use increased 1.08 kWh/day from 8.55 kWh/day to 9.63 kWh/day (12.6%). Other light and power decreased by 17.2% (from 9.65kWh/day to 7.99kWh/day).

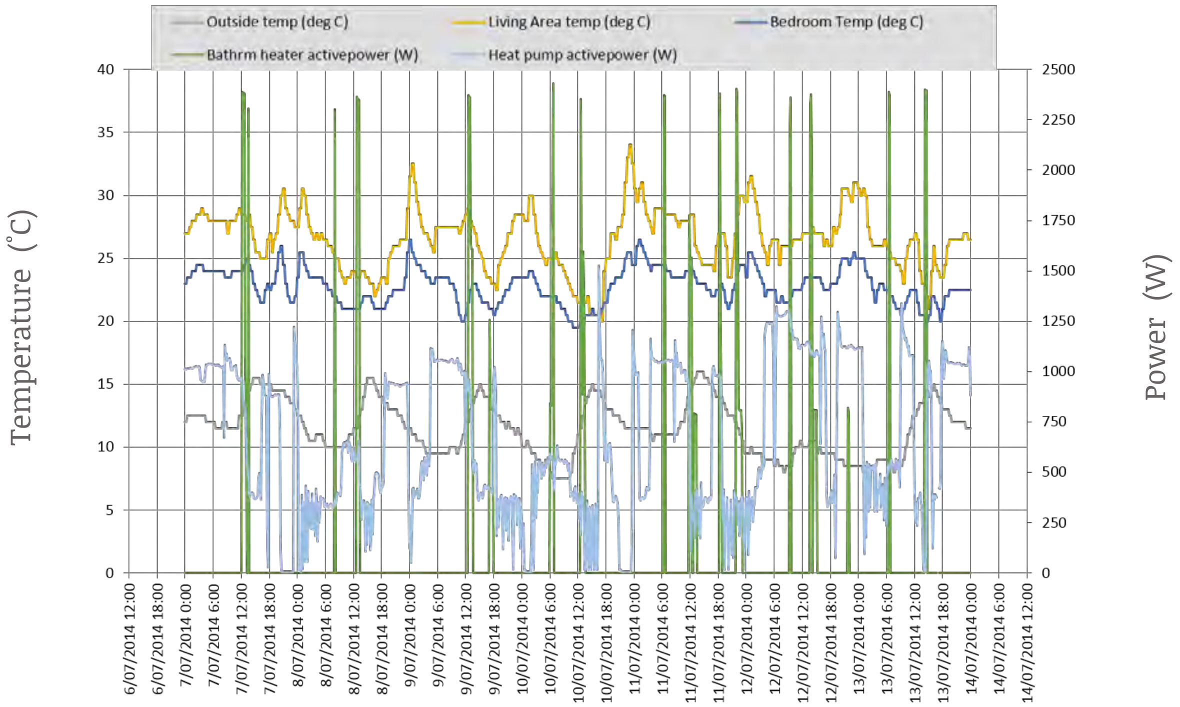
Likely linked to changes in heating is the change in moisture/mould where mould was noticed by Naomi for the first time in the after period. The house measurements showed that temperature did not meet dew point in the bedroom or living area and that peak humidity before was 75% and after was 70% and most often did not peak above 60%, so these measure show no regular issues. However it is important to note that condensation on cold surfaces can be more likely to occur, where there is a large temperature difference between inside and outside as is the case in this household. The higher internal air temperature allows more water vapour to me stored in the air. This, in combination with the poor thermal resistance of the building skin which leads to cold window and external wall surfaces, could lead to condensation occurring on those surfaces, even though our air temperature measurements make it seem that it would be unlikely.

When we first moved in to this house, I kept the heating up on 21 thinking that 21 was like optimum… a good temperature to have it… So anyway, I discovered after getting—I think the first bill was $600, so we turned it down to 18. And then the next bill was $900. But see, it was on 24/7. *(Before Interview 4/6/14)*

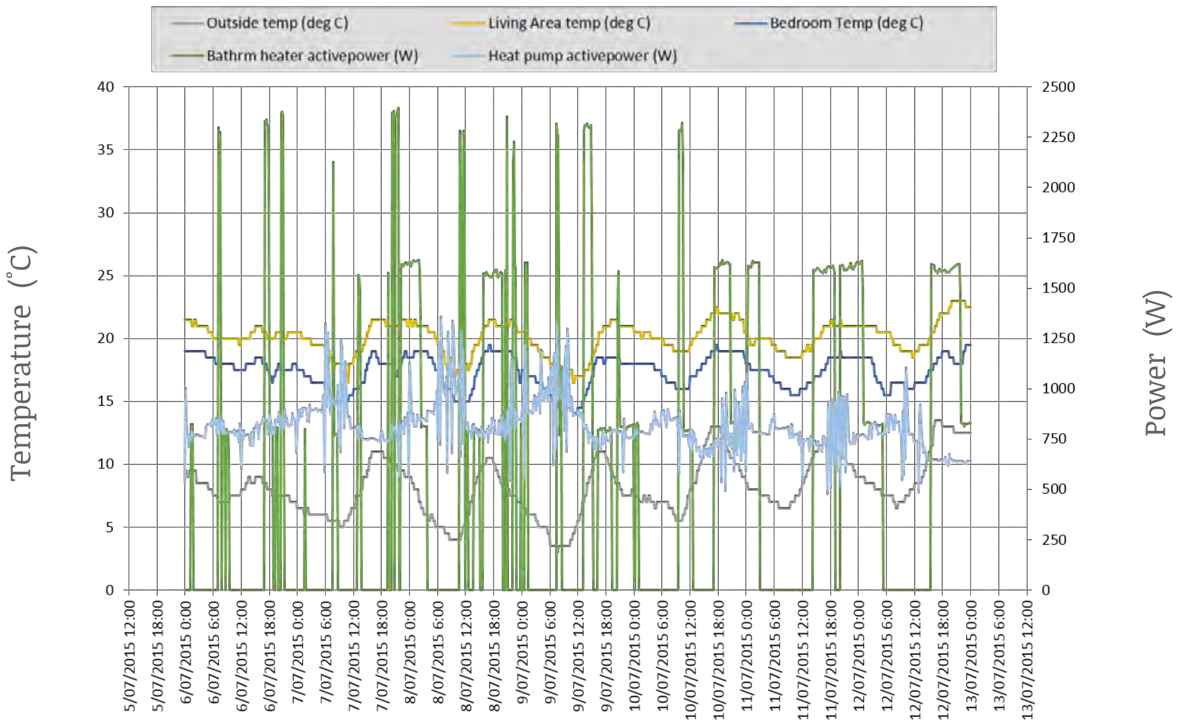
We've got a fan in the bathroom, it has a lot of cold air coming through it. So I pulled the cover off one day to clean it, and I had a look up there. I thought I'm going to cover it up, so I cut out a piece of round cardboard and popped it in there, to stop the… cold coming through. Because it's right above the shower, and when we get in the shower, and you can feel all this cold air coming through and it was really cold.

(After Interview 31/09/2015)

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Unsurprisingly, with her increased electricity use, Naomi also increased her power bills. Naomi stopped purchasing wood because it was too expensive and estimated that this saved her approximately $500-$600 per year. Offsetting these savings was some increase in heater usage which increased her power bill by approximately $200 per year. Overall, although Naomi's house was not as warm she had a very high percentage of time within the comfort zone, and she saved approximately $300 per year in heating costs.

Prior to participating in the Get Bill Smart program Naomi explained how stressed she was financially:

Last year I was struggling with the hydro [electricity bill] because I was unemployed for three months as a temporary.....That's when I copped the [huge] bill and I was just, you know, with Centrelink money, Hydro's getting most of it, it was ridiculous. I was getting someone delivering a food hamper to me every week, just with fruit and veggies and stuff...

If I hadn't had that we would have starved, I reckon.
(Before Interview 4/6/2014)

When we spoke with Naomi a second time she was thankful her bill had decreased:

I've only just got the winter bill, which was $800 something last year and it was only $700 this year. Only $700 is still a lot.
(After Interview 31/09/2015)

Much of this decrease she put down to the general decline in energy price as set by the electricity provider.

Personal and community change

Naomi, her two children, their two dogs and a cat manage to heat their home most of the time. Naomi is a shift worker and has irregular hours, making heating and home management more difficult. The move from using the wood fire to the heat pump and plug in heaters has changed the way she heats her home, comfort levels and also changed her overall heating costs. While the house is most often in the comfort zone, Naomi acknowledged how cold the place would be without heating:

It'd be freezing. [With the heater on it improves] a little....It takes a lot. You need the fire going for two or three hours at night time for the lounge room and hallway to warm up, so that's nice and comfortable. And if I'm cooking tea in here at night time this room will warm up.
(Before Interview 04/06/2014)

Naomi's house was not in very good condition and she had trouble getting the landlord to address some of the problems. For example, the toilet leaked on and off during her tenancy and there had been trouble with the wood heater.

Given that both Naomi and the landlord had very little money (as noted by Naomi) available for things, like accidentally broken windows, became long term problems. As Naomi explained,

We've got a broken window in the main bedroom, so there's only a piece of cardboard on there at the moment. That was just a random; that was really windy one night and the window just pulled open and broke. We can't afford the excess to get it fixed just yet. *(Before Interview 04/06/2014).*

Such problems contributed to the discomfort she felt in the house – the window making things particularly cold and draughty.

Despite the challenges of the home, Naomi did her best to keep herself and her family warm. She had blocked up vents, used bits of material to zone areas of the house and had made door snakes using rolled up towels held together with hair ties. She kept the house very clean and this helped to reduce the mould and moisture problems. She said,

Actually when I first moved in there was mould all over the windows and everything. But see, I keep it clean so... I clean a couple of times a week because we've got dogs and the fluff and hair that goes everywhere. *(Before Interview 04/06/2014).*

When we spoke to Naomi the second time she was renting from a new owner who was acting to improve the house a little. In an attempt to be proactive she had asked the landlord about possibilities for draught proofing but he was fairly dismissive of the problem. Naomi was frustrated by the poor quality and broken curtain and blinds in the home but similarly had no luck getting them replaced by the landlord.

Keeping the home warm was important for Naomi, not only did she want her family to be comfortable but she had carpal tunnel syndrome,

Yeah, well I've got carpal tunnel too, so I can't stand cold houses. It's one of those, I feel alright at the moment. But sometimes I'd get up in the morning and it's just, they're frozen. Carpal tunnel problem – need to keep it warm. *(After Interview 31/08/2015)*

Naomi felt that she lived in a strongly connected community. Her sense that there were people she could ask for help regarding energy efficiency and thermal comfort increased over the course of the project.

Naomi explained that she didn't have a strong personal community with her neighbours but had a strong connection with the neighbourhood house. At times when Naomi had need for assistance (food hampers etc.) the neighbourhood house really supported her. In turn, Naomi always made sure that when she had extra she passed it on through the community centre so that others who needed help could receive it.

Naomi said,

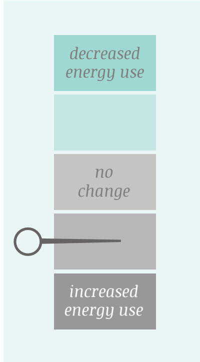
That's a pretty good community centre, they have a lot of programs going for local people and stuff. There's always people there, and my daughter was actually going through the training program, learning to drive. *(After Interview 31/08/2015)*

Despite this connection, Naomi and her children felt that the suburb they lived in was unsafe and they didn't tend to talk to people in the street or go out at night alone.

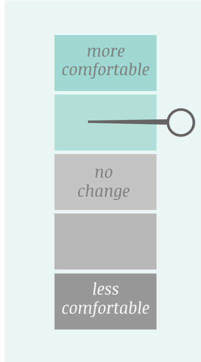
Overall Naomi was very proactive but was limited in what she could achieve because of income and her renter status. The house was thermally poor and required lots of heating to maintain comfort.

CASE STUDY 41
Olivia

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	RENTER	2	ONE STOREY TOWNHOUSE	HARDWIRED RESISTIVE

What did we do?

REPRESENTATIVE GROUP

> You know, I do wear warmer gear and wrap up as much as I can, you know, because that is a power eater.
>
> *(After Interview 01/09/2015)*

What was the result?

Over the course of the project Olivia slightly increased her power use and the time she spent in the comfort zone.

These increases are likely due to the increased severity of her illness and the long periods she was confined to the home.

Olivia added a new plug in heater to the living area and bought a warmer doona for her bed.

On a low income, Olivia had a history of careful home management and was very conscious of energy use and energy saving measures.

✗	Energy use increased by 1.51kWh (5.7%) from 26.6kWh/day to 28.11kWh/day.
✗	Energy costs increased by ~$231per year ($980-$1211).
✓	Time spent in the comfort zone increased from 29.8% to 34.4%.
✓	Heating efficiency increased from 0.38 to 0.41 (6.3%).
✓	Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
✗	Self reported increase in draughts.

Existing physical conditions of the house

Olivia lived in a recently constructed unit with double glazing and solar hot water. No moisture issues found. Temperature did not reach dew point. Humidity peaks reduced (from 65%–55% in living). Bedroom range was 70% before and 75% after.

Type	Conjoined unit, one storey in townhouse complex.
Age	0-5 years.
Construction	Brick veneer and fibre board walls, corrugated metal roof, concrete floor on ground (vinyl, carpet), solar hot water.
Insulation	Ceiling batts, walls batts.
Windows	Double glazed, aluminium frame.
Window coverings	Paired light and heavy curtains in living and dining.
Access to sun	Conjoined neighbours sit on north east and south west, living room receives north eastern sun.
Heating	Wired in radiant heater in living room, radiant heater elsewhere, plug in heater.

Changes to the home

Other changes to the home:

- Olivia was quite unwell and spent a lot more time at home in the winter and more time in the hospital in summer.
- Olivia installed an extra plug in heater into her kitchen area.
- The fridge was replaced and Olivia was given a chest freezer.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Olivia was always looking for ways to save money and energy use. She washed the dishes in a small amount of water, only filled the kettle up with one cup's worth of water, and always chose to put on more clothes or blankets when she first got cold.

While Olivia carefully managed her bills, when she became extremely ill she changed her behaviour. She realised that for her health she needed to be warm and that she would risk very large electricity costs. This increased heating use in both before and after periods.

Olivia increased her heating use in the after period. It is likely that this is due to her purchase of a new plug in heater (we did not have sensors on this heater – plug in heater use captured in Other Light and Power). The energy efficiency of Olivia's house increased which is likely due to slightly lower average temperatures (still above 18°C) but remains good. Double glazing and the ceiling and wall insulation contributes to the efficiency of the home.

As a tenant and on a low income, there were things that she could not do. For example she was frustrated by the draughty rattling of the internal bedroom door. Olivia also wanted fly-screens on her doors to enable her to make the most of cooling summer breezes.

While Olivia didn't get out a lot due to illness, she felt very supported by her local neighbours. Having been given a chest freezer a nearby resident advised Olivia that keeping in part full was the most efficient thing to do (sound advice).

Olivia's house performed to standard thanks to insulation, double glazing and solar hot water. However the heater was not well suited to the space. It was energy hungry and Olivia found it difficult to effectively manage comfort.

Average daily energy use and heating efficiency during winter conditions

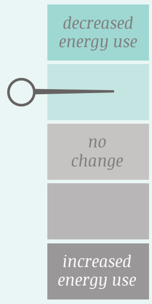
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	20.22	19.93	-0.28	-1.4%
Total Heating	20.22	19.93	-0.28	-1.4%
Other Light and Power (T31)	3.74	5.27	1.53	41.0%
Hot Water	2.64	2.91	0.27	10.0%
Total Household Electricity	26.60	28.11	1.51	5.7%
House Heating Efficiency (degree-hours/kWh/day)	0.38	0.41	0.02	6.3%

Average daily temperatures and time in comfort zone during winter conditions

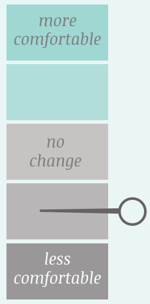
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	19.9	15.6	9.9	7.8	29.8%
After	19.6	15.6	9.4	8.1	34.4%
Difference between before and after	-0.3	0.0	-0.5	0.4	4.6%

CASE STUDY 42
Teri

ENERGY USE



COMFORT



	RENTER		ONE STOREY TOWNHOUSE	PLUG-IN ELECTRIC + HEAT PUMP
Occupants	Own or rent	Bedrooms	House type	Heating

What did we do?

REPRESENTATIVE GROUP

> Well I'm just getting over the flu, I don't know if that had anything to do with it. If I get really cold I go to bed. It's warmer there. *(Before Interview 26/5/14)*

What was the result?

Despite living in a cold house and having little knowledge of heater performance, Teri improved her comfort by switching off the radiant floor heater and switching on the heat pump in her living room. Teri had avoided using the heat pump, which she called 'that thing', until her daughter in law showed her how to use it.

✔	Energy use decreased by 1.85kWh/day (10.6%) from 17.40kWh/day to 15.55kWh/day.
✘	Energy costs increased by ~$139 per year ($1119-$1258).
✘	Time spent in the comfort zone decreased from 34.5% to 32.6%.
✔	Heating efficiency increased from 0.66 to 0.83 (24.5%).
✔	Displayed improved confidence that she could find information on thermal comfort if needed.
~	No change to self-reported moisture levels (no moisture observed).
✘	Draughts continued to be problematic
✔	Self reported comfort increased.

Existing physical conditions of the house

Teri lived in a federation-style, one-storey, timber suburban house that had been converted into two units. The unit received very little sun and the living area sat on the south-western side of the house. No insulation in the ceiling or walls coupled with poor orientation and an old structure meant the house sustained a cold microclimate. No mould or moisture problems noted – likely due to draughtiness.

Teri found the house to be draughty and reported that it was never comfortable in winter and rarely comfortable in summer.

Overall thermal performance was very poor. Teri found the house so uncomfortable that she decided to move again after under a year in the house.

Type	Single story town house, suburban.
Age	Approximately 100 years.
Construction	Weatherboard, corrugated iron roof, suspended timber floor (low – no skirt).
Insulation	Unknown (suspected none).
Windows	Single glazed, timber frames, no pelmets, living room skylight.
Window coverings	Heavy curtains (living, bedroom), blinds (other areas of the house).
Access to sun	Living room on south west side of house, very little solar access.
Heating	Plug in radiant heater with fan booster (living), heat pump (living).

Changes to the home

Other changes to the home:

- On the advice of a family member, Teri began to use her heat pump rather than the radiant floor heater (plug in).
- Teri used more blankets to keep warm.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Teri is in her 60s and lives alone. When we first met, she had lived in her house for less than a year. She found it so uncomfortable that at the last interview she explained that she intended to leave as soon as possible.

Thanks to a tip off from her daughter-in-law, Teri began to use the heat pump rather than the radiant heater. This made a big difference to her home heating efficiency (a shift of 24.5% from 0.66 to 0.83). Teri's time in the comfort zone decreased (from 34.5% to 32.6%), but this is because she spent more time above 24°C (from 12.2% to 15.3%). Teri dramatically reduced the use of her plug in heater in favour of the heat pump.

Average living room temperatures increased by approximately 1°C, while bedroom temperatures decreased by a similar amount.

Teri had a small house, good zoning practices and heavy curtains which meant that she was able to manage her heater use relatively efficiency.

However Teri explained that she was uncomfortable in the house due to draughts, cold surfaces and a lack of sunlight. Due to the discomfort Teri felt in the house she had decided to move out as soon as possible in search of a warmer home.

Teri was somewhat involved with her local community and attended a few local community run activities. She found her daughter-in-law the most helpful source of information regarding energy efficiency and other types of technological problems.

Average daily energy use and heating efficiency during winter conditions

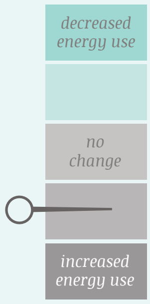
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	4.40	0.22	-4.18	-95.0%
T 41 Heating (hard wired heating)	6.91	9.11	2.20	31.8%
Total Heating	11.31	9.33	-1.98	-17.5%
Other Light and Power (T31)	4.11	4.19	0.07	1.8%
Hot Water	1.98	2.03	0.06	2.9%
Total Household Electricity	17.40	15.55	-1.85	-10.6%
House Heating Efficiency (degree-hours/kWh/day)	0.66	0.83	0.16	24.5%

Average daily temperatures and time in comfort zone during winter conditions

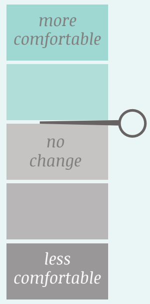
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.8	15.0	9.4	7.5	34.5%
After	19.9	14.2	9.4	7.7	32.6%
Difference between before and after	1.1	-0.8	-0.1	0.2	-1.9%

CASE STUDY 43
Kara

ENERGY USE



COMFORT



Occupants

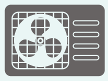
RENTER

Own or rent

Bedrooms

FREESTANDING ONE STOREY

House type



HARDWIRED RESISTIVE

Heating

What did we do?

REPRESENTATIVE GROUP

> Well I can't put the heater down any more in the winter when it's cold. I can't keep putting jumpers and jumpers on.
>
> *(After interview, 1 Sep 2015)*

What was the result?

Kara's energy use and comfort practices remained relatively stable over the course of the project. As someone living in NGO-provided housing she had received some basic assistance with draught-proofing which had improved her comfort. Kara wanted more help and would have liked to have received an upgrade. She managed her home well for energy efficiency and thermal comfort given the physical constraints of the house and her financial limitations.

✗	Energy use increased by 3.05kWh/day (17.2%), from 17.7kWh/day to 20.75kWh/day.
✗	Energy costs increased by ~$54 per year (from $830 to $884).
✓	Time spent in the comfort zone increased from 15.8% to 16.9%.
✗	Heating efficiency decreased from 0.48 to 0.40 (15.5%).
✓	Displayed improved confidence that she could find information on thermal comfort if needed.
~	Draughts remained problematic.

Existing physical conditions of the house

Kara's house was well maintained with no sign of mould. Intermittently temperature may have reached dew point and caused surface condensation. Moisture and humidity was not a problem in the living room, but in both the Before and After periods moisture reached 85%. This was a borderline house in terms of moisture problems and the draughts may have actually helped to reduce this. Overall, despite good curtains and solar access, the lack of insulation, single glazing and old inefficient heater meant this house had poor thermal performance.

Type	Stand alone, suburban.
Age	20 – 29 years.
Construction	Brick veneer, corrugated metal roof, suspended timber floor (1m above ground) (vinyl, carpet).
Insulation	Unknown (suspect none).
Windows	Single glazed, aluminium frame.
Window coverings	Heavy curtains (triple layer), vertical blinds in one window for privacy.
Access to sun	Long access north/south, open plan living/dining/kitchen on north end of house, all day sun .
Heating	Rad fan wired-in heater (living), fan heater (bathroom).

Changes to the home

Other changes to the home:

- Used heater more in the winter of 2015.
- Door seals (landlord).
- Attempt to fix heater (landlord).

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Kara's house was well-maintained and she had consistent energy use practices. When we first met her, she had just undertaken a substantial change to her routine and was in a transition period. She had significant problems with her heater, which she said 'drove her mad', and didn't think her house functioned in a supportive way. She would have liked to have had an upgrade and some extra help. She had in the past used the local community centre, but she felt less safe in her neighbourhood than she had previously and this stopped her seeking information there.

Kara's use of plug-in heating reduced slightly while her hard-wired heating use increased by 24%. This suggests she was heating her home more than usual, which was consistent with her observation that she used her heater more due to the cold winter. The other changes in her electricity use shown in the energy use table below are likely just due to slight changes in lifestyle patterns and the general dynamic of living in a house.

Although Kara's time in the comfort zone did increase by a small amount, the average temperatures in the living room and bedroom in mid-winter actually fell slightly (by less than 1°).

Average daily energy use and heating efficiency during winter conditions

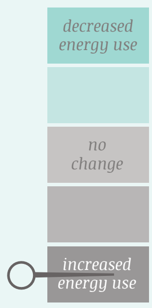
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.38	0.36	–0.01	–3.2%
T 41 Heating (hard wired heating)	10.32	12.85	2.53	24.5%
Total Heating	10.69	13.21	2.52	23.6%
Other Light and Power (T31)	3.14	3.21	0.07	2.2%
Hot Water	3.87	4.33	0.46	11.9%
Total Household Electricity	17.70	20.75	3.05	17.2%
House Heating Efficiency (degree-hours/kWh/day)	0.48	0.40	–0.07	–15.5%

Average daily temperatures and time in comfort zone during winter conditions

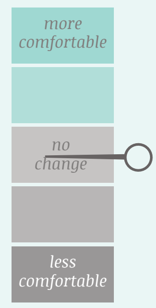
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	16.0	13.0	9.3	5.1	15.8%
After	15.8	12.5	8.8	5.3	16.9%
Difference between before and after	–0.1	–0.5	–0.6	0.2	1.1%

CASE STUDY 44
Martin and Fiona

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

REPRESENTATIVE GROUP

What was the result?

Overall, Martin and Fiona thought that they hadn't changed their power use much in the After period because they had not changed their heating practices. The data shows they heated to a higher temperature and thus used more power. The increase may have occurred when their second foster child came to stay during the GBS study period. Despite this change, Fiona had fairly consistent and regular routines for managing comfort and energy in their home. Martin and Fiona foster two children (one a teenager) who, along with Martin, have health issues that Fiona partly manages by keeping the house warm.

✗	Energy use increased by 6.51kWh (13.9%), from 46.80kWh/day to 53.31kWh/day.
✗	Energy costs increased by ~$55 per year (from $2752 to $2767).
✗	Time spent in the comfort zone decreased from 44.9% to 38% (time spent above 24°C in living increased from 76.5% to 86.1%).
✗	Heating efficiency decreased from 0.41 to 0.39 (3.3%).
✓	Displayed improved confidence that she could find information on thermal comfort.

We may have used a little bit more power but that was because it was so cold but overall I don't think, you know, because we've got Pay as You Go I think it's much easier because then you can keep a track of what you get.

(After Interview 2/9/15)

Existing physical conditions of the house

This home had no moisture issues. In winter the humidity peak was only 45% in the living area (higher in summer, at 70%, when heating was not in use). Humidity in the bedroom was 65% in the Before period and 60% in the After. Overall, even though the house was not well insulated and had single glazing its thermal performance was better than the average in this study (with heat being held inside to some extent) and worked to a poor/near standard level.

Type	Stand alone, suburban.
Age	50-59 years.
Construction	Vinyl with weatherboard under-cladding, cement sheeting under floor skirt, corrugated metal roof, floor (0.6m-1.5m off ground) (timber, tiles, carpet), front and back door deck (both enclosed with plastic blinds).
Insulation	Ceiling (batts).
Windows	Single glazed, aluminium frame, 2 pelmets in kitchen/living.
Window coverings	Vertical blinds and curtains (heavy) in living, all others lace.
Access to sun	North to south long axis, open plan living and kitchen at north end of house, sun into living in afternoon, eastern roofed deck reduces morning sun somewhat.
Heating	Heat pump in old fireplace position.

Changes to the home

Other changes to the home:

- Longer use of heater due to colder winter.
- Extra blankets on the beds.

GET BiLL $MART UPGRADES

Not relevant for this participant.

Overview

Martin and Fiona are aged in their 70s. They live in an area of Greater Hobart with a high incidence of fog. They currently care for two foster children, one in high school, who has been living with them for some time, and one in primary school, who arrived during the study period. Their regular heat pump use and consistently-managed home routines meant temperatures and airflow were good and the home was dry with no moisture issues. Martin is a skilled handyman, and he and Fiona have retrofitted their front and back decks with plastic blinds creating a wind block to stop draughts. Prior to the GBS project they had received federally-funded insulation upgrades and had also installed new, heavy curtains that had made a difference. They were already careful in their energy use, cooking outdoors on a gas barbeque because it was cheaper and turning appliances off at the power point when not in use. They reported that their foster children used a lot of hot water in their showers and baths, but hot water usage did decline in the After period.

Martin has previously had a heart attack and so Fiona was careful to use the air-conditioner in hot weather. They use their heat pump to heat the living area in winter; Fiona practices zoning but opens up the bedrooms at night so that heat can flow in. She reported that the heat pump is set on 20, but the average temperatures were much higher than this — in fact, time spent above 24° increased during the study period from an already high 76% to 86%. The average bedroom temperatures, at 19°, were also comparatively high (but actually more healthy than a lot of houses studied). Use of an unmonitored plug-in heater during the study period may have also contributed to the increased energy usage.

Both Martin and Fiona have strong connections in their community. They make regular use of their local community centre and provide assistance and advice to other people in the area. They are actually some of the 'go-to' people in their community. They are also active grandparents and have day to day contact with their children, grandchildren and great grandchildren.

Average daily energy use and heating efficiency during winter conditions

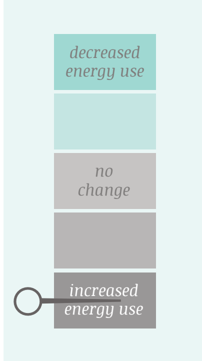
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	32.53	35.91	3.38	10.4%
Total Heating	32.53	35.91	3.38	10.4%
Other Light and Power (T31)	6.11	9.78	3.67	60.0%
Hot Water	8.16	7.62	–0.54	–6.6%
Total Household Electricity	46.80	53.31	6.51	13.9%
House Heating Efficiency (degree-hours/kWh/day)	0.41	0.39	–0.01	–3.3%

Average daily temperatures and time in comfort zone during winter conditions

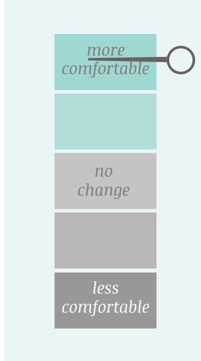
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	26.3	19.2	9.5	13.2	44.9%
After	26.9	19.0	8.8	14.1	38.0%
Difference between before and after	0.6	–0.2	–0.7	0.9	–6.9%

CASE STUDY 45
Leah

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	OWNER WITH MORTGAGE	3	FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

REPRESENTATIVE GROUP

> I don't even shut my curtains. I just leave them pulled. The only thing I pull down a bit is that blind of a night.
> *(After interview, 7 Sep 2015).*

What was the result?

Leah increased her time spent in the comfort zone as a result of changing her heating practices. Just to see what would happen she began leaving her heat pump on 24 hours a day. As expected this increased her time in the comfort zone, reduced her moisture problems and increased her energy use.

Leah's daughter had suggested she use her curtains, which were of good quality, to reduce heat loss but this was not something Leah had acted on.

✗	Energy use increased by 7.51kWh (24.2%), from 30.96kWh/day to 38.46kWh/day.
✗	Energy costs increased by ~$163 per year (from $1460 to $1623).
✓	Time spent in the comfort zone increased from 50.2% to 79.5%.
✗	Heating efficiency decreased from 0.29 to 0.28 (4.4%).
✗	Displayed reduced confidence that she could find information on thermal comfort if needed.
✓	Displayed improved confidence that she could access information on energy efficiency if needed.
✗	Draughts remained problematic.

Existing physical conditions of the house

This was a well maintained house that, despite insulation, performed poorly due to single glazing, aluminium frames and poor solar access. The house was draughty and had some level of moisture and mould. The dew point was sometimes reached prior to changes in heat pump use but was not a problem in the after period.

Type	Stand alone, suburban.
Age	Unknown
Construction	Concrete block, tiled roof, suspended timber floor (vinyl, carpet).
Insulation	Ceiling only (batts, installed 2009).
Windows	Single glazed, aluminium frame.
Window coverings	Combination lace and curtains, blind (kitchen).
Access to sun	Back covered deck on north-east, living room in south-west, no access to northern winter sun.
Heating	Heat pump, electric blanket (2).

Changes to the home

Other changes to the home:

- Use of heat pump 24/7 as experiment.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

In many ways, Leah was not particularly savvy with regard to energy efficiency. Her home was well kept but when we first met her she admitted that she didn't think much about energy use. She started running her heat pump 24 hours a day as an experiment to see what it did to her bill. As expected, her bill increased, but the longer running time also increased her time in the comfort zone — although this was also due to a reduction in time spent above 24°. She seems to have stopped using her plug-in heater in the after period. She did report improved confidence about finding information on energy efficiency and thermal comfort in the after period; although she did not think there was anyone in her community who could specifically help her with these things.

Leah kept her curtains and blinds open all the time. Her daughter suggested that she could make better use of them by closing them at night to keep the heat in, but Leah had not acted on this suggestion.

Leah had a strong sense of community. She was heavily involved with her local community centre, attending classes and recreational activities there. The centre provided transport which made these activities very accessible.

Average daily energy use and heating efficiency during winter conditions

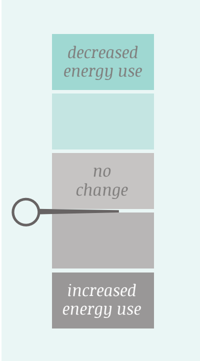
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.96	0.52	–0.44	–45.9%
T 41 Heating (hard wired heating)	20.62	29.42	8.81	42.7%
Total Heating	21.57	29.94	8.37	38.8%
Other Light and Power (T31)	6.51	5.67	–0.84	–12.8%
Hot Water	2.87	2.85	–0.03	–0.9%
Total Household Electricity	30.96	38.46	7.51	24.2%
House Heating Efficiency (degree-hours/kWh/day)	0.29	0.28	–0.01	–4.4%

Average daily temperatures and time in comfort zone during winter conditions

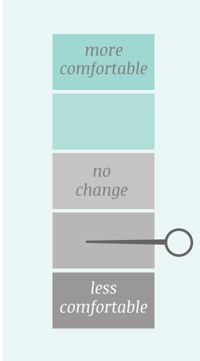
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	19.8	15.8	11.5	6.3	50.2%
After	22.0	17.9	11.6	8.3	79.5%
Difference between before and after	2.1	2.2	0.1	2.0	29.3%

CASE STUDY 46
Terrance and daughter

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	RENTER		FREESTANDING ONE STOREY	GAS HEATER

What did we do?

REPRESENTATIVE GROUP

I don't know, I'd be interested to find out what the insulation is like. Obviously it's not my house so I don't know how well insulated it is. I reckon probably most of the heat loss comes from the windows, so if it was my house I would consider things like double glazing and stuff like that, but obviously it's not mine so...

(After Interview 24/8/15)

What was the result?

Terrance and his daughter's energy use increased slightly. Because they were renters they did not really consider changing anything and he was happy to pay for the heating they needed. Despite his willingness to do this, they only spent around 30% of time in the comfort zone.

✗	Energy use increased by a slight 0.45kWh/day (1.6%) from 21.66kWh/day to 22.01kWh/day (all gas energy is included here – gas use was converted into kWh for comparison).
✗	Energy costs increased by ~$31 per year ($841-$872).
✗	Time spent in the comfort zone reduced slightly from 33.0% to 30.0%.
✓	Heating efficiency increased from 0.11 to 0.10 (6.7%).
✓	Displayed improved confidence that he could find information on thermal comfort and energy efficiency if needed.
✓	Draughts reduced.

Existing physical conditions of the house

Terrance's house was one story 1930s-style with a split level living room extension added over ten years ago. The house had gas heating, hot water and cooking.
The family had no problems with dew point as temperature clearly stayed away from dew point. Humidity peaked in the living room at 75% before and 70% after GBS activities, but winter tended to be under 65% humidity before and after.

Despite double brick walls, which would assist to slow heat loss down, the southern living room, single glazing, split level open plan (which creates stack effect) and the minimal insulation lead to a poor thermal performance.

Type	Stand alone, suburban.
Age	30-40 (extension) – original approximately 90 years old.
Construction	Double brick walls in original section, weatherboard timber frame in extension, corrugated metal roof, suspended timber floor (0.1-1.0m off ground) (carpet and vinyl cover). Split level between original house and living room extension.
Insulation	Part of ceiling has 100mm cellulose.
Windows	Single glazed, timber frame, skylight in kitchen.
Window coverings	Curtains (heavy) in living areas, blinds in dining, curtains + blinds in bedrooms.
Access to sun	All day sun, long axis northwest to south east, living on south east (3 external walls) so morning sun, living open plan with kitchen.
Heating	Gas ducted heating through house, electric blankets.

Changes to the home

Other changes to the home:

- No changes made.

GET BILL SMART UPGRADES

Not relevant for this participant.

Overview

Terrance and his teenage daughter were renting their house from a friend who was overseas.

Terrance valued a warm home and was happy to heat the house on demand.

Terrance and his daughter relied heavily on gas. Gas was used for heating, hot water and cooking. In the table below, gas was converted to kWh for comparative purposes.

Gas heating was estimated at 73.47kWh/day before and 81.36kWh/day after. Gas ducted heating also used electricity for ignition, fan and thermostats (2.27kWh/day to 2.43kWh/day).

The average temperatures in Terrance's home sit within, or are close to, the comfort zone. Given he has a ducted heating system with thermostat controls he is able to maintain fairly constant temperatures (which he does).

While Terrance had high levels of control over his comfort he also used a huge amount of energy to do so, indeed he is one of the highest energy users in the study.

Total heating energy increased by 10.6% in after period. This may have been because his teenage daughter lived with him more often. Terrance was also studying and this may have increased the time he spent in the home.

Average daily energy use and heating efficiency during winter conditions

	Before	After	Change
	(kWh/day)	(kWh/day)	(%)
T 31 Heating (plug in heating)	2.35	2.49	6.0%
T 41 Heating (hard wired heating)	0.00	0.00	0.0%
Total Heating	75.82[1]	83.85	10.6%
Other Light and Power (T31)	8.20	8.41	2.4%
Hot Water	11.11	11.11	0.0%
Total Household Electricity	21.66	22.01	1.6%
House Heating Efficiency (degree-hours/kWh/day)	0.11	0.10	-6.7%

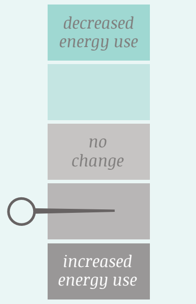
[1] This number includes gas energy converted to kWh. The electrical energy used to run the ducted gas heating system and fans, is listed in T 31 heating line.

Average daily temperatures and time in comfort zone during winter conditions

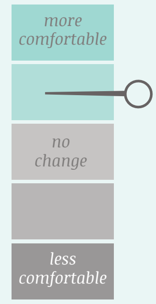
	Living Temp (°C)	Bedroom Temp (°C)	Study Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	18.9	15.1	18.9	9.3	8.4	33.0%
After	17.9	15.6	18.5	8.7	8.6	30.0%
Difference between before and after	-1.0	0.6	-0.3	-0.5	0.3	-3.0%

CASE STUDY 47
Phillip

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	OWNER WITH MORTGAGE	3	FREESTANDING ONE STOREY	HARDWIRED RESISTIVE + HEAT PUMP

What did we do?

REPRESENTATIVE GROUP

> As long as I don't have any unexpected dramas [I can manage on my low income], as in, if say for instance one of the family members came back or something like that, it might be a bit different. The change would be out of my control, whatever it is.
>
> *(After Interview 24/08/15)*

What was the result?

Despite his house being of standard construction, Phillip's home upgrades and careful energy management allow him to spend high levels of time in the comfort zone and to use his heater very efficiently. Phillip's ill health meant he relied on maintaining comfort "I couldn't have survived without the heating." Phillip shared energy efficient ideas with a couple of close friends who also worked towards energy efficiency. Phillip's reduction of income had been the catalyst for his focus on efficiency.

✗	Energy use increased by 0.85kWh/day (4%) from 21.32kWh/day to 22.18kWh/day.
✓	Energy costs reduced by ~$842 per year ($1984-$1142).
✓	Time spent in the comfort zone increased from 92.4% to 98.2%.
✓	Heating efficiency increased from 0.76 to 0.88 (16.4%).
✓	Displayed improved confidence that he could find information on comfort and energy efficiency if needed.

Existing physical conditions of the house

Phillip slept in his caravan (with a plug in heater) while his daughter and her partner lived in his home. Despite the age of the house and single glazing, Phillip's deciduous tree, living room position and heat pump all helped to make this house function thermally at a near-to-standard level.

Type	Stand alone, suburban.
Age	30-39 years.
Construction	Brick veneer, timber frame, tiles, concrete slab (vinyl, carpet).
Insulation	Ceiling only (batts).
Windows	Single glazed, aluminium frame.
Window coverings	Venetian blinds and curtains in all rooms.
Access to sun	Morning sun, main living access north east, skylight in living room.
Heating	Heat pump, column heater in main house, column heater in caravan, halogen heat lamps.

Changes to the home

Other changes to the home:

- Phillip's adult daughter and partner moved out of his house.
- Installed wood and glass barriers to windows in living area.
- Placed bookcases against walls for insulation.
- Partitioned heater areas so they were smaller areas to heat.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

When we first met Phillip he shared his house with his daughter and her partner. During this time Phillip slept in a caravan parked outside and used a plug in heater in the van. Phillip found that he had much less control of the household energy use while his family stayed with him. He explained that his daughter used a lot more hot water than he did and this is reflected in the nearly 10% reduction in hot water use in the after period. Interestingly total hot water use in the before and after periods is still relatively low.

Phillip was incredibly careful with energy use and the management of thermal comfort in his home. "I couldn't have survived without the heating," Phillip explained. He struggled with depression and as a result needed to keep his house warm at all times. That he did this is evident in the time spent in the comfort zone (98%). His spaces rarely went above the comfort zone. This was due to Phillip carefully thinking through where he had to sit to get the best from his heating and careful about management of heat flow through the house. The living and the bedroom (where we logged temperatures) were the two main areas he heated.

Efficiency remains good despite high levels of heating and this is likely due to Phillip's very careful management of heat in his home. He was constantly thinking of new ways to improve comfort and to be energy efficient. This continual improvement was supported by a couple of friends who he shared energy efficiency ideas with. Phillip was working towards energy efficient changes throughout the house by gradually making small things changes, for example he put plastic in between kitchen and living area and blankets on the top of wardrobes to stop heat flow.

Phillip explained that he became much more aware of energy efficiency when his income had reduced a number of years before. He found that being efficient allowed him to live on his low income fairly well.

Phillip's time in the comfort zone increased and his overall energy use increased as a result. Phillip's careful comfort management of the home and his endeavours to insulate and zone wherever possible is also visible in the improved time spent in the comfort zone.

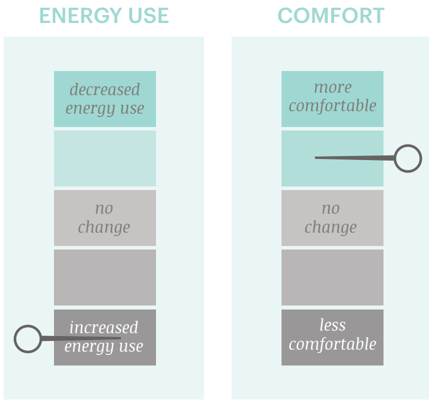
Average daily energy use and heating efficiency during winter conditions

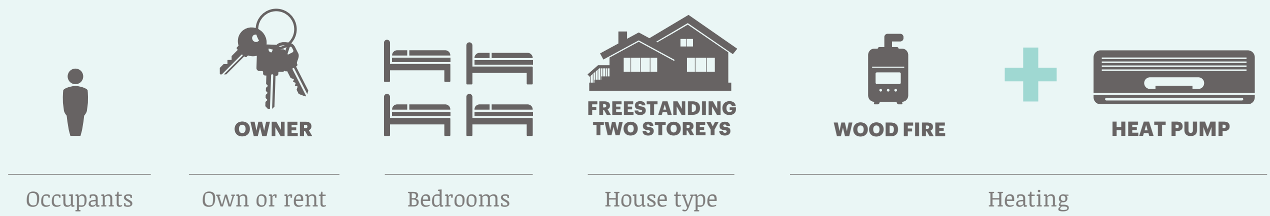
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	3.12	1.18	-1.94	-62.2%
T 41 Heating (hard wired heating)	9.62	12.03	2.41	25.0%
Total Heating	12.74	13.21	0.47	3.7%
Other Light and Power (T31)	4.96	5.69	0.73	14.8%
Hot Water	3.62	3.27	-0.35	-9.7%
Total Household Electricity	21.32	22.18	0.85	4.0%
House Heating Efficiency (degree-hours/kWh/day)	0.76	0.88	0.12	16.4%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	20.3	19.1	10.0	9.6	92.4%
After	21.7	20.2	9.3	11.6	98.2%
Difference between before and after	1.4	1.1	-0.7	2.0	5.8%

CASE STUDY 48
Gina





What did we do?

REPRESENTATIVE GROUP

> Yeah, I've had that on all the time on the lowest of the heat, it's on 18 all the time, and I have the bedroom doors shut too in the day normally and open them at night and that warms my bedroom. I shut my bathroom doors and it's freezing to go out to the toilet in the middle of the night, but that warms the bedroom. It certainly warms upstairs but there's no one up there. *(After Interview, 31 Aug 2015)*

What was the result?

Gina's energy use decreased dramatically, by nearly 50%. This is likely due to the departure of her granddaughter and because Gina no longer heats the shed outside for craft activities.

While her electricity use has decreased, Gina is actually spending more time above the comfort zone. This is in part because she has a wood heater.

- ✔ Energy use increased by 48.01kWh/day (49.7%), from 96.54kWh/day to 48.53kWh/day.
- ✔ Energy costs reduced by ~$37 per year (from $2667 to $2630).
- ✘ Time spent in the comfort zone decreased from 25.3% to 23.4% (more time spent above 24°C in living from 36% to 55%).
- ~ Given the wood heater, heating efficiency is not accurately measured for this home.
- ✔ Displayed improved confidence that she could find information on energy efficiency if needed.

Existing physical conditions of the house

This house has been well maintained however in recent years this has been more difficult after the death of Gina's husband and her own ill health. Due to old insulation, single glazing and lack of good year-round solar access, the thermal performance of this house was poor.

Type	Stand alone, suburban on very large suburban block.
Age	Approximately 40 years old.
Construction	Timber/brick walls, some timber framed, some triple brick, shingles/corrugated metal, timber suspended floors (300mm), some concrete slab (tiles/carpet).
Insulation	Ceiling insulation (batts – old), wall (batts and sisalation – old).
Windows	Single glazed, timber frame.
Window coverings	Curtains (bedrooms), exterior blinds kitchen/sun room.
Access to sun	Trees to the north east and north west that affected winter sun, living room on south west, open verandas around the living area which would have blocked sun, little direct sun to living room, 2 skylights.
Heating	Heat pump (living), wood fire (living), electric radiant (bathroom, other), fan heater.

Changes to the home

Other changes to the home:

- Granddaughter moved out.
- Changes to heating temperatures and use due to serious illness.
- Moved an outside heater inside – stopped using the shed for craft.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Gina's health was not good and she had felt a lot more vulnerable to cold in recent times due to her illness and ageing. It had also been a particularly cold winter in 2015. She had practical help and support from her family, but most of them lived on the mainland so could provide regular help. The family were not in a position to financially assist either. She has plans to sell her home soon and as a result was using some energy on maintaining a (mostly unused) swimming pool in order to keep it looking respectable. Although she was heavily involved in local community activities, she said she would prefer to ask her family for help first.

Gina uses both a wood heater and a heat pump, although she finds it increasingly difficult to manage the wood heater. She uses bottled gas to cook with.

She said she thought she was using her heater a lot more but that comfort was very important. Her time in the comfort zone actually decreased, but this was mostly because she spent more time above 24° (from 36% to 55%).

Gina's energy use, including heating use, and the moisture levels on her windows reduced dramatically during the study. This is most likely due to a long hospital stay, her granddaughter moving out, no longer spending time doing craft in the shed (which had been heated) and increased use of zoning due to living alone and having limited mobility. However, her use of the wood heater obscures the scale of these changes.

Average daily energy use and heating efficiency during winter conditions

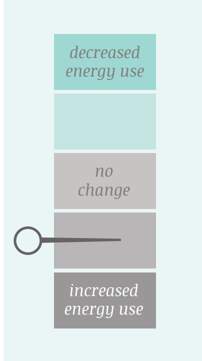
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.00	0.00	0.00	0.0%
T 41 Heating (hard wired heating)	38.67	28.54	–10.13	–26.2%
Total Heating	38.67	28.54	–10.13	–26.2%
Other Light and Power (T31)	39.49	13.10	–26.39	–66.8%
Hot Water	18.37	6.88	–11.49	–62.5%
Total Household Electricity	96.54	48.53	–48.01	–49.7%
House Heating Efficiency (degree-hours/kWh/day)	0.24	0.39	0.15	63.7%

Average daily temperatures and time in comfort zone during winter conditions

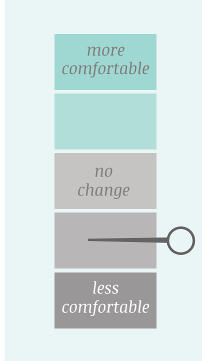
	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	22.3	14.4	9.1	9.2	25.3%
After	23.8	15.5	8.6	11.1	23.4%
Difference between before and after	1.6	1.2	–0.5	1.9	–2.0%

CASE STUDY 49
Anna

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
	OWNER		FREESTANDING ONE STOREY	GAS HEATER

What did we do?

REPRESENTATIVE GROUP

I feel more cold and I'm most of the time sick during the winter and I think it's because of the house. I cannot leave the heater 24 hours, it costs a fortune.

(After interview, 31 Aug 2015)

What was the result?

Anna decreased the time she spent in the comfort zone and continued to feel cold in her home. It is likely she reduced her gas heating in order to save money as her energy bills were a huge source of stress. Anna was cold and financially stressed in her home due to its poor thermal performance, thin curtains that were rarely used, and a low income.

✗	Electricity use increased by 0.66kWh (13.7%), from 4.80kWh/day to 5.46kWh/day.
✗	Electricity costs increased by ~$48 per year (from $369 to $417).
✗	Time spent in the comfort zone decreased from 19.7% to 12.7%.
~	Given the gas ducted heating, heating efficiency is not accurately measured for this home.
✓	Displayed improved confidence that she could find information on thermal comfort and energy efficiency if needed.
✗	Draughts remained problematic.
✗	Self-reported moisture and mould remained high.

Existing physical conditions of the house

This house was very draughty, with draughts through the floorboards, doors and windows. Some windows did not close properly. High levels of moisture and mould were reported, with humidity peaking at 80-85% in the after period. Temperatures were very close to dew point. The performance of this house was very poor.

Type	Stand alone, suburban.
Age	60+ years.
Construction	Weatherboard, timber frame, corrugated metal rood, suspended timber floor (tiles, polished timber), underfloor enclosed by brick wall.
Insulation	Unknown (suspect none).
Windows	Single glazed, steel frame.
Window coverings	Curtains (living room light, other rooms lace), lightweight blinds.
Access to sun	Northern living room sun access all day, afternoon sun in the kitchen, morning sun in bedrooms.
Heating	Gas ducted heating, plug-in electric.

Changes to the home

Other changes to the home:

- Worked hard not to increase power use due to concern about cost.

GET BILL $MART UPGRADES

Not relevant for this participant.

Overview

Anna was in her 80s. She felt the cold and suffered from various illnesses as a result. Her house was very draughty and had issues with condensation. She did not close the curtains because she liked to be able to look out and thought heavy curtains were ugly; yet, closing curtains would have significantly increased the thermal efficiency of her home. She tried to reduce energy use by turning appliances off at the power point when not in use and only heating the amount of water that she needed. She had also tried to install draught-proofing but found this difficult and the draught-proofing material fell off. She may also have stopped using one plug-in heater and changed it for another.

Anna uses gas for both heating and cooking. She was very stressed about her gas bill and her efforts to reduce it probably account for the reduction in time spent in the comfort zone. Similarly, although Anna's electricity usage increased, it is likely that when her gas usage is taken into account, her overall energy use decreased. (Lack of access to Anna's gas bills means this cannot be confirmed).

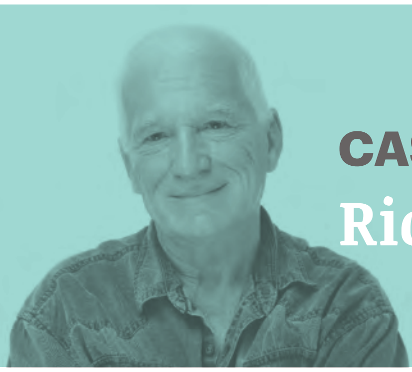
Anna's sense that there were people she could ask about energy efficiency and thermal comfort improved, but she did not think she had a strong community she could call upon when needed. Although she did have children who would look after her, she felt strongly the contrast between life in her original home of France and life in Australia; she thought that in Australia as an older person she was not cared for by the community.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	1.50	1.38	–0.12	–8.1%
T 41 Heating (hard wired heating)	0.00	0.00	0.00	0.0%
Total Heating	1.50	1.38	–0.12	–8.1%
Other Light and Power (T31)	3.16	3.84	0.68	21.4%
Hot Water	0.14	0.24	0.10	72.5%
Total Household Electricity	4.80	5.46	0.66	13.7%
House Heating Efficiency (degree-hours/kWh/day)	4.54	4.96	0.42	9.3%

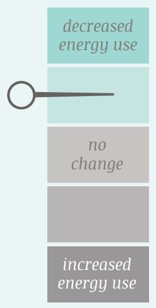
Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	15.1	15.5	8.5	6.8	19.7%
After	14.0	14.6	7.5	6.8	12.7%
Difference between before and after	–1.1	–0.8	–1.0	0.0	–7.1%

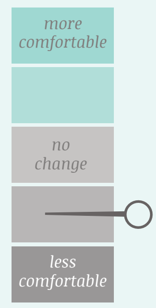


CASE STUDY 50
Richard and Deanne

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
2	OWNER	3	FREESTANDING ONE STOREY	PLUG-IN ELECTRIC + HARDWIRED RESISTIVE

What did we do?

REPRESENTATIVE GROUP

> But it would be very nice just to be comfortable [financially] so we didn't have to worry so much about if she's not well or of course I don't mind staying home or whatever but I'd like to have things set up so she didn't have to work too hard. Just making sure the comfort level can be met.
>
> *(Before Interview 25/05/2014)*

What was the result?

Richard and Deanne lived in a house that was very draughty and very difficult to keep warm and cost them lots in heating energy. On their limited budget, making improvements was very difficult, but they were renovating anyway. Renovations meant that things changed in the house quite regularly creating a dynamic living environment. Richard and Deanne would have benefitted from energy efficiency information to help them in their reworking of the house.

- ✓ Energy use reduced by 4.45kWh/day (7.3%) from 60.76kWh/day to 56.31kWh/day.
- ~ Self-reported energy costs remained the same (no billing data available for this participant).
- ✗ Time spent in the comfort zone decreased from 27.3% to 10.6%.
- ✗ Heating efficiency decreased from 0.14 to 0.12 (17.5%) – very low.
- ✓ Displayed improved confidence that she could find information on energy efficiency and comfort.
- ~ Draughts under doors.

Existing physical conditions of the house

Richard and Deanne live in a standalone suburban house on a standard block. Approximately 50 years old, the house is timber framed with weatherboard cladding, suspended timber floors (with carpet and vinyl), on a brick plinth and a corrugated metal roof. The house also had a skylight in the hallway. The house is on a main road with a train line near, so has reasonable access to sun. The long axis of the house sits northwest to south west. The living room is on the north corner of the house in open plan with the kitchen and dining areas which, sits on the west corner. The living and dining areas had access to sun most of the day. Heating was provided by an old radiant fan wired in heater in the living, a plug in radiant fan heater in the dining/living, wired in radiant strip heaters in the study, spare bedroom and bathroom and electric blankets.

Despite a reasonably well positioned living area, the lack of insulation, single glazing and poor choices for heating and other features lead to this house performing poorly thermally.

Insulation	External walls of dining area only (batts added in 2013).	VERY POOR
Windows	Single glazed, aluminium and timber frames, no pelmets.	POOR
Window coverings	Roller blinds (kitchen and dining) and curtains (heavy weight) varying condition other areas.	POOR
Under floor space	Suspended timber floor (at 1.0m high), underfloor enclosed with brick, no insulation.	POOR
Mould and moisture	Mould in toilet only. Measures show intermittent chance for temp to reach dew point and high humidity peaks in winter at 80 in bedroom before and after and 70% to 80% in after period in living area.	POOR
Other conditions of note	Currently renovating to update and improve condition.	
	Draughts under doors and due to work on going as part of renovation.	POOR

Changes to the home

Other changes to the home:

- Richard and Deanne purchased a new plug in heater and reduced the use of their wired in heater.
- The house was subject to ongoing renovations.

GET BILL $MART UPGRADES

Not relevant for this participant.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (%)
T 31 Heating (plug in heating)	35.25	38.62	9.6%
T 41 Heating (hard wired heating)	4.80	3.38	-29.5%
Total Heating	40.04	42.00	4.9%
Other Light and Power (T31)	10.70	3.80	-64.5%
Hot Water	10.02	10.51	4.9%
Total Household Electricity	60.76	56.31	-7.3%
House Heating Efficiency (degree-hours/kWh/day)	0.14	0.12	-17.5%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	17.7	12.6	9.4	5.8	27.3%
After	14.7	12.9	8.8	5.0	10.8%
Difference between before and after	-3.0	0.3	-0.6	-0.8	-16.5%

Total Household Electricity reduced by 4.45 kWh/day from 60.76kWh/day to 56.31kWh/day (-7.3%). Hard wired heater use reduced by 1.42 kWh/day, while plug in heating use increased by 3.7kWh/day (9.6%). Richard and Deanne relied heavily on plug in heaters as the hard wired heater was old, very energy intensive and not very effective.

Heating efficiency went down slightly from 0.14-0.12. This is a poor heating efficiency ratio. Richard and Deanne's wired in and plug in heaters were not heating spaces efficiently. In the living room because their wired in heater was so ineffective they often used plug in heating. The average daily heating energy suggests that they would have used heating for a long period every day. The intensity of heater use can be seen in the before and after examples graphs. While some of this heating was localised and would not have registered fully on the temperature loggers, some effect would be seen.

Living room average winter temps reduced from 17.7 to 14.7°C in the after period. The bedroom stayed more stable going from 12.6 to 12.9°C. These averages are much lower than average and median for the Greater Hobart no upgrade group and also the overall detailed study group.

Aligned with this percentages of time spent in the comfort zone reduced noticeably in the after period from 27.3% to 10.8% (with negligible time spent above the comfort zone at all). This is a small % of time in the comfort zone, especially considering the heating being used.

Energy and comfort

Richard and Deanne were in the middle of home renovations and throughout the project had different areas of the house being fixed and adjusted. This would have contributed to poor heating efficiency, and the reduction in temperatures and time in comfort zone. General poor thermal performance of the building shell would also have undermined efficiency and temperatures.

Electricity used on the Other Light and Power circuit decreased substantially from 10.7kWh/day to 3.8kWh/day, a change of 64.5%. This decrease may have been due to different appliance and equipment use in the home as dictated by the renovations, or possibly due to an unknown heater being used before and not after. Some stages of building renovations are likely to be more energy intensive than others and have required different heating practices.

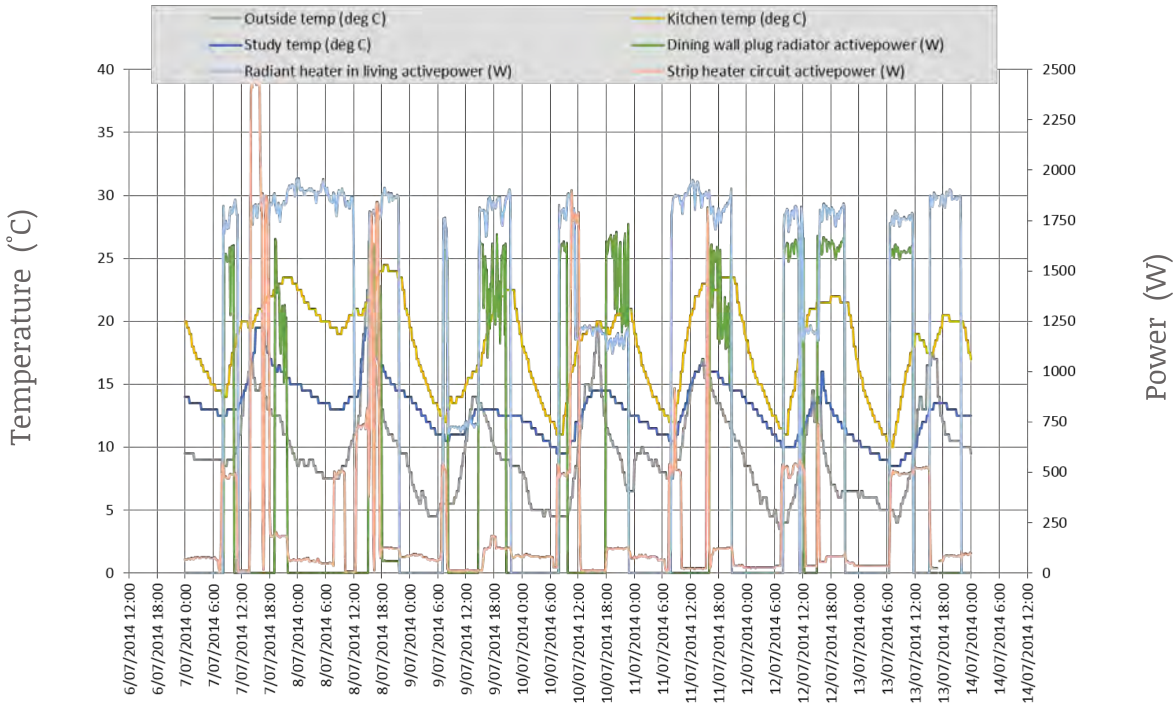
Richard and Deanne's household was quite dynamic over the period of the project due to their renovations and Deanne stopping her casual work. These changes would have all affected energy use and comfort in the house in different ways.

Moisture in the house did not appear to be a big problem, although mould was noted in the toilet. Measures show intermittent times where temp could reach dew point and some high humidity peaks in winter at 80 in bedroom before and after and 70% (before) to 80% (after) in the kitchen area. As with other houses surface condensation was still likely to occur at intervals due to the poor thermal performance of the building skin.

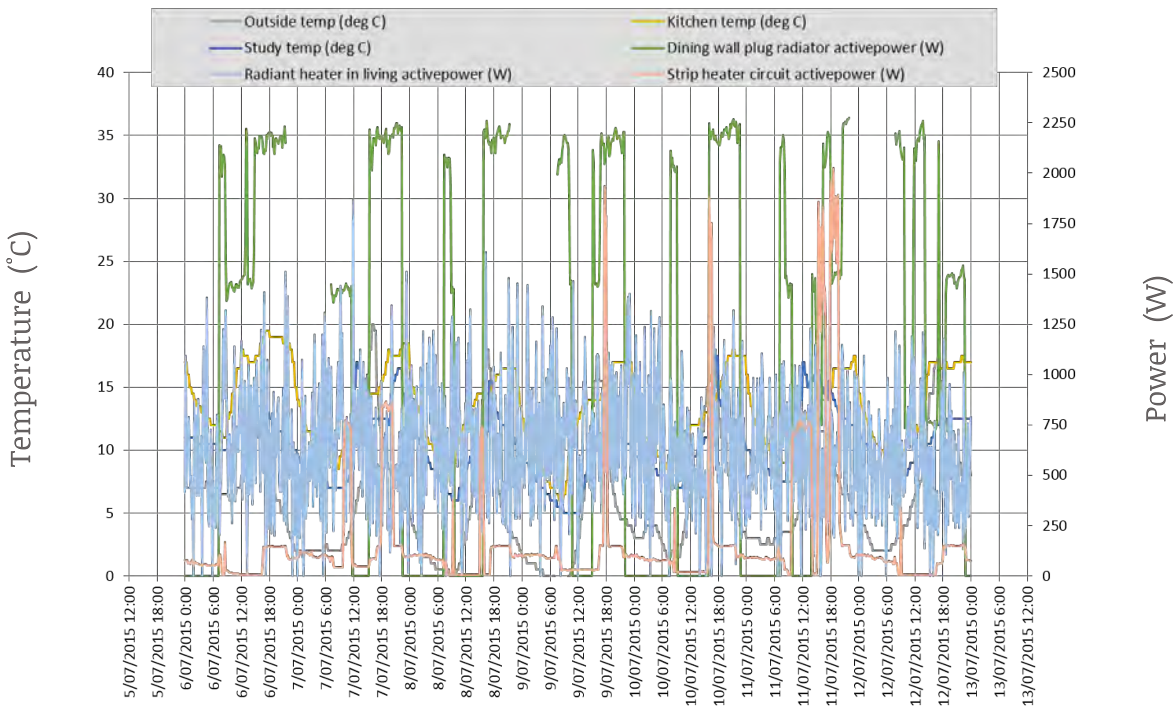
> It takes a couple of hours at least [to heat the house up].
>
> *(Before Interview 25/05/2014)*

> "I'd like to get away as much as I could from depending upon hydroelectric power just to do the heating as well. I'd like to have something a little bit more independent.
>
> *(Before Interview 25/05/2014)*

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Energy affordability

Richard and Deanne used a large amount of electricity. Richard explained that their energy bills showed them their relatively high use:

> When I get my power bill they give you the rating for two people or three people to have or whatever. The last couple of times there's been enough for six people in our house. So it's too much for us two people. *(Before Interview 25/05/2014)*

No energy billing data was available for Richard and Deanne but they were certain that their energy use had not changed at all over the course of the project. The electricity use data discussed above indicates that energy use did decline in the house and that Richard and Deanne are likely to have had slightly lower bills.

A decrease in bills would have been greatly appreciated by Richard and Deanne although they had careful systems in place to keep up payments:

> I have money taken out of the bank to pay for the power each fortnight. So at the moment it's been keeping pace because I don't have bills. I just have deductions the whole time.
>
> *(Before Interview 25/05/2014)*

Personal and community change

Richard and Deanne are a retired couple in their sixties. Deanne retired from a casual job partway through this project. While on a low income, Richard and Deanne are slowly renovating their house as the funds become available.

In doing their renovations Richard and Deanne have been conscious of trying to improve their comfort and energy efficiency. Deanne explained that she would like to replace the large living room windows on the north east of the house with smaller windows. When asked why she wanted to do this she explained that:

> You don't need the big windows, cold and heat, you don't need them big.
>
> *(After Interview 01/09/2015)*

It is likely that Richard and Deanne felt so cold in their house due to draughts and little thermal resistance. Sitting near the large windows in the living room, they were likely to have felt cold due to the cold radiant temperature of the windows. While replacing the windows would reduce heat loss, smaller windows would also limit the amount of sun that could heat the house. Richard and Deanne were conscious of energy efficiency and thermal comfort but perhaps not quite aware of all the potential implications of different changes.

When we visited them in September 2015 the curtains to the living area were closed during the day suggesting they may not have made much use of sunlight.

Personal and community change

Richard and Deanne were clearly frustrated by the house and the way that it performed. While doing their best to improve things on their limited budget, they explained:

> We do use too much [electricity]. Not knowing how to [reduce electricity use] because of the house and everything else. We just need to win lotto and move out.
>
> *(Before Interview 25/05/2014)*

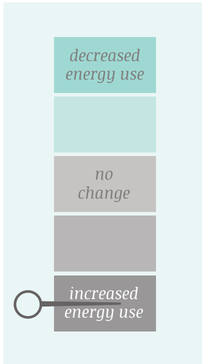
Deanne expressed a clear sense that they lived in a strongly connected community. They had good family connections close by and while they did not really know their neighbours, Deanne felt that she knew where to go to seek advice on energy efficiency and thermal comfort. Both she and Richard said that they would go to the local shops and talk to the gas suppliers or go to the energy supplier directly.

Richard and Deanne also received help from Community Base Support, a free support service for people with mental or physical challenges and their carers. This indicates there may have been some changes to the health situation of the householders and this may have affected energy use.

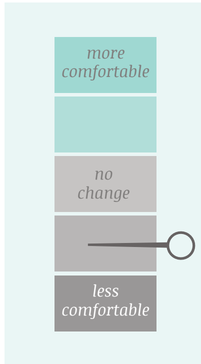
Richard and Deanne lived in a house that was very draughty and very difficult to keep warm. On their limited budget they were slowly making renovations to their home. Mostly these renovations are likely to improve their comfort and energy efficiency but limits to their technical knowledge limited their capacity for this somewhat.

CASE STUDY 51
Irene

ENERGY USE



COMFORT



Occupants	Own or rent	Bedrooms	House type	Heating
1	OWNER WITH MORTGAGE	3	FREESTANDING ONE STOREY	HEAT PUMP

What did we do?

REPRESENTATIVE GROUP

> [I don't put the heater on during the day] if I can help it; unless some visitors are coming around. But I didn't have very many visitors. Perhaps once I did put it on at 4pm – I couldn't bear it any longer. But I was using the computer so I was getting a bit cold so I put a water bottle on my lap and a blanket, one of these throw rugs, and kept warm like that and just layered up.
>
> *(After Interview 07/09/2015)*

What was the result?

Irene continued to live in a very cold house (well below her desired comfort levels) even with an increased use of heating. Her heating was inefficient and her low income made any changes or improvements impossible, despite her desire for a more efficient heater.

✗	Energy use increased by 9.09kWh/day (43%) from 20.81kWh/day to 29.9kWh/day.
✓	Energy costs reduced by ~$87 per year (based on estimated rather than actual data supplied by the energy provider).
✗	Time spent in comfort zone decreased from 7.7% to 7.2%.
✗	Heating efficiency decreased from 0.77 to 0.41 (47.1%).
✗	Displayed decreased confidence that she could find information on thermal comfort if required.
✓	Displayed increased confidence she could find information on energy efficiency if required.
~	Possible surface condensation (but may just avoid) – measures show temp regularly comes close to dew point in living and bedroom, but humidity peak is 75% (which is ok).
✗	Draughts remained a problem.

Existing physical conditions of the house

Irene lives in a stand alone house that is approximately 30 years old. The house sits on a steep slope that falls to the north. A split level open plan house; it is constructed with brick veneer, a tile roof, and suspended timber floors (with carpet and vinyl).

The long axis of the house is almost east to west and the living room sits on the north with solar access from the north (but Irene appeared to keep curtains drawn a lot). Bedrooms sat to the south of the house. The living room is on the lower level and is open plan to the kitchen and the corridor spaces, which lead to the higher level bedroom area. As the corridor to the bedrooms is open to the living area, Irene finds that heat easily flows through and up. Heating is provided by the original (now inefficient) heat pump that is as old as the house (likely one of the first heat pumps produced for homes).

With a lack of insulation, single glazing, an old heater and living room heat moving quickly away into corridors and bedrooms (up the split level) this house has a very poor thermal performance.

Insulation	Ceiling (batts) only.	POOR
Windows	Single glazed, aluminium frames, no pelmets.	POOR
Window coverings	Lace and heavy curtains (living and bedrooms), kitchen blind.	NEAR STANDARD
Under floor space	Suspended floor, underfloor enclosed with brick wall, no insulation.	POOR
Mould and moisture	Possible surface condensation – temperature regularly close to dew point, humidity peak 75% (peak slightly worse after period).	POOR
Other conditions of note	Very old built in heater – upgrading this would require filling in a wall and some other major adjustments.	POOR
	Draughts and stack effect from open plan, split level and cracks in bathroom wall.	POOR

Changes to the home

Other changes to the home:

- Irene has tried to stop using her heater during the day.
- Changed work hours mean that Irene is home more often in the evenings.
- Irene replaced her fridge with a smaller second hand one.
- Irene has a new television.

GET BILL $MART UPGRADES

Not relevant for this participant.

Average daily energy use and heating efficiency during winter conditions

	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
T 31 Heating (plug in heating)	0.15	0.35	0.19	125.2%
T 41 Heating (hard wired heating)	4.85	9.75	4.90	100.9%
Total Heating	5.00	10.09	5.09	101.6%
Other Light and Power (T31)	10.99	13.65	2.66	24.2%
Hot Water	4.81	6.16	1.35	28.0%
Total Household Electricity	20.81	29.90	9.09	43.7%
House Heating Efficiency (degree-hours/kWh/day)	0.77	0.41	-0.36	-47.1%

Average daily temperatures and time in comfort zone during winter conditions

	Living Temp (°C)	Bedroom Temp (°C)	Outdoor Temp (°C)	Avg out/in temp diff (°C)	% time in comfort zone (18°C – 24°C)
Before	14.1	10.8	8.6	3.8	7.7%
After	13.9	11.0	8.4	4.1	7.2%
Difference between before and after	-0.1	0.2	-0.2	0.3	-0.6%

Referring to the tables and graphs presented, multiple changes were noted. Total Household Electricity use increased by 9.09 kWh/day from 20.81kWh/day to 29.90kWh/day (43.7%). The increase in overall energy use is likely due Irene's changed employment patterns – she spent more time in her home in the after period.

Total heating increased by 101.6% with the bulk of this due to increased use in the heat pump (from 4.85kWh/day to 9.75kWh/day). Plug in heater (which was electric blankets in this instance) use increased very slightly from a low 0.15kWh/day to (also low) 0.35kWh/day. Heating efficiency greatly reduced in the after period as substantially more heating was used which stretched the capacity of the house to retain the heat. The heater being used was also very old and not very efficient due to its age and its need of maintenance.

People think I'm funny.
I went around to my friend's place who had a log fire and I've got this blanket on and they reckon 'Oh it's not cold'. To me, I was… you know, it's just my body temperature, I think. Perhaps when you get older, you feel really cool.

(After Interview 07/09/2015)

Energy and comfort

With the significant increase in heating Irene didn't really have a corresponding increase in heating efficiency or comfort in general. Heating efficiency reduced 0.77 to 0.41 (-0.36, -47.1%). Graphs show that she did not necessarily heat to higher temperatures, but more likely heated more frequently to the same sorts of temperature limits. The lack of an increase in heating efficiency with this sort of increase in energy use is notable and likely indicates something like a window was being left open or a new significant draught had developed. Irene mentioned there was a crack in the bathroom wall and that she kept windows in unused spare bedrooms slightly open. These would both create draughts.

There was around 4°C temperature difference between indoor and outdoor in this house. While better than some houses in this study, this difference is still indicative of very poor thermal resistance. From the charts, we can see that the living area responds to the outside temperature but that there is a buffer (temperature difference). The bedroom temperature also responds somewhat to the outside temperature but doesn't seem to have the same spikes in warmer temperatures. The charts show that once the heat pump is switched off the temperature inside drops quickly.

Time spent in the comfort zone decreased (from 7.7% to 7.2%) despite already being exceedingly low. The average temperature for Irene's living space was 13.9°C, while the average for the bedroom was 11°C. The living area average dropped slightly while the bedroom average rose slightly in the after period. These temperatures are well below the average and median temperatures of other houses in this study.

In the before period Irene was doing overnight care work away from home (caring for others) – she could be away up to 3 nights every fortnight. In the after period she was not doing the overnight care work and was actually looking for more care work. Such a change in household occupancy patterns would explain the increase in electricity consumption.

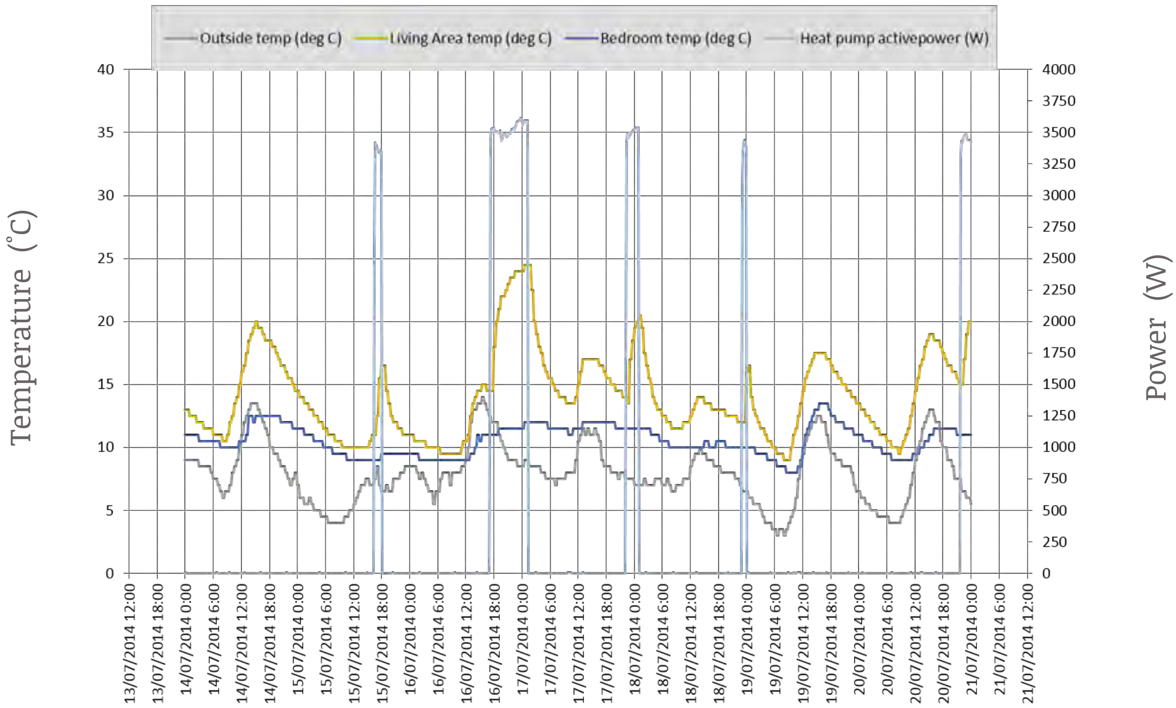
Hot water use increased 4.81 to 6.16kWhr/day (1.35kWhr/day increase, 28.0%). Irene said in her After Interview that she had longer showers when she was not working and had not had as much work in the after period.

Other Light and Power increased by 24.2% (from 10.99kWh/day to 13.65kWh/day). More power was again likely being used with an increased amount of time being spent at home (with more cooking, computer use and television, for example). Irene did purchase a replacement fridge, which was smaller but was second hand. This could have either increased or decreased her use of light and power as well.

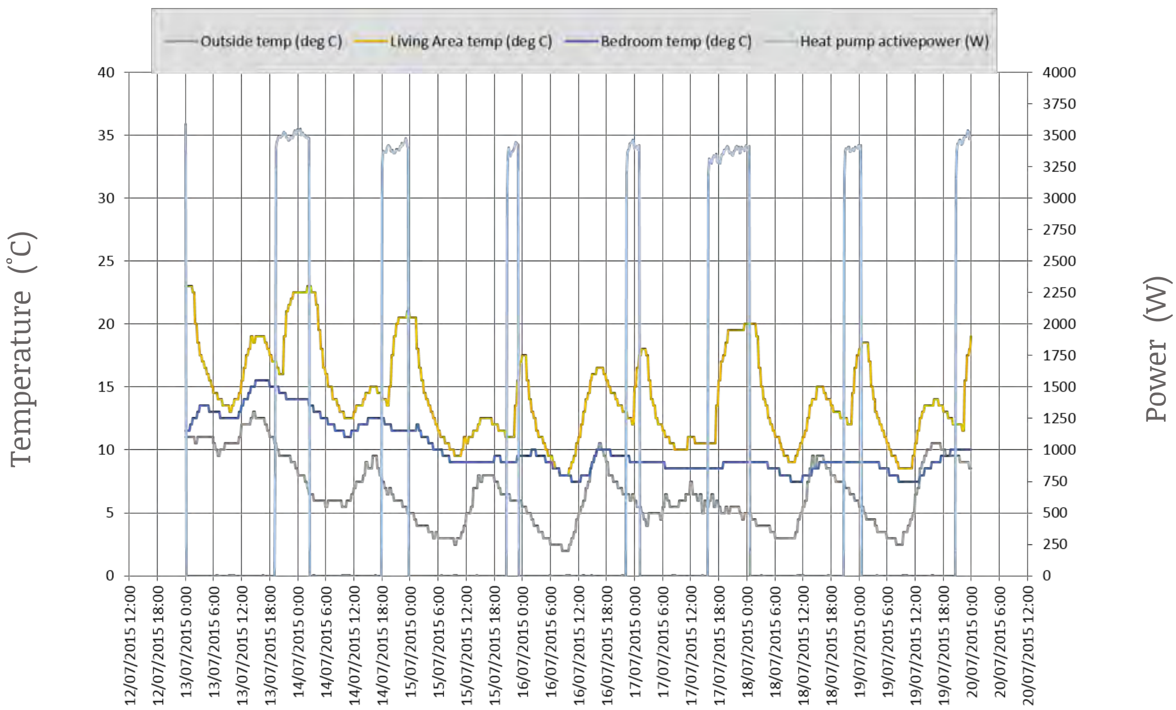
There was possible surface condensation, but Irene said she didn't have much of a problem. Measures show temperatures comes close to dew point in living and bedrooms with humidity reaching a peak of 75%. This humidity level as the peak is not too much of a problem. Ironically draughts probably help reduce any potential moisture problems here. Irene said when her (now adult) children lived with her moisture had been an issue in the bedrooms.

> But the shutters [on the heater] don't turn and it does start off with a cool draught. I feel it's not too bad but my friend's saying it's still cold. But if you go out in the other part of the house you can feel there is heat here. I notice the difference.
>
> *(Before Interview 10/07/2014)*

Before period: example week in winter showing selected energy use and temperature readings



After period: example week in winter showing selected energy use and temperature readings



Irene had less work than she wanted and this made paying household bills difficult:

> I haven't got a lot of hours in my work, so 23 hours a fortnight, that's not a week. So I'm just managing with my bills and things.
> *(After Interview 07/09/2015)*

When asked what she did when a big electricity bill arrived she said,

> I just spend less on groceries and stuff or juggle the finances. I've done that for a long time because I've been on and off employment and I haven't got as many hours as I used to. *(Before Interview 10/07/2014)*

To save money Irene rarely turned the heater on except when visitors came. While she would have liked to upgrade to a more efficient heat pump, this was beyond her financial capacity.

Irene carefully budgeted to ensure she was able to pay her bills, explaining:

> Everything has gone up, like rates and things, so you have to put spare money on the bills. Like, I want to try and pay the rates off gradually. So if I got the extra money, I'll start paying some more off because there's another $400 due in February and, say, if something else is due in February, it floods. So you have to try and reduce things in advance, that's what I find. That's how I did the Aurora bill last time. I paid $50 off a fortnight or something and then I reduced it down a bit so I didn't have a huge bill when it did come in.
> *(After Interview 07/09/2015)*

The billing data we have for Irene is based partially on estimates by the energy supplier. The supplier estimates that her bills have decreased by approximately $87 per year. Her energy use has increased in the winter periods but she may be using less overall. It is hard to say whether or not her energy bills have decreased.

Personal and community change

Irene is in her 50s and lives alone. Her house is very difficult to heat and the heat pump that she uses is very old. As Irene explained the heater often blows out cold air and that,

> It's out-dated now. I can't replace it. I was told it's nearly past its due date and needs replacing. But it was expensive in those days. $3,000 and they're still about the same price.
>
> *(Before Interview 10/07/2014)*

Not only is a replacement heater expensive, but Irene noted that the heat pump costs a lot to run. She said that,

> If it was that cold in the afternoon and I don't want to put the heater on I have put a water bottle on my lap and a rug over the top trying to save power because it's usually too expensive to have the heater going all the time.
>
> *(Before Interview 10/07/2014)*

Irene knew the heater was old and inefficient and also knew that trying to heat herself in the living area also meant having to heat upstairs near the bedrooms due to that area being higher than the living room. Irene also appeared to keep curtains shut when sun was available and leave windows in spare bedrooms ajar to ensure they stayed fresh. These two actions also undermined comfort.

Irene wanted to make some other minor changes to her home, such as shifting to energy efficient lightbulbs. She explained that this was physically difficult and that costs were prohibitive.

As a shift worker it is difficult for Irene to be involved in regular community activities. She liked to attend local council information evenings at the community centre, but often found the timetabling difficult. Over the course of the year, Irene increased her sense of connection to the local community and displayed improved confidence that there were people in her community who could help with energy efficiency and thermal comfort.

The poor thermal resistance of Irene's house, coupled with the old heater and the stack-effect (heat rising away from the living area) area, created an uncomfortable indoor environment. Despite her frustration, difficulty getting enough work meant Helen did not always have enough money for groceries, let alone making changes in her home.

4. Comparative analysis findings

This section presents tabulated comparative analysis of outcomes as compared with key parameters in order to examine outcomes of the interventions and to identify relationships between outcomes and household characteristics.

Comparisons are conducted using the data collected from the individual case studies, specifically: electricity consumption for heating; total electricity consumption; household heating efficiency; indoor/outdoor temperature differences (ÐT); average living room temperature; % of time in the comfort zone; and plug-in versus hard-wired heater use. Findings from the cases are collated and the average outcomes are compared across: GBS approach groups; for different house construction eras; and for different heater types.

There are five sets of comparative analysis which examine:

1. Whole of detailed study approach groups compared across key indicators (not including heating energy related indicators)
2. Approach groups compared across the energy and comfort indicators
3. Household heater type compared across the energy and comfort indicators
4. Households grouped into quintiles based on the energy and comfort indicators and then compared using energy and comfort indicators, and
5. Analysis by house construction age using 'before' baseline measures of energy and comfort.

Analysis set 1. above, includes all households in the study, but doesn't not undertake comparisons relating to heating energy. Analysis sets 2 to 5 do include analysis of heating energy and associated indicators, but to do this, sets 2 to 5, exclude households with wood heating, gas heating, and households that moved during the study. For wood and gas heating, the reason for the exclusion of these houses is that insufficient data on wood and gas use was available to enable reliable analysis of heating energy. For households that moved, these were excluded because the change of house created potentially very large changes to heating energy that are not attributable to the GBS project.

4.1 Whole of Detailed Study – Approach groups compared across key indicators

This section includes three comparative analyses across the GBS approach groups based on:

- Average daily total electricity consumption per household and per occupant. (kWh/day)
- Proportion (%) time in comfort zone, and
- Average hot water electricity consumption per household and per occupant. (kWh/day)

This section includes all households in the Detailed Study, including those with non-electric heating, and those households that moved house during the study. Outcomes relating to heating energy are not considered in this section.

Table 4 presents some background data on the number of households in each approach group and the average number of occupants per household in the different approach groups during the before and after monitoring periods.

Table 4: background data on detailed households

GBS Approach Group	Number of houses in Detailed Study Sample	Average occupants per household in the before period	Average occupants per household in the after period
CCB	16	3.2	3.1
EDUG + CCB	11	3.5	4.0
REP	12	1.8	1.6
EDUG	12	1.8	1.8

4.1.1 Change in Total Household Electricity use – All households

Change to avg daily total household electricity use				
GBS Approach Group	Before	After	Change	Change
	(kWh/day)	(kWh/day)	(kWh/day)	(%)
CCB	49.93	51.23	1.31	2.6%
EDUG + CCB	32.52	34.21	1.68	5.2%
REP	33.78	31.90	-1.91	-5.6%
EDUG	21.05	22.29	1.24	5.9%

Change to avg daily total household electricity use – compared to the representative group				
GBS Approach Group	Before	After	Change	Change
	(kWh/day)	(kWh/day)	(kWh/day)	(%)
CCB	16.14	19.33	3.28	8.2%
EDUG + CCB	-1.26	2.31	3.59	10.7%
REP	-----	-----	-----	-----
EDUG	-12.73	-9.61	3.14	11.4%

Findings

- Only the representative group showed an average decrease in overall household electricity use across the projects.
- There is a large difference in actual household electricity consumption between the different project groups. This can be largely explained by the fact that the household sizes in the Clarendon Vale /Rokeby area are much larger than the households in the Greater Hobart groups.
- Changes to wood heating usage, not reported in these results is having a significant impact on electricity consumption in some households and is skewing these results.
- Households moving between houses is also having a significant impact on electricity consumption in some households and is skewing these results.

4.1.2 Change in Total Electricity use per occupant – All households

Change to avg daily total household electricity use per occupant				
	Before	After	Change	Change
GBS Approach Group	(kWh/day)	(kWh/day)	(kWh/day)	(%)
CCB	17.05	17.72	0.67	3.9%
EDUG + CCB	12.36	9.89	-2.46	-19.9%
REP	24.01	22.96	-1.06	-4.4%
EDUG	12.31	12.68	0.37	3.0%

Change to avg daily total household electricity use per occupant – compared to the representative group				
	Before	After	Change	Change
GBS Approach Group	(kWh/day)	(kWh/day)	(kWh/day)	(%)
CCB	-6.97	-5.24	1.73	8.3%
EDUG + CCB	-9.83	-12.81	-2.99	-15.5%
REP	-----	-----	-----	-----
EDUG	-10.59	-10.28	0.31	7.4%

Findings

- The larger number of persons per household in the Rokeby/Clarendon Vale groups, leads to lower electricity consumption on a per occupant in those households.
- When considered on a per occupant basis, the EDUG + CCB households recorded a 15.5% reduction in energy consumption compared to the representative group. There were a number of households in the study in which people moved to and from the house, altering the participant populations for the after period in all four of the GBS approach groups.

4.1.3 Change to % time in defined comfort zones – All households

The thermal comfort zone was defined for the purposes of the study as the proportion of time over a 24 hour period that the internal temperature of the house was between 18 and 24°C. Here we present the time spent in the comfort zone for each group of houses during the before and after periods, and the change between the periods. All houses in the study are included in this comparison, including houses with wood fires, gas heating and households that moved.

Change to % time in comfort zone				Change to % time in comfort zone – compared to representative group	
	Before (%)	After (%)	Change (%)		Change (%)
CCB	45.6%	50.6%	5.0%	CCB	3.8%
EDUG + CCB	31.5%	35.4%	3.9%	EDUG + CCB	1.7%
REP	36.5%	38.6%	2.2%	REP	------
EDUG	21.6%	21.7%	0.1%	EDUG	-2.1%

Findings

- This comfort zone table compares all of the houses in the study, including houses with wood fires, gas heating and households that moved etc.
- All groups showed an increase in time in the CZ, but it was the CCB group that increased the most.
- Interrogation of individual household data showed that a major factor in this result was the number of households with wood fires, which were skewing the results.
- Once houses with non-electric heating are excluded from the sample more sensible comparisons of comfort between the study approach groups can be seen - (see further analysis in section 4.2.)

4.1.4 Hot Water electricity consumption per household – All households

Hot water consumption is compared across all houses in the study including houses with different heating types as this would not affect hot water heating.

Household hot water electricity consumption (kWh/household/day)				
GBS Approach Group	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
CCB	12.23	13.72	1.49	12.2%
EDUG + CCB	9.37	9.09	-0.28	-2.9%
REP	6.35	5.63	-0.72	-11.3%
EDUG	5.99	6.36	0.38	6.3%

Household hot water electricity consumption – compared to representative group				
GBS Approach Group	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
CCB	5.88	8.09	2.21	23.5%
EDUG + CCB	3.02	3.47	0.44	10.5%
REP	-----	-----	----	-----
EDUG	-0.36	0.73	1.09	17.6%

Findings

- Changes to hot water heating energy were varied across the approach groups with the CCB recording a 12.2% increase in use on a household basis. The Rep group had an 11.3% reduction.
- There is a large difference between the overall hot water use across the 4 groups. This is partly caused by different household sizes, which are larger on average in the CV/R groups.

4.1.5 Hot Water electricity consumption per occupant – All households

Hot water electricity consumption (kWh/person/day)				
GBS Approach Group	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
CCB	4.34	5.00	0.67	15.4%
EDUG + CCB	3.10	2.45	-0.65	-21.1%
REP	4.28	3.72	-0.56	-13.1%
EDUG	3.53	3.62	0.09	2.5%

Hot water electricity consumption per person – compared to representative group				
GBS Approach Group	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
CCB	0.06	1.29	1.23	28.5%
EDUG + CCB	-1.18	-1.27	-0.09	-8.0%
REP	-----	-----	----	-----
EDUG	-0.75	-0.09	0.65	15.7%

Findings

- When hot water consumption is analysed per occupant, the levels of consumption are relatively similar for the four different approach groups.
- Change to household hot water energy consumption per occupant is widely varied across the groups. This is in part because of the change in average occupant numbers across the groups.
- The baseline REP group experienced a 13.1% reduction in hot water consumption per occupant.
- The EDUG+CCB group had the largest reduction of 21.1% on a per occupant basis, 8% greater reduction than the REP group.
- Hot water consumption increased by 15.4% per occupant for the CCB group, or 28.5% more than the representative group.
- Hot water consumption increased by 2.5% per occupant for the EDUG group, or 15.7% more than the representative group.

4.2 Approach groups compared across energy and comfort indicators

In this section the four approach groups are compared across five key indicators of performance relating to household energy and comfort.

For these comparisons, houses with wood fires, or gas heating, and households that moved from one house to another during the study are excluded from the comparison. Unfortunately, not enough data was available to reliably calculate wood or gas heating consumption. The table below presents background data on the sample group sizes for this section of analysis, and the average number of occupants per household in the different approach groups during the before and after monitoring periods.

GBS Approach Group	Number of houses in Detailed Study Sample	Average occupants per household in the before period	Average occupants per household in the after period
CCB	9	3.7	3.4
EDUG + CCB	9	3.3	4.0
REP	8	1.8	1.5
EDUG	9	1.9	1.9

The key indicators are average changes to:

1. Total heating electricity (kWh/day) – the combination of all electric heating types in the house
2. Total household electricity (kWh/day)
3. House Heating Efficiency (HHE) (degree-hours/kWh/day)
4. ∆T – difference between inside and outside temperature (°C)
5. Proportion (%) of time the house is within the defined comfort zone (18–24°C)

All five comparisons are presented below on a 'whole of household' basis. Per occupant comparisons are also undertaken for heating energy and total electricity use.

At the end of this section there is also one further, specific comparison undertaken which analyses the changes to plug-in heating and hard-wired heating across the four approach groups.

4.2.1 Household based comparison of approach groups across five key indicators

Household comparison of approach groups across five key indicators								
Approach Group	Indicator 1		Indicator 2		Indicator 3		Indicator 4	Indicator 5
	Change to Total Heating Energy		Change to Total Household Electricity		Change House Heating Efficiency		Change to ∆T	% Time in CZ
	(kWh/day)	(%)	(kWh/day)	(%)	(deg hrs / kWh/day)	(%)	(°C)	(%)
CCB	1.88	6.2%	3.59	6.3%	0.00	0.5%	1.04	-0.3%
EDUG + CCB	4.00	29.2%	3.79	11.3%	0.21	25.4%	0.51	5.9%
REP	2.44	12.7%	2.78	9.2%	-0.02	-4.5%	0.65	1.9%
EDUG	0.67	7.2%	1.53	6.2%	-0.06	-7.6%	0.25	-0.1%

Household comparison of approach groups across 5 key indicators – compared to representative group								
Approach Group	Indicator 1		Indicator 2		Indicator 3		Indicator 4	Indicator 5
	Change to Total Heating Energy		Change to Total Household Electricity		Change House Heating Efficiency		Change to ∆T	% Time in CZ
	(kWh/day)	(%)	(kWh/day)	(%)	(deg hrs / kWh/day)	(%)	(°C)	(%)
CCB	-0.55	-6.4%	0.81	-2.9%	0.02	5.0%	0.39	-2.1%
EDUG + CCB	1.56	16.6%	1.01	2.1%	0.24	29.9%	-0.14	4.0%
REP	----	----	----	----	----	----	----	----
EDUG	-1.77	-5.5%	-1.25	-2.9%	-0.04	-3.1%	-0.40	-2.0%

4.2.2 Per occupant comparison of approach groups

Per occupant comparison of approach groups for heating and total electricity				
Approach Group	Indicator 1		Indicator 2	
	Change to Total Heating Energy per occupant		Change to Total Electricity per occupant	
	(kWh/day)	(%)	(kWh/day)	(%)
CCB	0.47	4.6%	1.50	7.9%
EDUG + CCB	-1.10	-16.7%	-2.58	-19.0%
REP	3.06	24.2%	4.22	20.8%
EDUG	0.17	3.1%	0.28	2.0%

Per occupant comparison of approach groups for heating and total electricity – compared to the representative group				
Approach Group	Indicator 1		Indicator 2	
	Change to Total Heating Energy per occupant		Change to Total Electricity per occupant	
	(kWh/day)	(%)	(kWh/day)	(%)
CCB	-2.59	-19.6%	-2.72	-12.8%
EDUG + CCB	-4.17	-40.9%	-6.80	-39.8%
REP	----	----	----	----
EDUG	-2.89	-21.1%	-3.94	-18.8%

Findings

Indicator 1 – Change to total heating energy

- All approach groups recorded an increase in total heating energy per household. The largest increase was in the EDUG + CCB group.
- However, when occupant levels are factored in, heating energy use reduced per occupant by 16.7% in the EDUG + CCB group.
- On a per occupant basis all 3 groups with support activities reduced heating energy consumption compared to the representative group.
- A major factor in the increase in household heating was the fact that the 'after' winter was a significantly colder winter, than the 'before' winter. For Hobart, the mean winter temperature for 2015 was 8.5 degrees and for 2014 was 9.9 degrees. (BOM, 2014). Across Tasmania, the after winter (2015) had the coldest winter mean temperature since 1966. Night time mean temperatures were the coldest since 1995 and daytime temps were the coldest since 1992 (BOM, 2015). The mean winter temperature for the before winter (2014) was above average across the state. These differences were reflected in the monitored outdoor temperatures at the detailed households.
- Increases in household heating did lead to an increase in comfort levels for the EDUG + CCB households.
- There was a significant switch to hard wired heating from plug-in heating. (refer to separate analysis later in this section)

Indicator 2 – Change to total electricity use

- Due to the large proportion of household energy being used for heating during the winter period, total electricity consumption is strongly linked to total heating consumption.
- Households in all 4 approach groups increased their total electricity consumption in the after winter. Again, however, when occupant levels are factored in, there is a decrease in electricity consumption by occupant with the EDUG group decreasing by 18.8%, the CCB group decreasing by 12.8% and the EDUG+CCB group decreasing by 39.8% relative to the representative group.
- The previous comparisons of hot water and other household electricity consumption demonstrate that the main contributor to overall increases in household electricity consumption was the additional heating in the after winter.

Indicator 3 – Change to House Heating Efficiency

- The house heating efficiency (HHE) results show a marked difference between the households in the CCB groups and in those in Greater Hobart.
- For the EDUG + CCB group HHE increased by 25.4%, and the CCB group increased by 0.5%
- For the EDUG group, HHE decreased by 7.6% and for the REP group decreased by 4.5%
- These results for the CCB groups are seen as being strongly related to the change in heater use from plug-in to hard-wired heaters (T31 to T41/42), which would have included greater use of heat pumps which deliver greater heating efficiency. One of the messages from the GBS community activities and in-home education sessions was that switching to T41/T42 heating sources would save the householder due to the cheaper tariff.
- While, upgrades as part of the GBS study may have had some minor affect in improving HHE. This is not seen to be a discernible impact. Other factors such as heater use and the differing winter conditions will have contributed the greater influence to changes in HHE across the groups.

Indicator 4 – Change to ΔT (Inside/Outside temperature difference)

- Households in all approach groups managed to increase the ΔT
- This however does not mean that it was warmer inside during the after period, because the after winter was colder.
- The larger ΔT was created by significant increases in heater use across all groups.
- The CCB group were able to create the largest increase in ΔT of 1.04 degrees between the before and after periods

Indicator 5 – Change to proportion (%) of time in Comfort Zone

- Though the ΔT was larger for all groups in the after period, only the EDUG + CCB group were able to record a significant increase in % time spent in the defined comfort zone (CZ).
- Using the representative group as a baseline, the EDUG + CCB group managed to achieve 4.0% more time in the CZ, while the CCB group experienced 2.1% and the EDUG group 2.0% less time respectively in the CZ.
- These drops in time in CZ are seen to be more to do with the colder winter than anything to do with the upgrade process.
- The increase in time in the CZ in the EDUG + CCB group is seen primarily as a result of significantly greater heater use.

4.2.3 Change to plug-in and hard-wired heating across the four approach groups

Change to plug-in and hard-wired heating								
	T 31 Heating (plug-in heating)				T 41/42 Heating (hard-wired heating)			
	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
CCB	6.21	5.05	-1.16	-18.7%	23.95	26.99	3.04	12.7%
EDUG + CCB	2.05	0.97	-1.08	-52.6%	11.65	16.73	5.08	43.6%
REP	5.53	5.16	-0.38	-6.8%	13.73	16.55	2.82	20.5%
EDUG	1.78	1.63	-0.14	-8.0%	7.50	8.31	0.81	10.8%

Findings

- There was a reduction in plug-in heating across all four approach groups.
- The greatest reduction was in the CCB groups.
- There was a corresponding increase in hard-wired heating across all groups. This includes both hard-wired resistive and heat pump heaters.

4.3 Household electric heating type compared across key indicators

In this section, households are grouped according to the types of electric heating within the house.
The four groups are defined as follows:

Electric Heating Type Group	Number of houses in Detailed Study Sample	Notes on group definition
All Houses with Heat pumps	24	Includes any house that has a heat pump, whether or not there are other electric heating types present in the household
All Houses with Hardwired resistive heaters	16	Includes any house that has a hard-wired resistive heating, whether or not there are other electric heating types present in the household.
Houses with ONLY heat pumps	5	Includes houses that have a heat pump/s as the only heat source in the household
Houses with ONLY resistive heaters	11	Includes houses that have resistive heating as the only heat source in the household

These four groups are not mutually exclusive. Houses with wood fires and gas heating and households that moved are excluded from the analysis in this section.

The heating type groups are compared using the various key measures, for the before and after periods and to compare the change between the periods. The following measures are used:

- Plug-in (T31) heating energy (kWh/day)
- Hard-wired (T41/42) heating energy (kWh/day)
- Total heating energy (kWh/day)
- Total household electricity use (kWh/day)
- House Heating Efficiency (HHE) (degree hours/ kWh/day)
- Living Room Temperature (°C)
- ∆T (difference between inside and outside temperature) (°C)
- Proportion of time (%) in the comfort zone.

4.3.1 Plug-in (T31) heating energy

	Daily average plug-in (T31) heating use			
Houses grouped by heating types	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
Houses with Heat Pumps	2.82	2.43	-0.40	-14.1%
Houses with Hardwire resistive heaters	5.11	4.56	-0.55	-10.8%
Houses with Only Heat pumps	n/a	n/a	n/a	n/a
Houses with Only Resistive Heaters	7.29	6.11	-1.18	-16.2%

Findings

- Plug-in heating is obviously greatest in houses with only resistive heaters.
- Houses with only heat pumps have no plug-in heating.
- On average, for all houses with plug-in heating there was a reduction in their use associated with the switch to hardwired heating.

4.3.2 Hard-wired (T41/42) heating energy

	Hard-wired (T41/T42) heating energy			
Houses grouped by heating types	Before (kWh/day)	After (kWh/day)	Change (kWh/day)	Change (%)
Houses with Heat Pumps	11.70	13.64	1.94	16.6%
Houses with Hardwire resistive heaters	16.96	21.01	4.05	23.9%
Houses with Only Heat pumps	14.55	16.01	1.46	10.1%
Houses with Only Resistive Heaters	16.30	22.60	6.29	38.6%

Findings

- For houses with heat pumps (with or without other heating) there is a lower hard-wired heating energy consumption on average.
- In the after period both households with and without heat pumps had increased their heater use due to the colder winter, but there was a significantly lower increase in heating energy consumption between the before and after periods, in houses with heat pumps (with or without other heating).
- In the before period on average households with heat pumps used 4.6kWh/day less than households with only resistive heating sources.
- in the after period on average households with heat pumps used 9.0kWh/day less than households with only resistive heating sources.

4.3.3 Total Heating Energy

	Total Heating Energy			
Houses grouped by heating types	Before	After	Change	Change
	(kWh/day)	(kWh/day)	(kWh/day)	(%)
Houses with Heat Pumps	14.52	16.07	1.54	10.6%
Houses with Hardwire resistive heaters	22.07	25.57	3.50	15.8%
Houses with Only Heat pumps	14.55	16.01	1.46	10.1%
Houses with Only Resistive Heaters	23.59	28.71	5.12	21.7%

Findings

- The total heating energy reflects the combined trend of T31 and T41/42 heating use.
- In the after period both households with and without heat pumps had increased their heater use due to the colder winter.
- For houses with heat pumps (with or without other heating) there is a lower total heating energy consumption on average.
- There was also a significantly lower increase heating energy consumption in houses with heat pumps (with or without other heating).
- In the before period on average households with heat pumps used 9.0 kWh/day less than households with only resistive heating.
- in the after period on average households with heat pumps used 12.6kWh/day less than households with only resistive heating.

4.3.4 Total Household Electricity

	Total Household Electricity			
Houses grouped by heating types	Before	After	Change	Change
	(kWh/day)	(kWh/day)	(kWh/day)	(%)
Houses with Heat Pumps	34.77	36.72	1.95	5.6%
Houses with Hardwire resistive heaters	40.20	44.05	3.85	9.6%
Houses with Only Heat pumps	36.83	38.52	1.69	4.6%
Houses with Only Resistive Heaters	39.31	44.80	5.49	14.0%

Findings

- Because heating is such a significant proportion of winter electricity consumption, the total household electricity consumption when broken down by heater types is similar to the pattern of total household heating energy consumption.
- For houses with heat pumps (with or without other heating) there is a lower total electricity consumption on average.
- There was also a significantly lower increase electricity consumption in houses with heat pumps (with or without other heating)
- In the before period on average households with heat pumps used 4.5kWh/day less than households with only resistive heating.
- In the after period both households with and without heat pumps had increased their electricity use due to the colder winter.
- In the after period on average households with heat pumps used 8.1 kWh/day less than households with only resistive heating.

4.3.5 House Heating Efficiency (HHE)

	Household Heating Efficiency			
Houses grouped by heating types	Before	After	Change	Change
	(°C-hours/kWh/day)			(%)
Houses with Heat Pumps	0.74	0.80	0.07	9.3%
Houses with Hardwire resistive heaters	0.47	0.42	-0.05	-11.3%
Houses with Only Heat pumps	0.75	0.76	0.01	1.3%
Houses with Only Resistive Heaters	0.35	0.29	-0.06	-16.2%

Findings

- There is a significant difference in HHE ratios for houses with and without heat pumps.
- The average of houses with heat pumps (with or without other heaters) was 0.74 deg hours/kWh/day in the before period.
- This compared to an average of 0.35 deg hours/kWh/day for houses with only resistive heating
- Houses with only heat pumps experienced a small increase in HHE in the after period.
- Houses with heat pumps and other heaters experienced the biggest improvement – a 9.3% increase in HHE. This is seen as being due to the switch from plug-in heaters to heat pumps
- Houses without heat pumps had reduced HHE in the after period. This is seen as being due primarily to the overall increase in energy use, and the colder winter. During colder outside conditions there is a larger temperature difference between inside and out, leading to a stronger heat flow through the poorly resistive building fabric of the typical houses in the study and reduced HHE.
- In the after period, households with heat pumps had more than 2.5 times the HHE of houses with only resistive heaters.

4.3.6 Living Room Temperature

	Living Room Temperature		
Houses grouped by heating types	Before	After	Change
	(°C)	(°C)	(°C)
Houses with Heat Pumps	19.1	19.5	0.3
Houses with Hardwire resistive heaters	17.7	17.8	0.1
Houses with Only Heat pumps	20.6	20.5	-0.2
Houses with Only Resistive Heaters	16.9	16.9	0.1

Findings

- Houses with heat pumps (with or without other heaters), maintained a higher temperature in living rooms during winter, than houses without heat pumps.
- On average the living room temperature in houses with heat pumps in the before period was 19.1 on average.
- For houses with only resistive heating the average temp in living rooms in the before period was 16.9 on average.
- On average there was little change in absolute temperature in the living rooms for houses with any heating type between the before and after period.

4.3.7 Average temperature difference between inside and outside (ΔT)

	ΔT		
Houses grouped by heating types	Before	After	Change
	(°C)	(°C)	(°C)
Houses with Heat Pumps	7.2	8.0	0.8
Houses with Hardwire resistive heaters	6.9	7.4	0.6
Houses with Only Heat pumps	9.1	9.4	0.3
Houses with Only Resistive Heaters	6.5	7.2	0.6

Findings

- houses with heat pumps (with or without other heaters) are able to maintain a greater difference between inside and outside temperature (ΔT).
- The houses with only heat pumps were able to maintain a the largest ΔT of 9.1°C during the before period.
- Houses with only resistive heating were able to maintain a ΔT of only 6.5°C during the before period.
- Houses of all types, on average were able to increase ΔT for the after period – even though this didn't translate into warmer absolute temperatures in living areas as seen above. This was because of the colder ambient temperatures during the after winter.

4.3.8 Proportion (%) of time in comfort zone (18°C – 24°C)

	% time in the comfort zone (CZ)		
Houses grouped by heating types	Before	After	Change
	(%)	(%)	(%)
Houses with Heat Pumps	41.6%	43.2%	1.6%
Houses with Hardwire resistive heaters	31.8%	34.5%	2.6%
Houses with Only Heat pumps	44.4%	42.7%	-1.7%
Houses with Only Resistive Heaters	26.0%	29.6%	3.6%

Findings

- Houses with heat pumps on average were able to achieve temperatures within the comfort zone 41.6"% of the time in the before period.
- This compared to just 26.0% of the time in the comfort zone for houses with only resistive heaters.
- There was a slight improvement to % of time in the CZ for houses with resistive heating, in the after period – primary due to the large increase in heater energy use.
- However, houses with only resistive heating are still spending 13.6% less time in the CZ than houses with heat pumps.

4.3.9 Total Heating vs House Heating Efficiency vs % time in comfort zone.

The following two tables present analysis of the households grouped by heating type as compared against:

- Total heating energy
- House heating efficiency, and
- Proportion (%) of time in the comfort zone, for the before and after periods

Before Period	Total Heating Electricity	House Heating Efficiency	% Time in CZ
Houses grouped by heating types	Before	Before	Before
	(kWh/day)	(°C-hours/ kWh/day)	(%)
Houses with Heat Pumps	14.52	0.74	41.6%
Houses with Hardwire resistive heaters	22.07	0.47	31.8%
Houses with Only Heat pumps	14.55	0.75	44.4%
Houses with Only Resistive Heaters	23.59	0.35	26.0%

After Period	Total Heating Electricity	House Heating Efficiency	% Time in CZ
Houses grouped by heating types	After	After	After
	(kWh/day)	(°C-hours/ kWh/day)	(%)
Houses with Heat Pumps	16.07	0.80	43.2%
Houses with Hardwire resistive heaters	25.57	0.42	34.5%
Houses with Only Heat pumps	16.01	0.76	42.7%
Houses with Only Resistive Heaters	28.71	0.29	29.6%

Findings

- The comparison of heating types against the key indicators of change in heating energy and comfort, demonstrates the benefits of heat pumps in terms of electricity consumption (and hence cost), heating efficiency, and household comfort.
- Households that relied solely on heat pumps used 9.0kWh/day less on average, than households with only resistive heating, during the before period. At the same time households with heat pumps achieved 15.6% more of the time in the CZ compared to houses without heat pumps.
- Houses with heat pumps had a HHE more than double that of houses with only resistive heating, during the before period.
- The benefits of heat pumps increased during the colder winter 'after' winter of 2015.
- Houses that relied solely on heat pumps used 12.7kWh/day less heating energy on average than houses with only resistive heating, while at the same time achieved 13.1% more of the time in the CZ compared to houses without heat pumps.
- Houses with heat pumps displayed a HHE more than 2.5 times greater than houses with only resistive heating during the after period.

4.4 Quintile Based Analysis

In this section, analysis is conducted by dividing households into quintiles based on the various measured parameters in the GBS project. The households in this quintile analysis are the same 35 households used in Section 4.2 (which excludes households with non-electric heating and who moved).

Quintile baseline performance analysis involves a series of comparisons based on 'before' performance of the households as measured by:

- Living room Temperature (°C)
- Average total heating energy (kWh/day)
- Average total household electricity consumption (kWh/day)
- Proportion of time (%) time in the comfort zone.

In each case the quintiles are colour coded from green through to orange, with the best performing households in the top quintile, Q1, at the top of the table in green, for each parameter.

Q1
Q2
Q3
Q4
Q5

Baseline performance of the households, as measured by these indicators, is used to establish quintile groups, which are then compared against key change indicators for the project:

- Change to total heating energy
- Change in living room temperature
- Change in time within the comfort zone

4.4.1 'Before' Living Room Temp – Quintile based analysis

Before Living Temp vs Before Heating Electricity vs Before Total Electricity vs % time in CZ				
	Before Living Temp	Before Heating Electricity	Before Total Electricity	Before % time in CZ
Living Temp Quintile	(°C)	(kWh/day)	(kWh/day)	(%)
Q1	23.00	33.50	59.76	65.6%
Q2	20.01	19.57	33.18	58.3%
Q3	18.17	13.37	28.63	29.4%
Q4	17.16	12.13	34.69	21.5%
Q5	14.62	11.76	26.29	11.1%

Findings – Before living temp vs heating electricity, total electricity & % time in CZ.

- There is a very clear correlation between living room temperatures measured and heating electricity used. Essentially to achieve warmer temperatures, more heating energy is used.
- This also translates to a clear correlation between heating energy and % time in the CZ.
- Essentially the more energy put into heating the more comfort the householder achieves.

Before Living Temp vs Change in Total Heating Energy			
	Before Living Temp	Total Heating Energy Change	
Living Temp Quintile	(°C)	(kWh/day)	(%)
Q1	23.00	2.64	13%
Q2	20.01	0.92	6%
Q3	18.17	0.56	5%
Q4	17.16	2.15	5%
Q5	14.62	4.95	51%

Findings – Before living temp vs change in total heating energy

- There is not a clear correlation between living room temperatures and the change to heating energy that occurred over the course of the GBS project.
- Not surprisingly the lowest temperature households had the highest increase in heating energy as they attempted to improve or maintain their living room temperatures during the colder after winter.
- However, the households with the highest internal temperatures also had an increase suggesting that householders will attempt to maintain the temp that they are used to and will use the extra energy to achieve that temp when it is colder outside.

Before Living Temp vs Change in living Temp		
	Before Living Temp	Change in Living Temp
Living Temp Quintile	(°C)	(°C)
Q1	23.00	0.81
Q2	20.01	0.22
Q3	18.17	0.23
Q4	17.16	-0.86
Q5	14.62	0.26

Findings – Before living temp vs change in living temp

- For the households in the lowest temperature quintile, even with the highest increase in energy consumption, the households were only able to achieve on average a 0.26 deg increase in living room temperature in the after period.
- Households in the top quintile managed to achieve a 0.81 degree increase on average with a heating energy increase that was significantly less than that bottom quintile group.
- Further analysis would be required to determine the reasoning behind these variations. It may be the relationship between households and heater types.

Before Living Temp vs Change in % time in CZ		
	Before Living Temp	Change in time in CZ
Living Temp Quintile	(°C)	(%)
Q1	23.00	-2.1%
Q2	20.01	4.8%
Q3	18.17	0.4%
Q4	17.16	-1.5%
Q5	14.62	7.6%

Findings – Before living temp vs change in % time in the CZ

- The bottom quintile of households ranked by living room temp had the greatest increase in % of time in the comfort zone, but they were starting out from a very low position.
- The decrease in time in the comfort zone for households in the top quintile may in fact be because of extra time spent above the 24°C limit. This raises an issue of energy 'wastage' through unnecessary heating above the standard comfort levels.

4.4.2 'Before' total heating electricity – quintile based analysis

Before Heating Electricity vs Before Living Temp vs Before Total Electricity vs % time in CZ				
	Before Heating Electricity	Before Total Electricity	Before Living Temp	Before % time in CZ
Total heating electricity quintile	(kWh/day)	(kWh/day)	(°C)	(%)
Q1	5.24	24.39	17.06	20.1%
Q2	10.05	28.56	17.49	33.5%
Q3	13.77	28.43	18.17	37.9%
Q4	20.27	35.01	19.69	38.4%
Q5	40.99	66.16	20.53	55.9%

Findings – Before heating electricity vs living temp, total electricity & % time in CZ

- As may be expected from the analysis based on before living room temperatures, there is a strong correlation between heating energy use and living room temperature and time in the comfort zone.

Before Heating Electricity vs Change in Total Heating Energy			
Total heating electricity quintile	Before Heating Electricity	Total Heating Energy Change	
	(kWh/day)	(kWh/day)	(%)
Q1	5.24	0.63	14%
Q2	10.05	4.07	38%
Q3	13.77	0.05	-1%
Q4	20.27	4.07	23%
Q5	40.99	2.40	6%

Findings – Before heating electricity vs change in total heating energy

– No clear relationship is found between initial household heating energy consumption and the change in heating energy consumption over the course of the GBS project. Analysis of individual households through the case studies may reveal why certain households used more and some less.

Before Heating Electricity vs Change in Living Temp		
Total heating electricity quintile	Before Heating Electricity	Change in Living Temp
	(kWh/day)	(°C)
Q1	5.24	-0.15
Q2	10.05	-0.01
Q3	13.77	0.23
Q4	20.27	0.63
Q5	40.99	-0.04

Findings – Before heating electricity vs change in living temp

– There seems to be no clear relationship between heating electricity consumption levels before the study, and changes to temperature occurring as a result of the study

– Households in Q3 and Q4 experienced an increase in living room temp on average, while households in Q1,2 and 5 experienced a slight decrease on average

Before Heating Electricity vs Change in % time in CZ		
Total heating electricity quintile	Before Heating Electricity (kWh/day)	Change in Time in CZ (°C)
Q1	5.24	1.4%
Q2	10.05	5.2%
Q3	13.77	0.9%
Q4	20.27	5.0%
Q5	40.99	-3.4%

Findings – Before heating electricity vs change in time in CZ

- No clear relationship is found between initial household heating energy consumption and the change in time in the comfort zone over the course of the GSB project
- Quintiles 1 to 4 experienced increases in % time in the comfort zone, though to varying degrees. Those households in the highest energy using quintile experienced a slight drop in time in CZ, however they were starting out with the highest percentage in the before period.

4.4.3 'Before' % time in comfort zone – quintile based analysis

Before % time in CZ vs Before Heating Electricity vs Living Temp vs Total Electricity				
% Time in CZ quintile	Before % time in CZ (%)	Before Heating Electricity (kWh/day)	Before Living Temp (°C)	Before Total Electricity (kWh/day)
Q1	78.5%	31.48	21.18	56.13
Q2	46.6%	21.66	21.47	38.23
Q3	31.5%	15.37	18.39	27.46
Q4	20.1%	9.68	16.69	30.96
Q5	9.2%	12.13	15.22	29.77

Findings – Before % time in CZ vs before heating electricity, living temp & total electricity

- There is a relatively strong correlation between the time spent in comfort zones and heating energy consumption.
- This also translates into a reasonably strong correlation between % time in comfort zone and overall house electricity consumption

Before Time in CZ vs Change in Total Heating Energy			
	Before % time in CZ	Total Heating Energy Change	
% Time in CZ quintile	(%)	(kWh/day)	(%)
Q1	78.5%	1.58	8%
Q2	46.6%	2.86	15%
Q3	31.5%	0.33	2%
Q4	20.1%	3.20	29%
Q5	9.2%	3.24	26%

Findings – Before % time in CZ vs change in total heating energy

– There does seem to be some relationship between the initial % of time in comfort zone and the change in household heating energy consumption.

– Households in the lowest 2 quintiles increased their heating energy consumption the most both in terms of absolute kWh and % of household heating energy consumption, presumably in an attempt to either maintain or improve their very low comfort levels.

Before Time in CZ vs Change in Living Temp		
	Before % time in CZ	Change in Living Temp
% Time in CZ quintile	(%)	(°C)
Q1	78.5%	0.45
Q2	46.6%	0.65
Q3	31.5%	0.06
Q4	20.1%	-0.18
Q5	9.2%	-0.31

Findings – Before % time in CZ vs change in living temp

– Unfortunately for those households in the bottom 2 quintiles, the extra heating energy consumption did not translate into increased living room temperatures. The extra heating was eaten up trying to maintain existing temperatures over the colder 'after' winter period

– Households in the top 2 quintiles for % time in CZ managed to increase their living room temperatures over the 'after' period

Before Time in CZ vs Change in % time in CZ		
	Before % time in CZ	Change in Time in CZ
% Time in CZ quintile	(%)	(%)
Q1	78.5%	0.7%
Q2	46.6%	1.8%
Q3	31.5%	1.1%
Q4	20.1%	3.1%
Q5	9.2%	2.4%

- There was a generally small increase to comfort levels for households in all 5 quintiles based on initial comfort levels, though slightly more increase in the bottom 2 quintiles.

4.4.4 Quintile based analysis of change indicators

This analysis is comprised of a series of comparisons of the households divided into quintiles as measured by the following key change indicators:

- Change in total heating electricity
- Change in House Heating Efficiency (HHE)
- Change to ΔT
- Change to % time in comfort zone

Performance of the households, as measured by these change indicators, is used to establish quintile groups which are then compared against the key change indicators for the project to help identify relationships between the indicators.

Change in Total Heating Electricity Vs other change parameters				
Quintile	Change in total heating electricity	Change in Heating efficiency	Change in ΔT	Change in % time in CZ
	(kWh/day)	(%)	(°C)	(%)
Q1	-3.72	31.9%	-0.45	-6.7%
Q2	-0.12	10.4%	0.64	4.3%
Q3	1.15	-3.7%	0.58	2.3%
Q4	3.18	-13.5%	0.76	-3.4%
Q5	10.73	-17.7%	1.53	12.8%

Findings – Change in total heating electricity vs other change parameters

- Change in heating energy has an inverse correlation to change in heating efficiency. The more heating used in a house, the less efficient that heating is in terms of the temperature difference created for the household.
- There is also a close relationship between change in heating electricity and change in ΔT. Less heating means less difference between inside and outside temperature.
- Some relationship to change in time in CZ with the biggest increase in heater energy use providing the biggest increase in time in CZ on average, however the other quintile's averages varied up and down.

Change in Heating Efficiency vs other change parameters				
Quintile	Change in Heating Efficiency	Total Heating Energy Change	Change in ΔT	Change in Time in CZ
	(%)	(kWh/day)	(°C)	(%)
Q1	41.1%	-3.21	0.10	-1.7%
Q2	10.0%	0.98	1.16	-2.2%
Q3	-3.3%	3.04	0.68	5.3%
Q4	-14.6%	4.81	0.53	1.5%
Q5	-25.8%	5.60	0.61	6.3%

Findings – Change in Heating Efficiency vs other change parameters

- The inverse relationship between heating efficiency and heater use is again demonstrated.
- Reduction in time within the comfort zone for those quintiles with improved heating efficiency, also demonstrates the same corresponding relationship as seen in the previous tables
- Change in ΔT however, does not seem to display the same relationship. This could demonstrate some interesting findings requiring closer investigation as it may demonstrate that an increase in heating efficiency is possible at the same time as an increase in ΔT, and potentially an increase in % time in CZ.

Change to ΔT vs other change parameters				
Quintile	Change in ΔT	Change in Heating efficiency	Total Heating Energy Change	Change in Time in CZ
	(°C)	(%)	(kWh/day)	(%)
Q1	2.29	0.6%	8.25	13.9%
Q2	1.04	-4.3%	2.45	0.7%
Q3	0.46	9.2%	1.41	1.6%
Q4	0.19	-8.6%	1.44	1.4%
Q5	-0.91	10.5%	-2.34	-8.5%

Findings – Change to ΔT vs other change parameters

- There is a close relationship between change in ΔT and change in % time in CZ as would be expected.
- There is also a closer relationship between change in ΔT and heating energy consumption
- There is seemingly no relationship between change in ΔT and household heating efficiency. Again this is cause for further investigation to discover how houses achieving an increase in ΔT do so, while also increasing the efficiency of household heating.

Change to % time in CZ vs other change parameters				
Quintile	Change to% time in CZ	Change in Heating efficiency	Total Heating Energy Change	Change in ΔT
	(%)	(%)	(kWh/day)	(°C)
Q1	18.5%	-4.3%	7.54	1.76
Q2	3.9%	-8.4%	3.19	0.55
Q3	0.6%	-11.0%	1.74	0.36
Q4	-2.9%	17.7%	-0.66	0.74
Q5	-10.8%	13.4%	-0.60	-0.34

Findings – Change to % time in CZ vs other change parameters

- There is a close relationship between change in time in CZ and change inΔT.
- There also appears to be some level of correlation between change in time in CZ and change to household energy consumption – with those households experiencing more time in CZ doing so at the expense of extra heating.
- There also appears to be an inverse relationship to HHE. Higher levels of comfort are achieved while HHE decreases due to extra heating energy consumption.

4.4.5 Households ranked by success of outcomes over the GBS project period

The following table presents all 35 households (with wood fire, gas heating and moved households excluded) in terms of overall success measured by the five key thermal and energy indicators.

The rankings are worked out by applying 5 points for each Q1 quintile ranking, down to 1 point for each Q1 quintile ranking, on the 5 key indicators.

House	Group	Total Heating Electricity Change	Total Household Electricity Change	Household Heating Efficiency Change	ΔT Change	% Time in CZ Change	Total rating
		(kWh/day)	(kWh/day)	(°C -hours /kWh/day)	(°C)	(%)	
GBS168	EDUG + CCB	-0.19	-0.22	1.73	2.03	20.1%	23
GBS156	REP	0.47	0.85	0.12	1.99	5.8%	23
GBS026	REP	-1.98	-1.85	0.16	0.21	-1.9%	19
GBS040	CCB	-3.83	-1.74	0.12	0.44	-0.7%	19
GBS724	CCB	-0.58	-5.34	0.03	0.55	2.0%	19
GBS023	REP	-0.28	1.51	0.02	0.37	4.6%	18
GBS045	EDUG + CCB	-0.32	0.89	0.03	0.26	0.0%	17
GBS046	EDUG + CCB	-2.25	-10.65	0.22	-0.33	-9.4%	17
GBS052	CCB	-1.81	4.21	0.04	1.11	-4.3%	17
GBS725	EDUG + CCB	-10.82	-9.88	0.19	-2.86	-16.8%	17
GBS726	EDUG + CCB	-3.84	-5.17	0.39	-0.77	-8.7%	17
GBS019	EDUG	1.47	-0.19	-0.24	0.93	3.0%	16
GBS094	CCB	3.57	2.82	-0.06	1.38	5.2%	16
GBS140	EDUG	-0.28	-1.32	-0.02	-0.36	3.5%	16
GBS022	EDUG	1.72	1.45	-0.07	0.72	4.1%	15
GBS041	CCB	0.58	5.07	0.00	0.19	9.2%	15
GBS097	CCB	2.07	5.01	0.12	3.46	-6.0%	15
GBS144	REP	8.37	7.51	-0.01	2.05	29.3%	15
GBS014	EDUG	-1.53	-1.60	-0.07	-0.92	-5.1%	14
GBS016	EDUG	1.27	9.80	0.00	1.09	-0.7%	14
GBS028	EDUG	0.77	7.20	0.02	0.57	-0.7%	14
GBS131	EDUG + CCB	15.67	20.22	-0.06	2.16	16.4%	14
GBS157	EDUG	1.67	1.61	-0.01	0.29	-1.3%	14
GBS029	EDUG	0.53	1.02	-0.05	0.28	2.6%	13
GBS047	EDUG + CCB	24.33	24.27	-0.47	2.55	43.3%	13
GBS090	EDUG + CCB	5.88	1.94	-0.07	0.44	3.3%	13
GBS098	CCB	7.02	7.41	0.00	1.79	-11.2%	13
GBS018	EDUG	0.37	-4.21	-0.07	-0.33	-6.1%	12
GBS037	REP	3.38	6.51	-0.01	0.89	-6.9%	12
GBS088	CCB	6.26	11.57	-0.01	0.59	4.0%	12
GBS099	EDUG + CCB	7.58	12.71	-0.04	1.15	4.5%	12
GBS036	REP	2.52	3.05	-0.07	0.23	1.1%	11
GBS166	REP	1.95	-4.45	-0.03	-0.78	-16.5%	11
GBS093	CCB	3.68	3.28	-0.22	-0.10	-0.4%	10
GBS268	REP	5.09	9.09	-0.36	0.26	-0.6%	9

Findings

- There is a distinct trade-off between increased comfort and increased energy consumption. See for examples GBS047, GBS131, which both achieved significant changes to time in the comfort zone, but at the expense of considerable extra energy consumption.
- The opposite trade-off is also seen where there is a decrease in energy consumption, but this is associated with decreased comfort. See for example houses GBS046, GBS725 and GBS726,
- Out of the 5 indicators, the HHE is the clearest indicator of overall success. All of the top quintile in HHE are in the top 11 of houses based on overall success ranking
- Such an analysis allows us to identify those houses that are being successful at reducing energy consumption at the same time as increasing comfort levels and then in term investigate more deeply into those cases to identify the underlying reasons for success.
- Likewise, for the opposite cases, where energy consumption has increased and comfort has decreased, we can investigate more deeply to discover what the barriers in those cases that are preventing successful energy and comfort outcomes.

4.5 Analysis by house construction age

Houses are analysed in this section, based on their age. Houses built after 2003 were required to meet energy efficiency standards that meant inclusion of features such as ceiling, wall and floor insulation, high quality, sealing windows, and potentially double glazing. This analysis also uses the 35 houses as described in section 4.2.

The numbers of households in the overall detailed study by house age are as follows:

- Post 2003–5
- 1980–2003–8
- Pre 1980–38

This analysis excludes houses with gas and wood fire heating, as well as households that have moved during the study.

Numbers of households in the sample groups are:

- Post 2003–5
- 1980–2003–6
- Pre 1980–24

Many of the older houses in the study had wood fires.

In some cases, the exact house age was not able to be identified so estimates have been made, based on an expert assessment of construction type, and location of the house.

Here baseline performance of the houses is compared using the data collected in the before period.

House age	Total Heating Electricity	Total Household Electricity	House Heating Efficiency	Living Temp	ΔT	% time in CZ
	Before	Before	Before	Before	Before	Before
	(kWh/day)	(kWh/day)	(degree-hours/kWh/day)	(°C)	(°C)	(%)
Post 2003	11.23	24.95	0.85	17.87	7.76	31.6%
1980-2003	17.90	30.59	0.46	17.10	6.01	37.6%
Pre 1980	19.53	40.40	0.61	19.11	7.33	38.2%

Findings

- Post 2003 houses use significantly less heating energy to achieve similar temperatures and ΔT to the older houses.
- This translates strongly into overall household heating use.
- On average, HHE is greatest in the post 2003 houses. This is not just explained by efficient heating types. Two out of five post 2003 households had heat pumps, the other three relied on resistive heating. 24 out of the 35 households in the sample have a heat pump in the house.
- The older houses are achieving a slightly higher % of time within the comfort zone, but at a significantly higher energy use.

5. Synthesis and discussion

In this section we bring together findings from the detailed analysis of individual cases and findings from the comparative analysis across all of the cases.

Section 5.1 brings together the changes to energy use and thermal comfort that have occurred during the GBS project, drawing on findings from the in-depth analysis of individual households through the case study process and findings from the comparative analysis process.

In Section 5.2 we then explore the factors influencing the changes that occurred, whether these changes were negative or positive. It is as important to understand what when right, to cause positive change, so that those factors may be replicated and improved upon. But it is also important to understand what goes wrong to cause negative change, or no change, so that those process may be avoided or improved upon.

Often it was found in the GBS project that householders were making trade-offs between energy efficiency, comfort and cost. Affecting positive change in one regard, while accepting negative change in the other. These trade-offs and several others related to comfort and energy efficiency are discussed in some detail in section 5.3.

We also provide a review of the methods of monitoring and evaluation as a final summary. Because the GBS project is part of a 'Pilot' scheme to test out the most effective programmes for improving energy efficiency and thermal comfort, a review of the methods of this Detailed Study component of GBS provides some valuable insight into the design of future programs.

5.1 Changes to household energy use and thermal comfort

When considering all houses in the detailed study, we saw both positive and negative changes to energy efficiency and thermal comfort in all approach groups. Across the energy based measures, the EDUG +CCB group displayed the most improvements when considered on a per occupant basis. It is found that the higher occupancy levels in those houses partly contributes to this efficiency. However, it must be said that there was a very wide variation in outcomes for individual households within each of the approach groups. For comfort measures, excluding those households with non-electric heating and those houses that moved, the EDUG+CCB group also displayed the greatest improvement in thermal comfort.

There was an increase in the bottom line, average household energy consumption figure, including all households in the study. More energy was used in the second winter than in the first. However, this increase is clearly explained by the increase in heating demand due to the colder winter in the second year of the study. A secondary influence may have also been the reduction in energy tariffs between the first and second winters that allowed households to feel a little more relaxed about energy costs.

It is difficult to identify any statistical trends out of the comparative analysis of the four approach groups. What is illuminating however are the dynamics and variation of outcomes across the range of individual cases in the Detailed Study. The differing outcomes, both positive and negative, that resulted from ostensibly the same GBS support activities lead the research team to investigate individual cases to search for the underlying factors that precipitated these varied outcomes.

Also informative is the identification of patterns or typologies of household energy use and thermal comfort habits. Such patterns can help to identify needs and or barriers in other households in the future.

5.1.1 Change in energy use during peak winter conditions:

When considering all households in the Detailed Study, it was only the REP group that showed a reduction in overall household electricity usage during the second winter period. When considered on a per occupant basis, these result change significantly, as there was a significant increase in the average occupancy of the EDG+CCB group households in the second winter. On a per occupant basis, the EDUG+CCB group recorded the most significant reduction in electricity usage of 19.9%.

Overall across the four approach groups we found:

	Major decrease	Minor decrease	Little or no change	Minor increase	Major increase
EDUG + CCB	3	3	2	0	3
CCB	2	3	1	6	3
EDUG	1	3	3	4	1
REP	0	2	2	4	4

The key factors in causing these changes are discussed in section 5.2.

5.1.2 Change in comfort during peak winter conditions:

When looking at all households including those with non-electric heating, all groups improved their thermal comfort in the second winter. It was the CCB group that improved the most at 5.0% more time within the comfort zone. The EDUG+CCB group improved by 3.9%, the REP group 2.2% and the EDUG group only marginally improved at 0.1% more time in the comfort zone.

When all houses with wood and gas heating as their main heating are taken out of the analysis, it is the EDUG+CCB group that show the greatest improvement at 5.9% more time in the comfort zone. The other groups had either a marginal increase or decrease in time in the comfort zone.

Overall across the four approach groups we found:

	Major decrease	Minor decrease	Little or no change	Minor increase	Major increase
EDUG + CCB	0	4	1	4	2
CCB	0	4	4	5	2
EDUG	0	1	5	6	0
REP	0	6	2	3	1

The key factors in causing these changes are discussed in section 5.2.

Comfort levels were measured as being between 18-24°C over a 24-hour period. It is understood that it is probably not necessary to have 100% of a 24-hour period within the 18-24°C range. A min of 60-70% is seen to be a good level when measured on this basis. Other more detailed definitions of comfort zones that factor in the time of day, and the different rooms of the household, could potentially be used if more time for data analysis had been available.

The interview and survey data tended to describe and greater increase in comfort as reported by householders, than was being measured by the temperature monitoring. A key factor in this discrepancy seems to be draught reduction, one of the tasks performed during home upgrade visits. Households reporting of reduced draughts and hence increased comfort was frequently not backed up by the temperature measurements. This does not mean that householders were imagining improved comfort. The temperature monitoring was only sensing air temperature. Air movement causes physiological cooling of people as air passes over them, even if the air temperature of the moving air is not cooler. Hence reduction in air movement will cause an increase in comfort in a cold climate, which will not be reflected in simple air temperature measurements.

5.1.3 Change in household heating efficiencies (HHE):

Excluding wood fire and gas heating (using the group of 35 analysed in 4.2 to 4.5), the EDUG+CCB group had the most significant increase in HHE (25%). The EDUG group's efficiency increased by 7.6%, CCB by 0.5% and the REP group decreased in efficiency. This effect is most likely due to a change in household use of heater. In the after period, there was more use of T41/42 wired-in heaters, particularly heat pumps and less use of plug-in heaters.

Generally, heat efficiency ratios, that is, the degree hours of heating achieved per kWh of energy input, per day, were fairly low, which indicated poor performance. Frequently ratios were found to be less than 0.4°C-hours/kWh/day. Across the sample of households this was highlighted by the fact that a few houses did have significantly higher HHE. These were the newer, post 2003 constructed houses and houses with heat pumps as the main source of heating in the house. Houses constructed post 2003 had an average HHE of 0.85°C-hours/kWh/day. Houses with only heat pumps for heating had an average HHE of 0.75°C-hours/kWh/day.

It was found that there are diminishing returns from extra heating energy put into houses. As increased energy is pumped in, less is translated into improvements to temperatures. This diminishing rate of return is found to be fastest in the worst performing, leaky, houses, which were generally older houses.

It must be understood that HHE is a result of a few key factors namely: the thermal resistance of the building shell; the type of heater/s being used; heating practices; window coverings and practices concerning these; door practices; and ventilation practices generally. Hence it is difficult to pin exact reasons on the variation of HHE for each individual household. In one house, the heating type may be the dominant factor, in the next house, the operation of windows, doors and ventilation strategies may be the dominant factor.

5.1.4 Change in heating energy use:

Overall heating energy was up in all approach groups (refer to tables in 4.2.1 for this heating discussion). These increases are seen as mostly being related to the colder winter. Interview responses noted that the cold winter led to more heater use. EDUG +CCB were the only group with heating increase over that of the REP group on a household basis. However, EDUG +CCB's increase clearly correlated with an outcome in terms of time spent in the comfort zone compared to other groups (refer to 4.2.1 change to temperature figures). EDUG had the greatest reduction in heater energy but had a correlating reduction in time in the comfort zone. When assessed on a per occupant basis all groups actually had a reduction in heating energy compared with the REP group. EDUG+CCB group had the biggest reduction on a per occupant basis. Notably, there was a significant increase in average household occupancy in the EDUG+CCB group over the study period (see Table 4 in section 4.1).

Home Energy Helpers, in many homes, encouraged use of more efficient heaters and advised about cheaper T41/42 tariffs. It seems clear that where householders took this advice there was a clear increase use in T41/42 hard-wired heating and corresponding decrease in T31/plug-in heating (refer to 4.2.3). This switch from plug-in heaters to hard-wired was largely beneficial for reducing cost, not necessarily for reducing energy consumption. In some cases, however, the switch lead to more effective heating of a space and therefore less energy use as well. For an example of this effect refer to Case 42 (Teri).

When households were compared across heater types, the results showed that energy use was increased across all heater types (refer to section 4.3). However, houses with heat pumps increased significantly less than houses with resistive heaters, irrespective of the approach group. This indicates heat pumps energy use are more efficient and/or used in more efficient ways. Heat pumps have a higher co-efficient of performance, and they have more effective thermostats and timers. Houses with heat pumps used less energy to begin with and then used even less energy afterwards relative to houses with resistive heaters.

There are however qualitative comments recorded in interviews and surveys that heat pumps do not necessarily provide the most comfortable form of heat. This is backed up by general understanding of comfort that says that radiant heat sources are more pleasant that convective or air borne sources of heat. Heat pumps rely on convective heat.

5.1.5 Change in hot water use:

Change to hot water energy use was varied across the approach groups. Compared to the representative group hot water increased most notably in the CCB group. However all groups increased relative to the representative group. On a per occupant the results were significantly different. Compared to the REP group the EDUG + CCB was the only group that reduced its use on a per occupant basis. CCB had a 28.5% increase in use and EDUG a 15.7% increase when compared to the REP group on a per occupant basis.

Home Energy Helpers, as part of upgrade visits, had retrofitted water efficient shower heads, hot water tank insulation and hot water pipe insulation to various of the houses in the upgrades groups, which did have a notable effect in some individuals houses as seen in the case studies.

5.1.6 Change in moisture levels:

Moisture levels in households was not a key indicator compared across all houses and approach groups. Rather it was assessed on a case by case basis where moisture problems were either noted by the householder or by the research team (refer to case studies for moisture discussions).

Most of the older and poorly insulated houses in the study were seen to be at risk of condensation occurring internally, and often problems of moisture and mould were only avoided through what appeared to be careful management by householders. Internal temperatures in the newer houses were typically well above dew point leading to less surface condensation.

Generally, where moisture was an issue, a reduction was seen over the course of the GBS project, either measured through air temperature and humidity monitoring, or as reported by householders. There were two notable cases where moisture got worse over course of the project. One of these was a newer house that received a home visit upgrade (Case 2, Nonie). This house had existing moisture problems and water leakage into the house due to construction problems. It is believed that there may have been vapour barriers incorrectly installed in relation to the wall and or ceiling insulation adding to the moisture problems in this house. The other house was from the representative group (Case 40 Naomi) where the household used their wood fire much less during the after period and consequently reduced their temperatures and lost radiant heat that previously dried out the house.

5.2 Key factors influencing change to energy use, comfort and energy affordability

Limited household income, the key characteristic of households that are the focus of the LIEEP, was certainly found to be the key barrier to householder making change. Limited incomes meant less capability to improve homes. It was the key barrier to physical upgrades mentioned by householders.

Many other factors also affected household energy use, energy affordability, comfort and the potential for improvement to energy efficiency and comfort. Key influences as gleaned from cases were:

- Income level
- Tenure
- Health and physical capacity of occupants
- Whether there was time available to understand and act
- How much contact (exposure) householders had with home energy helpers and energy champions
- Trust between organisation and householders
- Housing quality (especially thermal performance)
- Occupant numbers and occupant dynamics in the home
- Occupant house use patterns (eg home during day or not)

- Daily energy use practices, eg heater use practices
- Appliance (especially heater and hot water) performance, appropriateness, quality and efficiency
- Availability of affordable high quality fuels for heating, electricity, gas and wood
- Personal and household capacity
- Access to connected community that knew about energy and comfort management
- Payment methods for bills and related feedback on electricity consumption
- Persistence and of daily habits after support activities
- Complexity of everyday lives of occupants.

Below we explore a selection of issues critically influencing household capacity to engage in change for energy efficiency and comfort.

5.2.1 Household Tenure

Renters clearly had less capacity to make any significant changes, particularly structural ones. Troy (case 12) had mentioned that he would have liked to make some small changes, like hanging a curtain over the open doorway to hold in heat, but then said 'it's not my house to do it' and 'I guess I don't want to ruin their house' (before interview 25/6/14). While rental tenure difficulties are well understood (Gabrielle et al 2010), the regularity with which tenure issues were raised points to it being an unresolved issue for a number of GBS participants. The influence of tenure is a structural housing issue that needs resolution through policy.

There were some households that had a good relationship with their landlords, and had managed to effect changes through negotiations with the landlords, for example, Danielle in case 35 had a landlord who was open to her making useful changes to the house.

5.2.2 Physical conditions

The majority of houses in the GBS project are poor building stock that creates uncomfortable indoor environments for householders. This is reflective of low income housing generally. Most thermal performance measures of housing we observed sat within the very poor to under standard categories, (which is why the categories used had more poor performance levels than good). The combination of poor performing building fabric and an inefficient heating system creates a very low comfort environment, higher energy use, and consequently high energy costs. Poor physical conditions are often very difficult to improve without major intervention, and creates significant added stress for the low income householders.

A bright spot in improving house fabric performance as noted in the case studies was draught proofing. This was the most commonly noted upgrade that householders perceived had made a positive difference. Insulation in ceilings and curtains hung by Home Energy Helpers in a small number of houses also raised the thermal performance of elements of the physical house. The effect of these changes often had noticeable effects for households in terms of comfort but were still difficult to discern in temperature or energy monitoring. Stacey's case (22) provides an example of the positive effects that hanging good quality curtains can have.

Discrepancies between reported and measured comfort occurred for various cases. Reporting discrepancies are partly because overall detailed study houses performed poorly and minor improvements would be noticed by householders. Discrepancies also arose because there are so many overriding factors affecting day to day comfort levels, such as weather and occupancy patterns. Despite small upgrades noticeably helping householders with comfort and energy efficiency, such poor baseline standards of performance are hard to overcome with minor home upgrades.

Most houses in the study were standalone dwellings on suburban blocks and had potentially good solar access, but the siting and layout of houses rarely took advantage of this solar access. Living rooms and windows often had east, west or southern aspects. Houses also most commonly had single glazing with aluminium or timber frames with gaps around the frames. Almost without exception walls and floors were uninsulated. Houses constructed post 2003 did have insulation in walls and there were a couple of households where insulation had been retrofitted to floors. Ceilings were sometimes insulated, but typically to a low level or with aged insulation. Alone this ceiling insulation is nowhere near enough to support energy efficient heating.

Poor insulation levels were observed in houses that were built before energy efficiency standards were introduced in 2003. Age of construction therefore has a significant effect on thermal performance of the houses. Interestingly of the three age groups defined, post 2003 was the best performing, but 2003 to 1980 houses performed worse on average than pre 1980 houses. The poor insulation in all older houses is clearly demonstrated by the difference between indoor and outdoor temperatures and the poorer HHE in the older houses.

Only five houses that we observed in the detailed group were built since energy efficiency standards were introduced to the Building Code of Australia. Post 2003 houses in the study show very different outcomes compared to the older houses in terms of thermal resistance of the building shell. Examples such as the houses Olivia (case 41) and Alice (case 37) lived in demonstrate how the new construction facilitates better retention of heat internally. This can even be seen in Emily's house (case3) house, despite the moisture problems that were occurring in this house. This case also demonstrates that it is important when using increased insulation levels and sealing up houses for thermal resistance (as is now the practice) that moisture issues are considered. It is still possible that moisture issues can occur if condensation risk minimisation guidelines are not followed.

Window coverings also often did not provide much thermal resistance. Some medium and heavy curtains did provide reasonable resistance but windows often only had vertical blinds and aluminium horizontal blinds that, while they could help to angle sunlight, did not provide thermal resistance.

In some very poor thermal conditions householders moved house and managed to make significant improvement to indoor comfort and reduce energy use. Case 27 (Pam) and case 725 (Susie) are examples of this.

Some households conducted their own home upgrades – some over many years, for example Dale and Joanne (Case 9) and some during the GBS study period, for example Frank (Case 21). These households are discussed in more detail under the section on personal and household capacity.

5.2.3 Community networks with households

Several of the case studies reveal that help from locals in community is both influential and valuable. See Caitlin's case 6, Danielle's case 35 and Naomi's case 40 (also refer to cases in Watson's 2013 study).

GBS Community capacity building (CCB) activities and Energy Champion interaction with the Clarendon Vale and Rokeby community brought awareness of the GBS project, and energy efficiency generally, to the community and brought validity to the 'one on one' EDUG process rolled out within this local community. Energy champion training and activity embedded knowledge in the local community by upskilling people within the community rather than just relying on outside experts to come in and impart knowledge.

There was a distinct lack of engagement in formal community activities such as workshops and BBQs organised as part of the GBS project. Despite this, engagement by the Energy Champions (self-titled 'Power Rangers') was memorable to the householders (as evidenced through interviews and surveys). Qualitative data and cases point to regular word of mouth interactions between householders and Power Rangers and between householders and others in the community and discussion of energy efficiency in those interactions.

There is evidence of community influence outside of the Get Bill Smart activities encouraging thought and action related to energy efficiency, such as in Danielle's case (35) and Phillip's case (47). Some householders were triggered to act because of involvement in the GBS project. Even some participants without home visits in the representative group did record notable improvements thanks to discussions with their family relations or friends (though generally they didn't record large changes) (see cases 42 – Nonie). GBS CCB activities provided a catalyst to encourage this sort of interaction more often and in more of the community.

Participants saw community networks as requiring some give and take. 'Community' was seen as something that is there when they needed help. Often help would be received through the community neighbourhood centres, but this was also the mechanism through which help could be given to others (for example case 21, Frank). A number of householders were actually the 'wise advisors' in their community without being an official 'Power Ranger' as part of the GBS project. Others would give to the neighbourhood centre if they had extra because they recalled the help that had previously been given to them.

The use of CCB activities as part of energy efficiency programmes can learn from Australian and overseas examples. For example, Hawe et al (2000) describe community health promotion programs that have successfully used CCB. Critiques suggest that for CCB to work effectively there must be a real devolution of power to local community champions so decision-making is not centrally determined. There also needs to be local ownership of the programme and distance kept from commercial interest (Burchell et al 2014). These concepts are supported by the GBS findings.

Evidence in the Detailed Study shows that CCB is most beneficial when used in conjunction with the home visits and home upgrades (EDUG).

5.2.4 Personal connection versus community forums

In the CCB approach there was a lack of engagement by the community in the formal activities organised by the GBS project team. Engagement by Energy Champions (Power Rangers) with householders one on one or in small groups, however, was more effective and was also more memorable for householders interviewed. Hearing about problems and potential solutions from Energy Champions, people that are in similar situations to themselves, created an openness to change in householders.

Overall it is found that the one-on-one Power Ranger's influence and upgrade visit from the Home Energy Helpers was more helpful for direct change than the community forums alone.

People who had a personal relationship with one of the local Energy Champions often thought about change more or made more changes to their house. Caitlin (case 6) and Monique (case 23) provide examples of this. However, even with close family or friend connections in the community, involved as Energy Champions, some households did not record changes (for example, case 15 Gayle and Dennis and case 24 Joe and Beth). In these cases, there seem to be overriding issues such as health, new babies and/or other significant life stresses that take over and prevent engagement with energy efficiency issues.

5.2.5 Personal and individual household capacity for making change

Some householders exhibited personal interest in technology and or skills in the technology or energy area and were inherently more open to engagement and interested in the GBS project, whether or not they had connections to a power ranger in the community (for example, case 9 Dale and Joanne). These people were already more aware of the potential benefits of being energy efficient and had acted to make changes to their home. Often these households were older, retired or semi-retired with a bit more time available to consider change and put plans into action.

There were a small number of households with enough financial and physical capacity to gradually make energy and comfort changes to their houses on their own. One example is Frank (case 21) who had already made change before the GBS study. Frank made further improvements during the study by replacing an old window with double glazing. Another example is the previously mentioned Dale and Joanne who had renovated to include insulation, heat pumps and a heat transfer kit to transfer hot air from the ceiling space into rooms of the house. Both of these households performed well in measured comparison to most of the households in the study.

The majority of households demonstrated an improved capacity to seek information on how to reduce energy use/household comfort. There was also clear evidence that there was household capacity to make small changes to their abodes and lifestyle to improve household energy efficiency and comfort.

5.2.6 Persistence of practices

With some exceptions the study found that there were only a few households who changed markedly on either energy use or thermal comfort indicators, suggesting that household practices and expectations of thermal comfort and energy cost are fairly well fixed. Higher energy use before = higher energy user after and low energy use before = low energy use after. This was also the same for the average temperatures that householders maintained in their houses. If people were living with high temperatures before still lived with fairly high temperatures after.

The concept of acceptable temperature thresholds is reinforced by the findings. The 2015 after winter was colder than the 2014 before winter, but almost all households increased their heater use in order to maintain the same temperature and comfort levels. This applied to equally to households that maintained relatively low temperatures and to households that maintained relatively high internal temperatures.

5.2.7 Heater practices

Heater use practices are important enough to be considered separately. Patterns of heater use do not increase in a linear fashion as temperature decreases. In milder conditions, heaters are not used. As temperature drops, there comes a point where a threshold is reached and the householder turns on the heater. This threshold will be different for each household, explaining the higher or lower temperatures and higher or lower energy use across different households. Making change to energy use will be difficult without changing these thresholds.

Adding complexity to the issue of heating thresholds is the characteristics of the heating device being used. Most resistive heaters have just one or two settings, with no, or poorly functioning thermostats. Hence it is difficult to control the amount of heat being provided by the device. Wood fires are worse in terms of the ability to control heat output. Numerous houses in the study with wood fires were seen to be heating the house to well above the typical comfort levels, but then quickly diving back well below those comfort levels once the fire is out.

Heat pumps tend to be slightly better at providing control, being newer technology, typically they have better functioning thermostats, and are fitted with timers allowing better control of heat delivery.

5.2.8 Occupant living patterns

Work practice and household occupancy practices greatly affected energy use. In several cases changes in occupancy or work patterns overwhelmed potential energy savings. Examples are: Danielle (case 35), who moved her work to home, Emily (case 4) who had a new baby and Erica (case 7) where another adult moved in with consequent changes to bedroom arrangements and heating practices.

Some participants were mismatched to the size of their houses. There were bigger (eg 3 bedroom houses) with one occupant, such as in Maureen's house (case 1). It can be hard to control comfort in big houses with one person, but there is the benefit that the individual doesn't need to negotiate with others regarding energy use and comfort levels. At the other end of the scale is Nonie's household (case 2) which had 10-12 people in a small 3 bedroom house. This mismatch is, in part, a structural problem with housing availability around Tasmania generally, with such a large proportion of dwellings being detached single houses.

It must be noted, and it was clear from the data gathered in the GBS project, that when considered on a per occupant basis households with more occupants are more energy efficient per person.

5.2.9 Ways of paying for energy

The use of payment plans for paying quarterly electricity bills eased the stress of big bills but also appeared to make people less aware of their energy use overall. It seemed that householders were left with a watered down impression of their energy use patterns. Many also paid for energy in the payments without even seeing the money as it went straight from their pensions or Centrelink payments. This meant there was very little feedback about energy use and people did get confused. There were several instances where householders thought they were using less power but had in fact increased their energy use (or vice versa) according to billing or electricity monitoring data.

The 'Pay as you go' (PAYG) electricity provision system was generally liked by householders in the study because of the control it provided, the awareness of energy use it allowed and the avoidance of big 'bill shock'. HEHs advised on tariffs in general and PAYG tariff explanations were very much appreciated.

For some householders that are good at budgeting, the PAYG system allows them to have a high degree of control and monitoring of their personal energy use. For others it was simply a case of putting money in the meter as required. At least these householders who were less thoughtful about their energy use did have an idea of how much money was being used and how frequently this was being used. The householders got feedback when money was required more frequently through the winter periods.

5.2.10 Heating for comfort and health

A major influence on comfort requirements and energy use is householder health and wellbeing. This is discussed further in the section 5.3, but it is important to mention as a factor influencing change. Poor health and incapacity because of health issues was seen found to be a major barrier to positive change in several GBS households. Health problems, leading householders to need to be in the house more and to being less active, meant that higher levels of comfort were required. Where that need coincides with poor performing housing fabric, and or poor heater efficiency or effectiveness, this invariably lead to high energy use and an incapacity to change or reduce that use (for example, case 15 – Gayle and Dennis).

5.2.11 The complexity and dynamic nature of people's lives

From personal experience we know, and through the case studies it can be seen that, lives are complicated and therefore so too is home management. Many households visited were living in dynamic and changing circumstances in terms of, health issues, occupant numbers, income, work hours, or renovations they were undertaking (as just some of many examples). In interviews we heard not only about busy lives but also about partners moving in or out, kids/grandkids moving in and out and people becoming seriously ill. Added to general complexity in life, in low income and rental households' lives can be even more dynamic. Renters, for example, tend to move house more frequently than other householders.

General comparative analysis does not convey these complexities yet complexities are important to consider because a) they may be hiding energy efficiencies or other gains that are being achieved, and b) they reduce the control people have over their lives and hence their ability to plan for change. If you are moving house, have new people in, or are changing jobs, you're not less likely to have the space and time to think and act to make improvements for comfort or energy efficiency

Households in the GBS study could be roughly divided into two categories based on demographics. One category is young families, the other is older couples or single person households. A pattern seen in the project was that the older, more established households were leading more stable lives, and had more stable household environments and were abler to plan for and facilitate change. The younger family households tended to have more complex and less stable household situations, and were therefore in a less favourable position to plan for and facilitate positive change.

5.2.12 Wood fuel and wood fires

There seemed to be a number of households relying on wood fired heating to reduce energy bills and improve comfort. While this may be a reasonable heating option, wood fired heating still comes at a cost if the appropriate wood for the fire is to be purchased, and wood fired heating may create indoor air quality concerns. For example, smoke may release into the house if the fire/stove is not properly flued or on the starting up of fires. Several households reported that sourcing properly seasoned dry wood could be difficult and Patricia (case 29) could not use her wood fire because of it smoking indoors.

In favour of wood fires is that fact that they produce radiant heat that is generally accepted as being more comforting than convective heating provided by heat pumps and fan heaters. However as discussed previously the heat output from wood fires is difficult to control leading to overheating and inefficient distribution of heat around the house. In addition, in suburban areas wood fires tend to cause problems for others in the community.

5.3 Critical Trade offs

Often it was found in the GBS project that householders were making trade-offs between energy efficiency, comfort and cost, that is, affecting positive change in one regard, while accepting negative change in the other.

There are many other priorities that householders are dealing with on a daily basis that compete for attention with energy and comfort goals. For example, changes to the time spent in the home due to changes in employment circumstances, or health and wellbeing issue such as householders who stayed at home to care for ill family members or young children. These priorities cannot be ignored and have consequences for comfort and energy consumption.

5.3.1 Energy use versus cost, comfort and health

There was a critical tussle that went on between energy use, cost, comfort and health parameters in most households in the GBS study. Trade-offs between reducing energy costs and maintaining basic levels of comfort came up again and again. Trade-offs becomes particularly apparent where households had to incorporate the comfort of household members suffering illness or chronic health conditions, for example Olivia (case 41) and Cassie (case 34). Another example is when parents were considering the vulnerability of young children to cold and damp conditions. There were many examples of mothers and grandmothers saying they were heating to keep the children healthy (Caitlin case 6, Sarah case 17, Queenie case 20, Pam case 14, Nancy case 113, Beth case 24, Martin and Fiona case 44, and Anna case 49).

The research found that typically, when a household wasn't gaining their desired comfort level (ie a comfort level where they felt warm enough to get on without feeling miserable) and an opportunity to use a little more energy occurred, the household would use it. Most often this was for health reasons. Basic comfort requirements were not being met in many of houses and any opportunity they had to better meet those needs, the households took.

We know that poor public health indicators are linked to low socio-economic status (SES) (Rasanathan et al 2011). Low SES often equates with poor housing stock which in turn can impact on health – including for those vulnerable to respiratory conditions or allergies that might be affected by cold and /or damp or poor indoor air quality (Thompson et al 2009, Howden Chapman et al 2011). So SES presents both direct and indirect impact, direct because a household has less financial capacity to improve their circumstances and indirect because their economic circumstances constrains their housing choice.

Many households in the study are already very low energy users and cannot possibly be more efficient with their energy use (for example Ingrid, case 33). However, for this frugality, the trade off is very low comfort levels, to the point where life style and physical and mental health are negatively affected.

For most households the thought of saving money through reduced energy use was attractive. However, the study found that when there was evidence of savings being made through energy use reduction or efficiency gains, that money was often put straight back into achieving better comfort through more energy use. For example, if savings were made through the lowering of electricity tariffs, or through changes in usage to the cheaper T41/T42 tariffs, these savings were typically offset by more energy consumption to increase comfort. This is supported by New Zealand research into trade-offs (Howden-Chapman 2009).

5.3.2 Surface condensation/mould vs draughts

There is a delicate balancing act going on in many of the homes in the GBS study. Often the draughts that make people cold can help to dry out surface condensation in a poor performing house. Just a small reduction in humidity levels can be the difference between persistent condensation that causes mould, and intermittent condensation that dries out each day. The frequent occurrence of surface condensation is primarily a result of low indoor temperatures and low thermal resistance of the building fabric. Even in some cases where the air temperature measures recorded did not suggest condensation was likely, householders reported condensation occurring on windows and the insides of external walls. This is because of the significantly colder surface temperature on these surfaces as compared to the air temperature being measured. The drop in temperature at the surface precipitates the moisture out of the air as condensation.

There were a few cases where surface condensation issues appeared kept at bay because of draughts (Irene, case 51, Deanne and Richard case 50, Dale and Joanne case 9). People in Tasmania have before commented that they understand they need to air out/dry out their houses in winter to avoid damp indoors (Watson 2013).

5.3.3 Other trade-offs

There are many other tradeoffs occurring due to the multiple, potentially conflicting, demands on householders. Here we briefly discuss a few of the more pertinent types that were encountered.

Occupant micro-politics at the household scale – This could include differences in priorities of the different householders, negotiations with landlords, caring for animals in the house. These issues can pull householders in differing directions. We observed, for example, that when only one householder was keen to save energy or make changes or one occupant was primarily responsible for paying energy bills, then energy saving actions were often overridden by other occupants (for example teenage hot water use, partners using more energy). New occupants to a home were observed to create a jump in energy use and a loss of control over energy efficiency practices. Tenants would put aside ideas of energy upgrades if landlords didn't support them or if tenants thought landlords would disapprove. Householders would also prioritise animals and their movements through the house over energy efficiency practices.

Lifestyle expectations – Expectations differed about how householders thought they should be able to live. At one extreme frugal householders would not spend any money on heating and their lifestyles suffered as a consequence. At the other extreme, householders expected to be able to do what they wanted when they wanted and to be comfortable no matter what, and hence paid for the privilege to do so.

Heat pumps vs radiant heaters – Heat pumps are significantly more efficient to run and deliver other benefits relating to control of heating, however there is a distinct dislike of convective, fan forced heating systems. Some householders preferred to use radiant heat sources, even if they were less efficient and cost more to run because of the negative perceptions around heat pumps.

Heater flexibility – Plug-in heating is less efficient and costs per kWh being on the T31 tariff, however plug-in heaters can often be more effective at delivering heat to where it is required in the household. Fixed, hard-wired heating may be more efficient, as in a heat pump, but may not be well positioned in the home, leading to more energy use to achieve the same comfort levels.

Moving House vs Staying Put – moving house places a big stress on the householders, but for some the extremely poor performance of their houses and the cost of keeping up comfort levels means that moving house for the sake of comfort is worthwhile. If the move can create a significant increase in comfort levels and or a significant decrease in energy bills, then additional benefits may be gained through making the move. There may be less of the other trade-offs required in the new house.

5.4 Review of methods for monitoring and evaluation

Because the GBS project is part of a broader scheme investigating the best ways to improve household energy efficiency and thermal comfort, it is important to review the success or otherwise of the methods used in monitoring and evaluating the project in order to inform future similar programmes. What other information/data could have been gathered that would have added to the knowledge? What would we have done differently/better?

- The use of integrated qualitative and quantitative research methods proved critical to achieving the desired outcome of gaining detailed understanding. Neither of the qualitative or quantitative data sets collected, on their own would have provided the same insight. This is seen as a success in terms of data collection and triangulation of evidence to reinforce credibility and viability of the results.
- The research approach was a complex and therefore time consuming and costly exercise. Doing the same level of research on future projects, if similar in scope and aims to the GBS project, would seem to be unnecessary.
- Specifying data logging devices and systems for constant logging and for remote data feeding was problematic. Data logging specification and engagement with suppliers was long winded taking several months to resolve. Purchasing electrical logging equipment continued to be challenging into initial field work with the Champions. Commercial problems with supply of 3G modems from Telstra and low supplies of routers in Tasmania meant that the initial electrical monitoring was challenging, was very time consuming and therefore became complicated and held up work on other aspects of the project.
- We settled on relatively new technology for the electricity monitoring, that was not tested in the context for which we were putting it to use. This technology was chosen from existing, off the shelf technologies. We were therefore we pushing the technology and the services behind the technology to achieve beyond its intended usage. The monitoring was a success overall, but there were struggles along the way, getting the technology to work as we required it to.
- Recording and sending information to a remote cloud storage facility proved to be problematic at times within the CVR community because of poor 3G internet coverage in the area. Several householders reported that they had this problem with their own phones.
- Having electricity and temperature sensors left within participant households for over 15 months was potentially fraught with difficulty. In generally however, participants did a great job in looking after the equipment. There certainly were many occasions when equipment was accidentally un-plugged or turned off. Remote monitoring of the electricity monitoring equipment meant that these disruptions could be detected and the householder contacted to quickly rectify the problem. There was only one household in the study, for which the equipment was removed and the monitoring terminated because the household was not able to keep the equipment plugged in.
- The temperature logging equipment worked extremely well. They loggers were extremely reliable and simple to use and simple to access data form. There was less than 1% failure rate in temperature data gathering over the life of the project.
- Data extracting from the cloud storage proved very problematic and time consuming. This was partly due to the large amount of data to be extracted, but also partly due to the inexperience of the provider in working on this sort of project and at such a large scale
- Many of these problems with technology could be avoided the next time around if a similar project were to be undertaken.
- The evolution of the two approaches are not the same level. In-home upgrades are a relatively long-established form of energy efficiency improvement activity. The GBS team had been involved in delivering such services for many years and hence had refined the process. The CCB approach was new to all in the GBS team. Further refinements of the approach over time may yield improved results in terms of participation and or outcomes for households.
- The numbers of households in the different approach groups not the same, possibly leading

to some distortion in the results. The numbers are also relatively small. Though given the time and expense in undertaking such detailed research in to 51 houses, it is difficult to see justification for expanding the numbers at such a detailed level of research.

- Reliance on recall of participants is a problem so measuring certain types of change is difficult
- Data on wood usage is one specific piece of data, that while difficult to accurately collect, would have been very beneficial to have more completely collected. The data that was collected was insufficient to make reliable calculations of wood heater energy use.
- Electricity billing data collected was not easy to compare to the detailed monitoring data, because different timeframes were involved, and different methods had to be used to work through the bill data. The detailed data was specifically focused on the peak winter period, whereas the billing data was limited to the billing cycle.

It was a lot of effort to gather such a broad range of data and to such depth at the same time, however this is a very valuable data set that could be used for many other purposes into the future.

6. Conclusion

The Detailed Study aimed to gain further insight into energy efficiency and thermal comfort behaviours through more nuanced understanding of the conditions that householders experience, the changes (outcomes) that occur over the GBS study period, key influences affecting those changes, and trade-offs made between energy use and comfort.

Through analysis of the case studies we were able to identify the performance of individual households and the rich and varying ways they responded to energy use, energy costs and comfort needs. The use of mixed qualitative and quantitative data sets provided a useful picture of household experiences and allowed researchers to detect important changes and improvements. Comparisons across households provided insight into key performance indicators and patterns of energy and comfort change. Through these explorations we identified some key findings, namely:

- Changes measured after GBS activities were undertaken suggest the EDUG +CCB group showed most signs of improvement of all of the groups. While the CCB component needs further refinement, it shows signs of being beneficial when undertaken in conjunction with in-home education and upgrades.
- A wide range of factors influenced household energy use, energy costs, and comfort. These factors are important to consider when designing programs as they will affect potential outcomes.
- The effects of various factors on energy and comfort outcomes becomes clearer when trade-offs are examined. The occurrence of trade-offs indicates conflicting priorities for the householder. Critically, energy savings were regularly traded to improve comfort and health.
- Differing priorities across households indicate that any one single measure cannot be relied on in an energy efficiency program. Further, energy use reduction, thermal comfort improvement and householder cost savings are three separate goals that may not be achievable simultaneously for a household. Programmes therefore need to be designed to accommodate these goals in order to be effective.
- In general, energy and comfort performance of the physical housing stock and heating systems was poor. Houses that were built before 2003 had very poor levels of thermal performance; homes built since 2003 performed significantly better. This is a significant structural problem for energy efficiency programs to overcome.
- There were significant differences in household heating efficiencies which were caused by widely varying heater performance combined with widely varying thermal performance of housing fabric.
- The persistence of householder practices and expectations around comfort and energy use was notable. Householders tended to increase their heater use in order to maintain the same temperature and comfort levels that they were accustomed to in the colder after (2015) winter.

A key theme of all these conclusions is that there is a complexity, variation and dynamism across low income households which suggests the need for a tailored approach to future energy programmes. The depth of understanding developed through this Detailed Study can be used to guide, not only the tailoring of, but also the overall structural development of, energy efficiency programmes for cool temperate climates such as Tasmania.

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(Footnotes)

1 This number includes gas energy converted to kWh. The electrical energy used to run the ducted gas heating system and fans, is listed in T 31 heating line.