Energy Saver Study

Final report

Low Income Energy Saver Direct Care and Motivators Project

2 May 2016

SECCCA
South East Councils Climate Change Alliance

This activity received funding from the Australian Government.

Australian Government
Department of Industry, Innovation and Science

The South East Councils Climate Change Alliance (SECCCA) supports communities, businesses and industries to the south east of Melbourne in responding and adapting to the impacts of climate change. SECCCA is an incorporated association of eight councils committed to delivering high-quality, innovative projects and research programs at a regional level.

SECCCA is:

Our vision is for the communities to the south east of Melbourne to produce zero net emissions and have a high capacity to adapt to climate change.

Published by:

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May 2016

Acknowledgements

SECCCA gratefully acknowledges and would like to thank the following organisations and people for their valuable input to the project:

- Department of Industry, Innovation & Science: Zoe Huang
- The 320 householders that voluntarily took up the invitation from SECCCA to participate in the project; to be surveyed and asked numerous questions, to let council, SECCCA and contractor staff into nearly every little nook and cranny of their homes, to have photos taken of their homes, energy monitoring undertaken, equipment installed and home improvement works completed
- Consortium Partners and their staff including:
  - Local councils
    - Bass Coast: Eliza Horsburgh Price, Sam Wightman, Wendy Davis & Mary-Anne Hunt
    - Baw Baw: Raj Manihar, Olivia Lineham, Robert Barr & Jessie Ablett
    - Bayside: Rachael Murphy, Leanne Stray, Nicole Richards & Liane Paine
    - Cardinia: Desiree Lovell & Carol Nouwens, plus from Mecwacare, Anne Wright
    - Casey: Nicola Ward, Mark Akester, Ros Pruden, Jo Smale & Thelma Wakelam
    - Mornington Peninsula: Jessica Wingad, Jenny van Riel, Peter Cracknell, Michelle Wright & David Keeling
  - Air Barrier Technologies: Brian Kelly, Barrie Dobson & Terry Mahoney
  - Aspect Studios: Ian Rooney, Angela Arango, Tobias Blackwood & Lucinda Roberts, plus from Studio Binocular: Laura Cornhill and Sam Curcio
  - Briar Consulting: Brian Sharpley
  - CSIRO: Michael Ambrose & Melissa James
  - Energy Makeovers: Bryn Dellar, Melanie van Ree & Andrew Law
  - Energy Monitoring Solutions: Geoff Clarke & Adam Baker, plus from Ecofront, Stuart Andrews
  - Just Change: Craig Irvine & Michaela Lang
  - RMIT: Nicola Willand

Reviewers, contributors and editors to the *House In Order* training manual: Richard Keech, Andrew Armstrong, Peter McKernan, Richard Hamber, Dwayne Purdy, Lucy Allinson, Janet Armstrong, Mark Akester, Romesh Kapukotuwa, Dan Pleiter and Anne Eastaugh.

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Glossary

Word/phrase	Definition
ACM (asbestos containing material)	A material that contains asbestos fibres
ADS (Aged and Disability Services)	Support services provided for frail older people and younger people with disabilities to live in their homes and it includes support for their carers.
Air Exchange Rate	The leakage rate of air through a building measured in ACH (air changes per hour)
CHSP	Commonwealth Home Support Programme
CO (Carbon monoxide)	A toxic gas which is colourless, odourless, tasteless and extremely poisonous. It can result from and be emitted by faulty gas appliances.
Consortium	The group of SECCCA, its 6 participating member councils plus other public, private and non-government organisations that together planned, governed and delivered this study
Database	A structured set of data held in a computer
De-identified data	Data collected and recorded from homes in the study with the name and address of participants removed by SECCCA before it is sent to the Department of Industry, Innovation & Science
DIIS	Department of Industry, Innovation & Science
EAP (Energy Action Program)	A support and information program provided to householders as part of the study to increase their knowledge, capacity and actions regarding energy efficiency at their home which may also benefit their comfort, health and wellbeing
ELO (Energy Liaison Officer)	Staff members hired by SECCCA and local councils to recruit and support eligible householders to participate in the study and improve their energy efficiency
Friable asbestos	An asbestos containing material that is generally quite loose and, when dry, can be crumbled into fine material or dust with very light pressure. These products usually contain high levels of asbestos (up to 100%), which is loosely held in the product so that the asbestos fibres are easily released into the air.

GST (Goods and Sales Tax)	A tax of 10% that is charged on most goods, services and other items sold or consumed in Australia
HACC (Home and Community Care)	Support services provided for frail older people and younger people with disabilities to live in their homes and it includes support for their carers.
IHD (In-Home Display)	An electronic device that shows current and historical information about the energy use in the home i.e. when energy has been used & how much
Interval data	The amount of energy (in kWh or MJ) used during a defined period; e.g. during a 30 minute period
Intervention	An action facilitated by SECCCA to support participating households to improve the energy efficiency, costs, health, comfort and/or wellbeing at their home e.g. i) purchase & installation of energy efficient products i.e. LED lights, draught sealing, insulation, heaters/coolers, hot water service, window furnishings or ii) providing support such as energy efficiency information or advice, awareness of other benefits
LIEEP	Low Income Energy Efficiency Program
Low Income Household	One or more of the following conditions must apply: • Household income is in the bottom 40% of the Australian population's income range • Householder is in receipt of an Australian Government concession card • Household income is mainly derived from income support payments • Householder is a member of a particularly disadvantaged target group e.g. Indigenous, culturally and linguistically diverse, new arrivals, person with a disability • High energy needs due to either individual or locational factors e.g. disability or climate (high energy usage relative to household size and composition)
Payback	The money saved due to more energy efficient design, materials or appliances
Payback period	The length of time required to recover the cost of an investment
RECs/STCs	Renewable Energy Certificates/Small Scale Technology Certificates - entitle the owner of the certificate to a financial rebate for the one tonne carbon dioxide equivalent (CO2-e) that has been abated due to the specified energy saving

	activity
SECCCA (South East Councils Climate Change Alliance)	The incorporated association of eight councils committed to delivering high-quality, innovative projects and research programs at a regional level
VEECs (Victorian Energy Efficiency Certificates)	An electronic certificate that is provided by the Victorian Government (Essential Services Commission) which entitles the owner of the certificate to a financial rebate for the one tonne carbon dioxide equivalent (CO2-e) that has been abated due to the specified energy saving activity known as Prescribed Activities being done

Executive Summary

Introduction

The Low Income Energy Efficiency Program (LIEEP) was funded and managed by the Australian Government. The Energy Saver Study (formerly *Residential Energy Efficiency Motivators Program for Low Income Households*) was coordinated by the South East Councils Climate Change Alliance in Victoria. It was one of twenty LIEEP research projects that aimed to trial and evaluate a number of different approaches in various locations that assist low income households to be more energy efficient and capture and analyse data and information to inform future energy efficiency policy and program approaches. This 3-year project aimed to investigate the most effective ways to support low income householders to improve their household energy efficiency. The project also aimed to determine if the support provided to householders decreases the householders' energy costs and has benefits for their health, comfort and/or wellbeing. It also aimed to confirm whether delivery of a support program to low income householders is effective when done through local council Home and Community Care (HACC) departments.

This project received $4.4 million from the Department of Industry, Innovation and Science (DIIS) LIEEP funding Round 1 in April 2013.

This report is designed to provide information to government staff and politicians. It is to help inform future government policy and programs related to supporting and protecting vulnerable, low income community members, to help them reduce their energy and living costs, improve residential energy efficiency, community health and wellbeing.

Project rationale

Low income householders including council HACC clients (those that receive discounted gardening, cleaning, cooking or home maintenance services from council) which are often the most vulnerable in the community to the impacts of climate change, given their socio-economic status and the types of houses in which they live. These homes may be old, inefficiently designed or built (in terms of energy) or poorly maintained. These low income householders may face barriers to improving energy efficiency including no/little access to money, poor physical and/or mental health or they may have acute health conditions, a lack of mobility, limited knowledge of residential energy efficiency opportunities, limited/no English and they often live in homes where they need approval from landlords/property managers to undertake work on the home.

Approaches

The project was delivered in 3 stages:

- Householder recruitment and pre-intervention data gathering
- Interventions
- Post-intervention data monitoring and evaluation

This project recruited participants through already trusted and well regarded organisations: the local council Home & Community Care teams. Householders were then allocated to one of the 4 main study groups as follows (see Table I below):

- Group A: receive home improvements/retrofits (80)
- Group B: receive energy action information and support (80)

- Group C: receive home improvements **plus** energy action information and support (80)
- Group D: receive no support i.e. this is a scientific control group until after the monitoring period (80)

Energy monitoring equipment was then installed in 120 homes to collect and compare with data from energy distributors. 30 of these homes received custom designed In-home displays showing their energy use. A further 30 homes received off the shelf in-home displays. Another 60 homes were draught tested, with 26 of them receiving draught sealing and retesting to determine the effectiveness of draught sealing. A further 60 were assessed for their pre-intervention star rating and 28 had their star rating re-assessed after home improvements.

The intervention approaches the project used to assist low income householders in various locations to become more energy efficient (plus the associated co-benefits) included:

- Employ and train 6 Energy Liaison Officers (ELOs) to recruit and support 320 eligible householders that receive Home and Community Care services
- Deliver a tailored energy efficiency support program through local council HACC Services to reduce the existing barriers of finance, information, capacity, communication and lack of trust in existing providers.

The project captured and analysed data and information to inform future energy efficiency policy and program approaches. It compared between the 4 main intervention study groups to determine the most effective and best value approach to overcome capacity, cost and risk barriers.

The project developed a robust framework, tools, training and a training guide (*House In Order*) for ELOs in the delivery of the additional home retrofit and support services to clients.

An RMIT PhD research project was undertaken simultaneously which identified and described individual and socially shared householder practices. It quantified outcomes in indoor temperatures, energy use, energy costs and householder health and explained how householder practices influenced these outcomes.

An additional Swinburne University Masters research project was added to the project during 2015 exploring social influence on household energy practices. Social influence was being researched through the householder's social network. Interviews regarding social influence patterns on householder actions and their Most Significant Change have been completed and preliminary findings identified.

Characteristics of the target audience

The householders were predominantly retired, aged and had either a chronic or acute health condition. Most but not all were single females. Some were physically and cognitively very able and had the capacity to plan, organise and arrange their life.

Table I: Household study groups and activities

Group	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7
1A (30 households)	energy audit	air-barrier testing (15 houses only)	draught sealing (15 houses only)	star-rating assessment (15 houses only)	energy retrofit		energy monitoring equipment
1B (30 households)	energy audit	air-barrier testing (15 houses only)		star-rating assessment (15 houses only)	basic energy retrofit (post-Activity)	behaviour change program	energy monitoring equipment
1C (30 households)	energy audit	air-barrier testing (15 houses only)	draught sealing (15 houses only)	star-rating assessment (15 houses only)	energy retrofit	behaviour change program	energy monitoring equipment
2A (50 households)	energy audit				energy retrofit		
2B (50 households)	energy audit				basic energy retrofit (post-Activity)	behaviour change program	
2C (50 households)	energy audit				energy retrofit	behaviour change program	
1D Control Group (30 HHs)	energy audit	air-barrier testing (15 houses only)		star-rating assessment (15 houses only)	basic energy retrofit (post-Activity)		energy monitoring equipment
2D Control Group (50HH's)	energy audit				basic energy retrofit (post-Activity)		
TOTAL	320	60	30	60	320	160	120

Results

Councils

It was worthwhile and important that councils participated in the study. All councils were able to identify and recruit householders. Three different models were used to deliver the project across the six councils. Five councils appointed an Energy Liaison Officer and placed them within the councils' Home and Community Care team. One council outsourced their HACC services to a private provider that co-supervised their Energy Liaison Officer. The sixth council was willing for their HACC Home Maintenance team to provide home retrofits to householders. Councils provide good access to client data which can lead to targeted and successful recruitment.

The study helped to improve the credibility of the council among householders who received the retrofitting and behavioural change activities. It improved communication and established links within the councils. It raised awareness and provided information and ideas to both council staff and clients. Both councils and the householders benefited from the project and had increased knowledge and capacity as a result of the project

Companies can be contracted by councils at very competitive rates to supply goods and services. This procurement can be replicated in the future by governments/organisations at the relevant scale.

Future funding of householder support regarding energy efficiency, home safety, comfort, maintenance and modifications could be provided to and via the future HACC providers (CHSP providers, which may be wider than local government from 1 July 2016 onwards).

Impacts of interventions

The combination of home retrofit and behaviour change interventions achieved statistically significant energy efficiency outcomes (compared to control group) including averages of 10-11% reductions in total energy use, 13-18% less gas use and similarly cheaper bills, 14-18% lower greenhouse emissions due to gas use and increasing living room temperatures by 1.6°C in winter. LED light upgrades resulted in 22-36% reductions in lighting electricity use, 22% cheaper bills and lower greenhouse emissions.

'Retrofit only' interventions achieved a statistically significant energy efficiency outcome of 7% reduction in total energy use based on distributor data (compared to control group), whilst simultaneously increasing winter indoor temperatures by an average of 1-1.9°C.

It was noted anecdotally that some 'retrofit only' householders began to improve/increase their energy efficiency actions/practices in their home after they received their retrofits, even though they were not provided with behaviour change support. This could be interpreted to indicate that householders' that receive energy efficiency retrofits/support for little/no cost to themselves are more likely to take actions to improve their energy efficiency at home.

In addition, some of the "low income" householders that received a smaller "thank-you/retention $495 retrofit" at the end of the study co-contributed to this between $100 - $4000 themselves to replace/upgrade faulty/inefficient appliances of their own initiative. This could be interpreted to indicate that i) not all local government Home and Community Care clients are necessarily poor i.e. they may be low income but may have savings that are

available for energy efficiency improvements to their homes and ii) that supporting low income householders with relatively small retrofits can trigger them to undertake more significant energy efficiency actions/works themselves at their own cost, rather than at the government's cost i.e. has a low cost: benefit ratio.

Households receiving 'behaviour change only' intervention didn't show a noticeable improvement in any of the energy measures, although the average number of energy efficiency actions by householders in the behaviour change study groups did increase from 16 to 19 actions during the project.

Householder feedback

The retrofits met the expectations of householders and improved their comfort. Householders indicated their strong endorsement of the Energy Saver Study in the post-intervention survey. Over 95% of householders would recommend a similar program to others. When asked why, the major reasons were it helped lower energy bills, they enjoyed the visits by project staff, it helps keep people in their homes, they trust the home care service and it was educational.

Future delivery

The existing HACC delivery model will not exist from 1 July 2016 and will be replaced by the Commonwealth Home Support Programme (CHSP). Future funding of householder support regarding energy efficiency, home safety etc could be provided to and via the CHSP providers. They will determine how the householders' goals are put into practice and are likely to offer home maintenance/modification services (but need to be funded by the Australian and/or state governments to do so).

Future providers will need to either make themselves aware of the goods and services required to deliver residential energy efficiency, safety and client wellbeing, or be trained/supported to do so. This will need to include identifying how a home can be modified and made safe in terms of indoor temperatures, affordable energy bills, satisfactory performance and low operating costs.

Additional research findings

The RMIT PhD study has identified that the contextual factors (i.e. the physiological capabilities of the householder, the modes of energy bill payment and the social construction of the adequacy of indoor temperatures) are additional pathways to health outcomes that go beyond the material qualities of the dwelling. The study identified coping and adaptation practices that may be able to build resilience.

The combination of a retrofit to the building envelope and the upgrade of the heating system may be more effective in providing benefits in warmth, affordability and householder satisfaction than just retrofits to the building envelope. Further work is needed to establish the validity of this.

The attention in residential energy efficiency initiatives should shift to the systems-approach of housing, energy and health. Initiatives that target energy consumption have to be sensitive to the prevalence of cold homes in Victoria, its causes and its effects.

The retrofits of fuel poor households may fall short of expectation due to the pre-bound effect. Voluntary underheating in this study concurs with the results of other studies. Non-heating of bedrooms, and allowing living room temperatures to drop below recommended levels during the night, seem to be practices that are socially shared. Exposure to temperatures below certain thresholds constitute a health risk, especially for older people. This may help explain Australia's winter excess death rate, which is surprisingly high considering Australia's temperate climate.

From the Swinburne Masters Research the overall story of Most Significant Change chosen by householders was to manage the use of standby power.

Challenges

A wide range of challenges facing the study were identified. Many were transitional and overcome overtime, while others possibly restricted the outcomes of the study. Challenges included:

1. the complex nature of the study
2. the tight and changing timeframe and the workload of the ELOs who were all employed part-time
3. involving and communicating effectively with vulnerable householders in the project, the ELOs needed to develop trust, overcome householder resistance to participate, understand and work effectively with participants
4. the amount and diversity of data required by the project design and accessing the data over a wide project area and limited timescale
5. dealing in vulnerable peoples' homes with private sector contractors and tradespeople who are time poor and profit driven - their work was often invasive of people's homes and lives
6. safety issues such as electrical hazards, gas leaks and carbon monoxide emitting heaters, asbestos, working at heights, lone worker issues, multiple contractors onsite simultaneously and the age of homes
7. ensuring tenants security of tenure was protected

Future research opportunities

A priority for future research is to trial the efficacy of different intervention subtypes i.e. trial each of the different home improvement retrofits against each other, and different behaviour change methods against each other to identify the most effective interventions. Studies are also recommended into epidemiological patterns of indoor cold and health outcomes and to investigate the ability of coping strategies to protect people from cold related ill health.

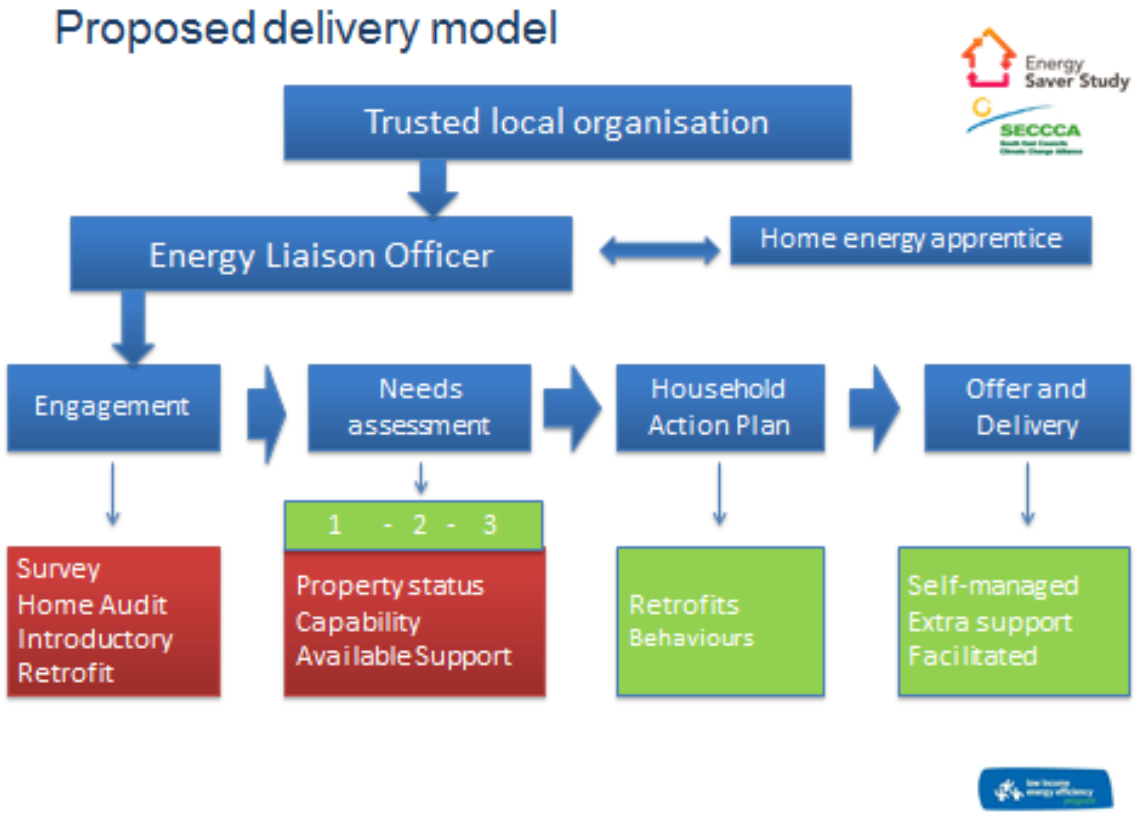
Recommendations

For future policy and program design the project makes the following recommendations:

- focus on strategies which provide home retrofit **plus** behaviour change support programs to low income households as this is the most effective pathway
- focus on a broad range of simultaneous outcomes including improve energy efficiency, energy bill costs, indoor temperatures and safety, householder health and wellbeing i.e. aim to make homes warmer and more comfortable during cold weather,

as well as cooler and safer during extreme hot weather, rather than just more energy efficient

- redefine and fund the role of organisations that provide future CHSP home maintenance/modification services to provide combined energy efficiency support programs (branded as home safety and affordability of living) as a core responsibility of supporting the community to age in place (thereby improving the safety of the homes)
- provide leadership, resources and organisational change support to existing/potential providers to facilitate this redefinition of CHSP role and responsibility
- ensure that as part of the process to identify and support first the most vulnerable people, assessment of clients' eligibility to receive support services takes into account the client's current income, the value of their assets and their access to cash
- investigate/consider the proposed home energy efficiency support delivery model as indicated below which:
    - recruits low income households through an existing trusted organisation (local government and/or CHSP service providers, not-for-profit NGO's)
    - supports clients via both and Energy Liaison Officer and low-cost Energy Efficiency Apprentice/Trainee, together with energy efficiency rebates/low cost finance options
    - provides support based on client capacity and needs, the condition and design of each home and the opportunities for the improvement of energy efficiency, comfort, energy costs, health and wellbeing
    - resource/educate/inform existing CHSP assessment, team leader, direct care and home maintenance workers of the opportunities and benefits to improve the energy efficiency of homes and in doing so, increases their capacity to provide clients with relevant resources and support
    - support CHSP providers to have and provide useful energy efficiency information to clients about how they can improve the energy efficiency at their home, as well as the additional benefits of energy efficiency i.e. reduced energy bills, improved comfort, health and wellbeing



Proposed future energy efficiency support delivery model

1 Introduction

1.1 Description of the project

The Energy Saver Study (formerly *Residential Energy Efficiency Motivators Program for Low Income Households*) is a three-year research project that aims to investigate the most effective ways to support low income householders to improve their household energy efficiency. The project also aims to determine if the support provided to householders decreases the householders' energy costs, has benefits for their health, comfort and/or wellbeing.

The project is to produce findings that can be used to inform future policies and programmes to assist low-income households become more energy efficient. The project also seeks to confirm whether delivery of a support program to low income householders is effective when done through local council Home and Community Care (HACC) departments.

A council's HACC clients (those that receive discounted gardening, cleaning, cooking or home maintenance services from council) are often the most vulnerable in the community to the impacts of climate change, given their socio-economic status and the types of houses in which they live. These homes may be old, inefficiently designed or built (in terms of energy efficiency) or poorly maintained. Householders may face barriers to energy efficiency improvement, including no/little access to money, a lack of mobility and limited knowledge of residential energy efficiency opportunities, limited English and they often live in homes where they need approval from landlords/property managers to undertake works on the home.

The project seeks to investigate these and other barriers to energy efficiency for householders and the best interventions to overcome them. This project aims to see if it can overcome these barriers through i) delivery of support to households by a trusted organisation i.e. the local council, ii) supporting households financially to access energy efficiency improvements and iii) providing information and awareness to households about energy use, efficiency and supply options.

The project also aims to identify how much home improvements cost (average $ cost/home) to improve the energy efficiency, comfort and health and reduce the energy costs for low income householders.

Householders and homeowners/managers were supported to improve the energy efficiency of their homes with home improvement retrofits, behaviour change support, a combination of retrofits and behaviour support, or no interventions. This was so that the contributions of home improvements and energy efficiency information/awareness could be quantified, allowing a determination of the most effective interventions that resulted in improvements in energy efficiency, energy costs, health and/or comfort.

In cases where householders were tenants living in a rented home, terms of agreement between the homeowners /property manager and tenants were negotiated so both parties stood to benefit and the security of tenure was maintained.

The expected outcomes of the project are to:

- identify the most effective ways to support low income householders to improve their household energy efficiency, either retrofits, behaviour change support or a combination of both
- demonstrate that the targeted support provided to householders decreases the householders' energy costs and has benefits for their health, comfort and/or wellbeing
- produce findings that can be used to inform future policies and programmes to assist low-income households become more energy efficient
- confirm that delivery of a support program to low income householders is really effective when done through local council Home and Community Care (HACC) departments, or trusted existing organisations
- confirm that barriers to energy efficiency for low income householders can be overcome by them when they are supported by a trusted organisation with home retrofits **and** energy information and awareness
- confirm whether financial support of between $200-$3000 to each home for home energy efficiency retrofits will improve energy efficiency significantly and produce co-benefits of improved comfort and reduced energy costs
- confirm whether low income householders will have high regard for an energy efficiency support program that includes home retrofit and behavioural support

1.2 Lead organisation and consortium members

The lead organisation is South East Councils Climate Change Alliance (SECCCA). SECCCA is a network of eight councils committed to delivering high-quality, innovative projects and research programs at a regional level. SECCCA supports communities, businesses and industries to the south east of Melbourne in responding and adapting to the impacts of climate change. Additional information about SECCCA can be found at www.seccca.org.au

The consortium members include:

- 6 member councils
    - Bass Coast
    - Baw Baw
    - Bayside
    - Cardinia (including MECWACARE as the private HACC provider)
    - Casey
    - Mornington Peninsula
- Air Barrier Technologies
- Aspect Studios
- Briar Consulting
- CSIRO
- Energy Makeovers
- Energy Monitoring Solutions
- Just Change
- RMIT

Air Barrier Technologies is a company that tests the rate at which air moves through buildings, identifies where air leaks are occurring and take actions to seal the leaks to reduce the air and energy flow in and out of buildings.

ASPECT Studios is a design firm which specialises in Landscape Architecture, Urban Design and Digital Media. Aspect Studios role in this project was to create the project brand, look and feel and to create communications material that aims to improve energy efficiency outcomes in participating households e.g. brochures, documents, webpages, videos and computer software.

Briar Consulting Pty Ltd is the project evaluator and has been providing research, evaluation and curriculum development services to governments, businesses and community groups for over 19 years. The major areas of evaluation have been in education and community sustainability. The principle Dr Brian Sharpley has a Masters in Environmental Science and a PhD. Over the past few years he has focused on evaluating projects where behavioural change and community involvement are central and has developed a range of tools to monitor projects, provide ongoing feedback and data collection, analysis and interpretation.

CSIRO have delivered on large and small projects requiring the characterisation of energy consumption in residential buildings. These projects have typically required assessment of buildings, household services and appliances across large numbers of residential buildings. CSIRO has internationally recognised expertise in this area includes analysis of house, appliance and householder energy efficiency, cost effectiveness of energy saving measures and characterisation of behavioural influences on energy consumption to name a few. Their role in this project was to store and analyse building, energy, intervention and cost data, determine and report on energy use and their findings.

Energy Makeovers is an Australian energy services company dedicated to assisting families and businesses achieve a sustainable future. Their focus is to provide and promote practical information, more efficient use of energy and renewable energy to residential, commercial and industrial building owners and tenants. Their role in the project was to provide and complete home energy audits on all homes and to calculate, report and recommend home improvements to improve energy efficiency in the homes.

Energy Monitoring Solutions operates to provide its clients and business partners with energy monitoring tools and knowledge to optimise investments in energy efficiency and their energy usage. Their role in this project was to identify suitable homes to receive energy monitoring equipment, install the equipment, collect and transfer data to CSIRO and monitor, maintain and remove the equipment where required. They also designed and supplied energy use In-Home Display devices in homes so households can access their energy use easily.

Just Change work to activate relationships between low income tenants, landlords and property managers to enable energy efficiency improvements to rental properties. Their role in the project was to facilitate recruitment by SECCCA of rental households & homes into the project and support SECCCA staff to ensure that tenants are treated fairly by property owners and managers.

Nicola Willand is a PhD Candidate at RMIT University with a particular interest in the holistic approach to sustainability in the built environment. As an architect, Nicola finds that

initiatives towards a more sustainable built environment tend to focus on environmental and economic outcomes, while the social aspects are often neglected. In order to facilitate triple bottom line sustainability, Nicola is aiming to develop strategies for the built environment that will minimise environmental impacts and life cycle costs while maximizing productivity, health and social equity. Her PhD research focusses on the multiple benefits of residential energy efficiency initiatives.

1.3 Objectives of the project

The objectives of the project were to:

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

The project specifically aimed to:

- Deliver a new and innovative energy efficiency retrofit and behaviour change program to low income households through local government Aged and Disability Services using Direct Care Workers (Energy Liaison Officers (ELO's)) to overcome the barriers of information, communication and trust barriers.
- Establish through the delivery of the project a comparison between different household groups. These groups will be subject to a range of interventions to determine the most effective and best value approaches to overcome capacity, cost and risk barriers.
- Establish the project components that can be transferred to other regions and councils to overcome barriers of reach and scalability.

1.4 Benefits

The likely benefits of this project 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 or clients.
- Build the capacity of Australia's energy efficiency technology and equipment companies by maximising the opportunities for Australian industries to participate in the projects

1.5 Approaches

The approaches that the project used to assist low income householders in various locations to become more energy efficient included:

- Employ and train 6 Energy Liaison Officers (ELOs) to recruit and support 320 eligible low income householders that receive Home and Community Care services

- Deliver a tailored energy retrofit and/or support program through local council HACC Services using ELO's to overcome the barriers of information, communication and lack of trust in existing providers
- Capture and analyse data and information to inform future energy efficiency policy and program approaches
- Establish a comparison between different household study groups that receive different interventions to determine the most effective and best value approach to overcome capacity, cost and risk barriers
- Establish the project components that can be transferred to other regions and be delivered almost anywhere in Australia
- Collaborate with the RMIT PhD student Nicola Willand to investigate the correlations between buildings, human health and wellbeing

1.6 Methods

Householders to participate in the project were recruited by random selection from the retired, elderly or disabled low income HACC clients at each of the 6 participating councils using an online random number selection tool. Each of the randomly selected clients were then assessed by the Energy Liaison Officer (ELO) for their eligibility to participate i.e. the HACC clients invited to participate in the project needed to have the physical and cognitive capacity to participate in this 3 year study until it ends e.g. be able to receive numerous visits from a wide range of staff and contractors and answer a series of surveys including questions about self, living arrangements and actions.

The eligibility of randomly selected HACC clients was judged by ELOs after consulting with the council HACC client database, the HACC client assessors and existing direct care workers.

From the 320 householders that were judged as eligible to participate and accepted the invitation to participate, householders were then allocated to one of the 4 study groups as follows (see Table 1 below):

- Group A: receive home improvements/retrofits (80)
- Group B: receive energy action information and support (80)
- Group C: receive home improvements **plus** energy action information and support (80)
- Group D: receive no support i.e. this is a scientific control group until after the monitoring period (80)

Table 1: Household study groups and activities

Group	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7
1A (30 households)	energy audit	air-barrier testing (15 houses only)	draught sealing (15 houses only)	star-rating assessment (15 houses only)	energy retrofit		energy monitoring system
1B (30 households)	energy audit	air-barrier testing (15 houses only)		star-rating assessment (15 houses only)	basic energy retrofit (post-Activity)	behaviour change program	energy monitoring system
1C (30 households)	energy audit	air-barrier testing (15 houses only)	draught sealing (15 houses only)	star-rating assessment (15 houses only)	energy retrofit	behaviour change program	energy monitoring system
2A (50 households)	energy audit				energy retrofit		
2B (50 households)	energy audit				basic energy retrofit (post-Activity)	behaviour change program	
2C (50 households)	energy audit				energy retrofit	behaviour change program	
1D Control Group (30 HHs)	energy audit	air-barrier testing (15 houses only)		star-rating assessment (15 houses only)	basic energy retrofit (post-Activity)		energy monitoring system
2D Control Group (50HH's)	energy audit				basic energy retrofit (post-Activity)		
TOTAL	320	60	30	60	320	160	120

Allocation of householders to a study group was relatively random i.e. using random number selection tool again, except that those householders which were most capable to receive high numbers of visits and contact were placed in Study Group C which was likely to receive lots of visits. This was to maximise the number of householders that participate in the project until the project ends to make the research data as complete as possible. This process recognised that all householders were not comfortable to receive a high number of visits and contact, and if they did, they were more likely to stop participating.

The project developed a robust framework, tools and training to guide ELOs in the delivery of the additional home retrofit and support services to clients.

Home energy audits were undertaken at all homes soon after recruitment. High level audits were completed at 60 of these homes to establish the characteristics and star ratings of houses that these clients live in and to determine the most cost effective energy efficiency improvement services to implement. All other homes received a 100-point audit to inform future interventions.

The project provided the Behaviour Change Program (hereafter referred to as Energy Action Program [EAP]) to 160 households. The EAP trialled and tailored language, messages and use of technology to encourage the adoption of new energy related actions by households to improve their energy efficiency. Embedding these approaches in councils' range of services attempted to demonstrate the potential of energy efficiency improvements to low income households and establish the transferability of this support service to other municipalities.

After each householder joined the project, energy distributors were asked to provide energy use information about each participating home for the previous 1-2 years. This was so that SECCCA could compare the historical energy use with the energy use after householders joined the project and received energy efficiency support. 120 homes also had energy monitoring equipment installed in them. This equipment monitored electricity and gas use at the homes (and generation in the case of solar electricity) including when and how much. This onsite energy use data was compared with the energy use data provided to SECCCA by energy distributors to see if the energy use data was similar.

An RMIT PhD research project investigated the correlations between buildings and human health and wellbeing. It investigated the effects of energy efficiency improvements and support services on householders' health and wellbeing in this project.

An additional Swinburne University Masters research project was added to the project during 2015. The Masters researcher was exploring social influence on new, failed and sustained household energy practices. Social influence was being researched through the householder's social network, including the number and type of relationships, frequency of contact, relationship priority and the type of information and feedback received. This is a longitudinal, mixed methods study which is still in progress. Stage 1 & 2 interviews regarding social influence patterns on new and failed householder actions and Most Significant Change have been completed and preliminary findings have been identified.

1.7 Problems or limitations in the scope of the project

The design of this project is complicated in that it includes 4 main study groups, plus sub – groups within each study group that receive different interventions. This, for some purposes, can make the numbers of homes receiving an intervention sub-type (e.g. hot water services) too small to achieve statistical significance or comparison with other similar sub-types. In contrast, for the 2 types of In-home Display intervention sub-type, the number of each of

them was 30 and this allowed a level of statistically significant comparison of their effectiveness versus homes without them.

Home retrofits were provided to householders in at least 10 different ways e.g. LED lights, draught sealing, insulation top-up in the ceiling or floor, replace old appliances including heaters/coolers, hot water services, TVs or fridges, provide window furnishings etc.

At some homes the home improvement support included numerous simultaneous interventions e.g. they received LED lights, draught sealing plus ceiling insulation. This meant the project was not able to say that any single retrofit action was the best thing to do.

This retrofit situation (with numerous different retrofits being made available) occurred because during householder recruitment the project committed to provide 160 householders with at least $2500 each of home improvements. This was to maximise householder retention in the project. The home improvements needed to have a high chance of improving the energy efficiency at each home and the home owner needed to agree to the works. To achieve these two criteria a diverse range of retrofit options was offered and provided to participants.

In contrast, some homes received one retrofit intervention only e.g. a new heater/cooler. If there was a statistically significant number of homes receiving a single intervention e.g. 30 or more homes, then the project may be able to indicate that a single intervention is likely to be a beneficial intervention. It is likely that the project will only be able to identify if any of the interventions at study group level led to particular outcomes i.e. were home retrofits the most effective, was behaviour change most effective? Was a combination of retrofits plus behaviour change most effective? The project cannot guarantee that it will be able to determine nor recommend specific actions to achieve specific outcomes due to the complexity of interventions.

The behaviour change program also provided support to householders in different ways e.g. face-to-face visits, information sheets and brochures, group information workshops, videos, in-home displays. The project will be able to assess the behaviour change intervention type as a whole, but it may be impossible to scientifically determine if any particular sub-type of behaviour change support led to a particular outcome.

Participation in behaviour change programs usually needs to be voluntary to be effective but in this project, participants in behaviour change study groups were obliged to participate in it, which may have reduced its effectiveness/skewed the results.

1.8 Funding sources and trial duration

This project received $4.4 million in funding from the Department of Industry, Innovation and Science (DIIS) Low Income Energy Efficiency Program (LIEEP) funding Round 1 in April 2013. Consortium partners provided $1.5 million of in-kind contributions e.g. intellectual property, survey content, house survey software, analysis, recommendations, staff time and resources.

The project commenced in April 2013 and concluded in May 2016.

1.9 The context of this report

This report was written as a requirement of the contract that SECCCA has with the DIIS to complete the LIEEP project that was originally titled “Low Income Energy Saver Direct Care and Motivators Project”. The project was retitled “Energy Saver Study” to attract

householders to participate as volunteers. The project was one of twenty similar LIEEP projects being undertaken in Australia, but focused uniquely on delivery of energy efficiency and community support services through local government community services departments.

This report is designed to provide information to government staff and politicians. It is to inform future government policy and programs related to supporting vulnerable, low income community members, to help manage peoples' energy and living costs, improve residential energy efficiency plus community health and wellbeing. The lead author was Adam Shalekoff and contributing authors were Michael Ambrose, Melissa James, Brian Sharpley, Nicola Willand and Lucy Allinson.

After reading this report the reader should be able to identify and describe a range of policy and program opportunities. The reader may be able to provide advice to inform future policies and programs that are likely to improve energy efficiency, reduce the cost of living and improve comfort, health and wellbeing in the homes of vulnerable people and low income earners.

2 Methodology

2.1 Location

The project occurred in 6 of the local councils to the south east of Melbourne CBD i.e. Bayside, Casey, Mornington Peninsula, Cardinia, Baw Baw and Bass Coast (Figure 1).

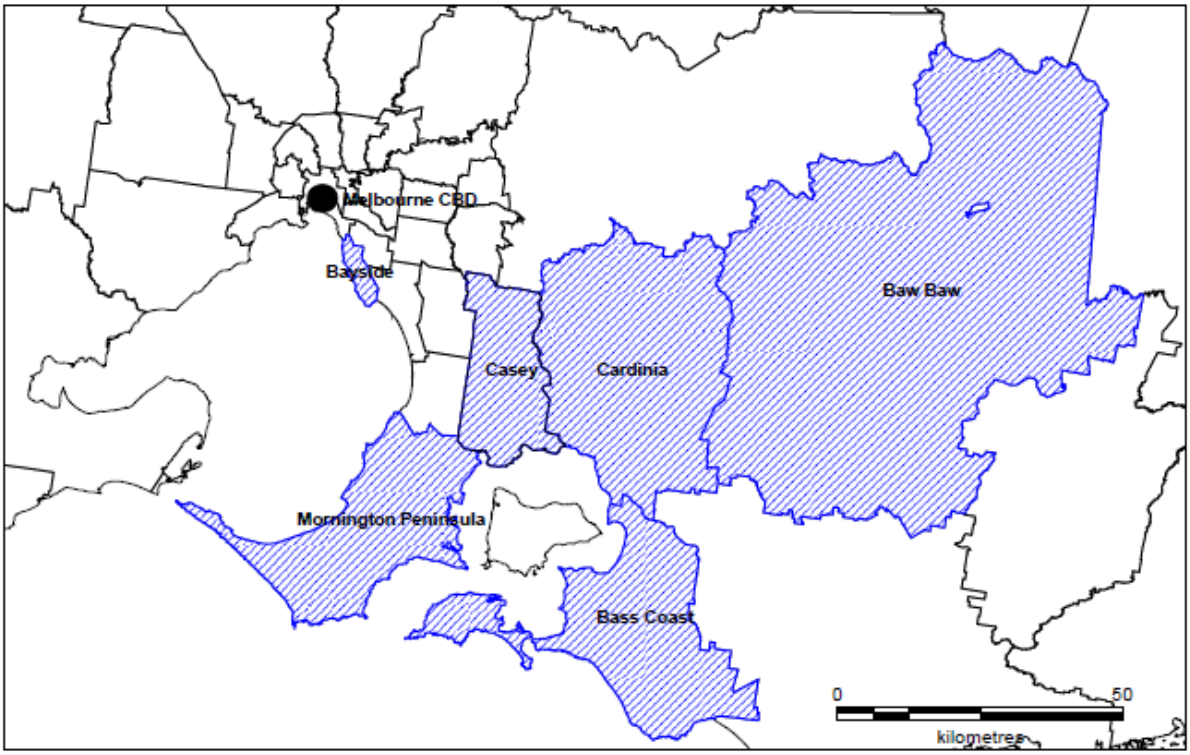


Figure 1: Participating local council areas

Bayside is an urban area adjacent to Port Phillip Bay close to Melbourne's CBD. Casey and Cardinia are peri-urban growth areas. Bass Coast and Mornington Peninsula are predominantly coastal peri-urban/rural areas with many small to medium sized towns, green

wedge areas plus numerous coastal/rural villages that are also undergoing significant population and urban growth. Baw Baw is a peri-urban/rural area with many small to medium sized towns, green wedge areas plus numerous rural villages.

The approximate locations and the study group of each participating household are shown in Figure 2 below.

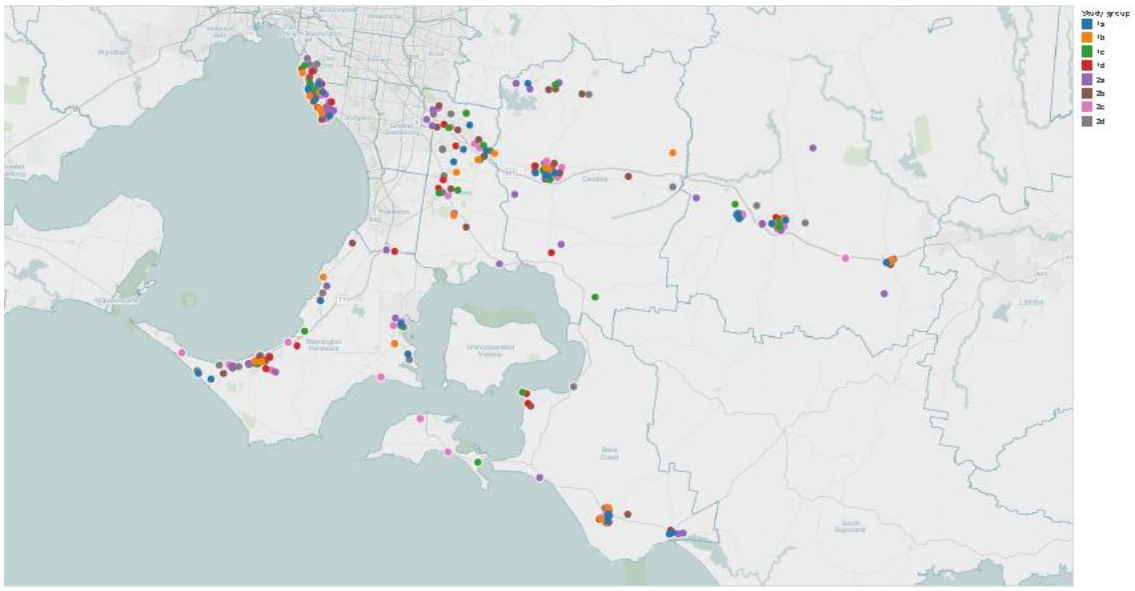


Figure 2: House locations by study group

2.2 Project planning

The project was initiated and planned by SECCCA and its member councils. SECCCA approached other organisations, discussed opportunities and formed a consortium to apply for the project funding from DIIS. A draft Project Plan and subsequent sub-plans (Risk Management, Data Collection & Reporting, Evaluation and Compliance) were developed and formed collateral materials to accompany the funding application and guide the project delivery after funding was received. The project plan and supporting plans were updated during the project.

The project plan was to identify and test the effectiveness of new, ambitious, innovative ways to engage low income householders and support them to improve energy efficiency at their homes. This was the project's focus because low income householders can be hard to engage in energy efficiency projects. This can be due to their age, health, disabilities, income status and/or their distrust in cold calling, private sector marketing and sometimes questionable levels of honesty practiced by goods and services providers.

2.3 Privacy

All personal information and energy use data collected by the project was stored and used as per the Privacy and Data Protection Act 2014. Each household that was provisionally accepted to participate in the project was provided with the DIIS LIEEP Privacy Notice (see Appendix 1) to read prior to them agreeing in writing to participate in the project.

When each household joined the project they were assigned a unique identifier. All project data with the participants' personal data attached to it had the address and personal

information removed from it and linked to the unique identifier before data was provided to DIIS.

2.4 Project governance

A Project Steering Committee was formed in late 2013 to oversee the project. This committee met at least four times/year and committee members from the respective organisations included:

- SECCCA:
  - Executive Officer - Greg Hunt
  - Climate Change Projects Coordinator - Daniel Pleiter
  - Business Support Officer – Janet Armstrong
  - Energy Saver Study Coordinator – Adam Shalekoff
  - Energy Saver Study Team Leader – Lucy Allinson
  - Energy Saver Study Research & Training Officer – Andrew Cooper
- Baw Baw Council:
  - Environment Education Officer – Olivia Lineham
  - HACC Team Leader – Robert Barr
- Bass Coast Council:
  - Climate change & sustainability Coordinator – Eliza Horsburgh Price
  - Aged & disability planning & programs Coordinator – Sam Wightman
- Bayside Council
  - Environmental Sustainability & Open Space Coordinator - Rachael Murphy
  - Environmental Sustainability & Open Space Officer – Leanne Stray
- Casey Council:
  - Climate Change & Energy Officer - Mark Akester
  - HACC Team Leader – Ros Pruden
- Cardinia Council:
  - Environment Team Leader – Desiree Lovell
  - mecwacare HACC services – Anne Wright
- Mornington Peninsula Council
  - Renewable Resources Team Leader – Jessica Wingad
  - Intake & Assessment Aged & Disability Services Coordinator – Peter Cracknell
- Briar Consulting – Brian Sharpley

A schematic representation of the project governance and delivery is provided in Figure 3 below.

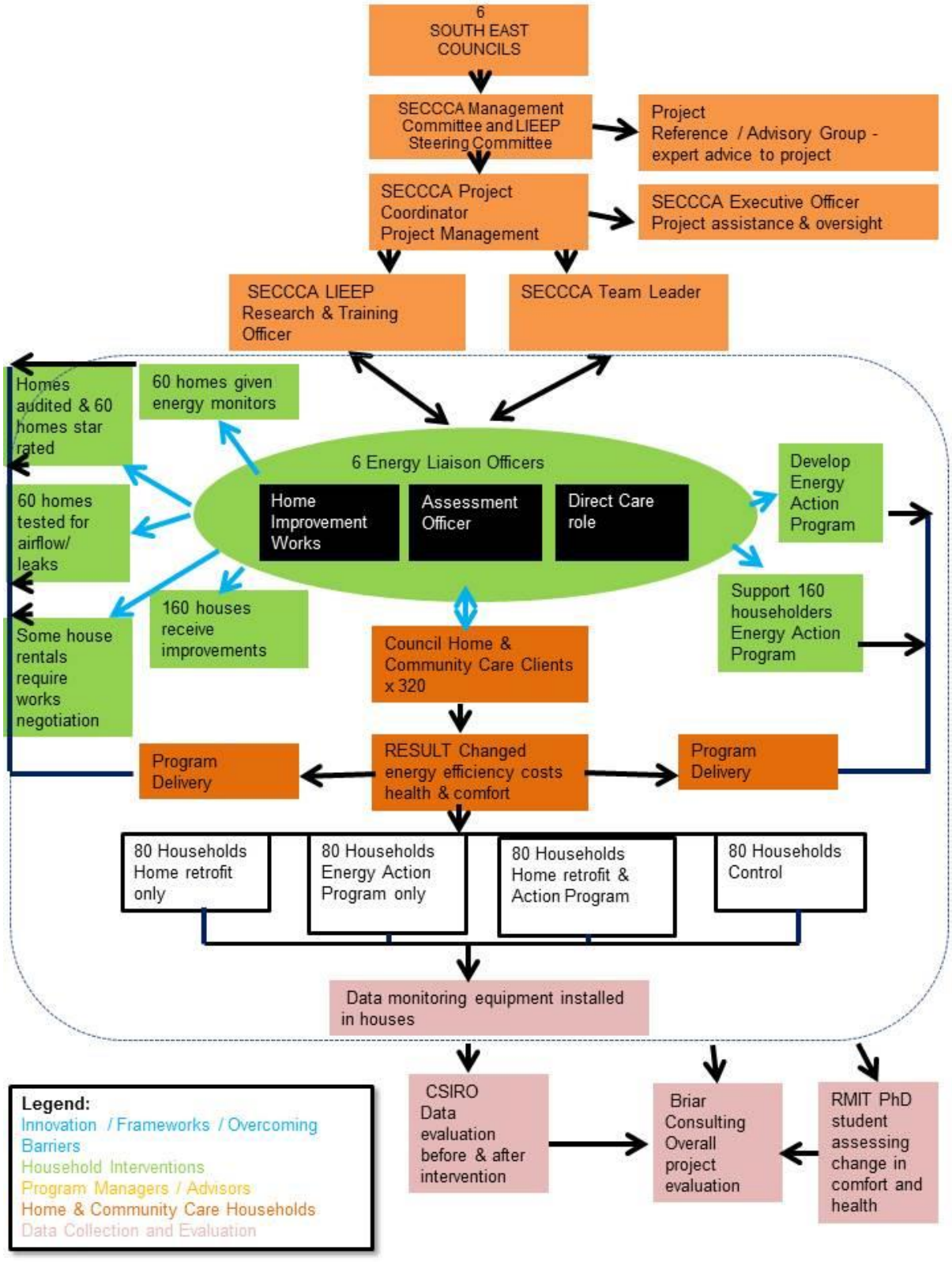


Figure 3: Energy Saver Study governance and delivery arrangements

A Data Committee was formed which met at least twice per year, with attendees varying depending on which stage the project was at. It included the following people:

- SECCCA:
    - Energy Saver Study Coordinator – Adam Shalekoff
    - Energy Saver Study Team Leader – Lucy Allinson
    - Energy Saver Study Research & Training Officer – Andrew Cooper
- CSIRO:
    - Urban Systems Land and Water Team Leader - Michael Ambrose
    - Cities Research Program Experimental Scientist - Melissa James
- EMS
    - Geoff Clarke
    - Adam Baker
- Energy Makeovers
    - Melanie van Rees
- Briar Consulting – Brian Sharpley

The Project Delivery Team met approximately fortnightly (or as required) to manage progress, delivery, monitoring, review, improvement and reporting of the project and consisted of:

- Coordinator – Adam Shalekoff
- Team Leader – Lucy Allinson
- Research & Training Officer – Andrew Cooper
- Briar Consulting – Brian Sharpley

A Project Reference and Advisory Group (PRAG) was formed in late 2013. The PRAG members were highly regarded professionals in the home and community care and/or environmental science. The purpose of the PRAG was to provide technical advice and critical reflection to the project, particularly with regard to local, regional and state and national contexts for the delivery of services within the health and community development sectors. Members of PRAG also provided comment on the delivery of services to participants including energy efficiency and behaviour change. The PRAG met four times during the project and its members were:

- Jenny Van Riel: Manager, Aged & Disability Services at Mornington Peninsula Shire Council.
- Mary Rydberg: Manager Community Care & Library Services at City of Greater Dandenong
- Daniel Voronoff: Senior Project Officer, Environmental Management Unit at Department of Human Services
- Rita Battaglin: Pathway and Support Services Manager at Springvale Community Aid and Advice Bureau.

Reports were provided to the SECCCA Management Committee by the Project Coordinator approximately 9 times per year which included project progress, budgets, successes, challenges and key learnings.

SECCCA and DIIS formulated a milestone schedule in the funding contract with 13 milestones throughout the project. SECCCA provided a milestone report to DIIS by each milestone date. DIIS approval of milestone reports was required and was followed by payment of the relevant funds to SECCCA.

2.5 Arrangements for collaborating with local councils

The project and local councils' roles in the project were integrated in a range of ways.

Firstly, an environment team representative from each council became a member of the project steering committee. As the project moved from the planning phase to implementation within a HACC services context, representatives from each council's HACC team were invited and some occasionally attended the steering committee meetings. HACC coordinators were co-supervising the ELOs. To do this effectively they needed to be aware of the project procedures, arrangements and progress at any time.

In late 2013 SECCCA and the then 7 participating councils advertised for and appointed 7 ELOs. The ELO roles were framed within the guidelines provided by the Project Delivery Team but were also influenced by the internal dynamics of the appointing council.

The project originally aimed to have 7 councils participating. One council (Kingston) appointed an ELO and the ELO was employed in the role for approximately one month. The ELO decided to leave the role, Kingston then decided it no longer wished to participate in the project and withdrew due to concerns around staffing, workload and risk to council. Other councils absorbed the 'lost' homes by increasing the number of homes they recruited to participate. This was to keep the total number of homes at 320.

The Project Delivery Team provided the direction of the project and developed the timelines, specific tasks (such as recruitment, auditing, interventions) and training workshops for the ELOs. Five of the ELOs were staff members of their council's HACC team, but all were substantially independent of the councils. They were co-supervised by the SECCCA Team Leader and a HACC representative. This required the ELOs to be self-motivated and self-reliant. For most this meant they were isolated with minimal support within their workplaces. ELOs also liaised between themselves via phone and email to develop a 'community of practice' which complemented the regular training and workshops.

2.6 Variations between council arrangements

Cardinia council does not provide HACC services to clients itself, but engages 'mecwa*care*' to provide HACC services to clients. Mecwa*care* is a private not-for-profit organisation which provides care to the community on behalf of Cardinia council and other organisations. As a result the ELO for Cardinia was selected by an interview panel including SECCCA, Cardinia and mecwa*care* representatives and the ELO was employed and co-supervised by SECCCA, with mecwa*care* co-supervising as well and providing staff in-kind to identify suitable clients from its client database to participate in the project.

Mornington Peninsula council decided to trial having its HACC Home Maintenance team (team leader plus 4 staff) providing some home retrofits to clients i.e. draught sealing, light globe changing and improving insulation of hot water services.

The remaining 5 councils decided that SECCCA was to identify, arrange and supervise contractors to deliver home retrofit works to their participating clients. Bayside and Cardinia both had a common preferred supplier (Urban Maintenance Systems P/L, or UMS) to maintain their council facilities and SECCCA hired this contractor and their subcontractors for some home retrofit works. This was to trial the model of using councils' existing preferred suppliers (of building/appliance maintenance) to provide home retrofit works to HACC clients' homes, to see if this might prove effective and be attractive to councils to continue after the project.

2.7 Training of Energy Liaison Officers

Training and project information was provided to Energy Liaison Officers at regular 3-hour sessions throughout the project. This was to ensure the ELOs had the skills, knowledge, resources and support required to complete their jobs i.e. communicate with and recruit householders, facilitate and provide support to participants and facilitate and carry out data collection.

Training was focussed on two key areas:

- Effectively recruiting, retaining and supporting the householders
- Residential energy efficiency

Both were delivered as weekly/fortnightly 3-hour sessions during 2014.

In 2015 the workload was greater for ELOs and training was transformed into monthly 3-hour information sessions which were attended by the Project Delivery Team and ELOs and sometimes by consortium members. These sessions were designed to facilitate a 2-way discussion which included information sharing, ELO debrief and feedback opportunity to maximise continuous review and improvement, and high quality delivery of the project.

2.7.1 Training about recruiting and supporting the participants

Project information and practical training about recruiting and supporting the participants was provided to ELOs by the ELO Team Leader to ensure they had the tools and skills to deliver the job. This focussed on the overall project schedule and timelines, interpersonal skills, record keeping, activity scheduling, understanding the participants and reporting. Active learning with role plays using different participant character types was a priority, to emphasize the importance of using different communication styles for each individual client. An atmosphere was created to encourage questioning, sharing, learning and understanding of the different successes and challenges for Energy Liaison Officers.

The training included:

- Understanding and working effectively with participants
- Communication with participants
- Recruitment
- Working with tenants
- Lone Worker procedure
- Home audits and householder surveys
- Energy monitoring equipment
- Sources of financial advice
- Client databases
- Embedded energy networks
- Energy Action Program

Access to specialist HACC training was also provided. This training is offered to HACC staff for free by the Victorian Government (Department of Health & Human Services) – for more info go to https://hacc.chisholm.edu.au/. Examples of training offered and received by project staff included Managing Grief and Loss, Managing Challenging Behaviours, Work Within A Relevant Legal And Ethical Framework, Providing Support for People with Dementia and Support Older People to Maintain Independence.

2.7.2 Training about residential energy efficiency

The Research and Training Officer provided residential energy efficiency training to ELOs with topics covered including:

- How the house works and building terms
- Energy use and bills (including calculating energy use and cost)

- The rebound effect
- Insulation
- Draughts, ventilation, draught testing and sealing
- Lighting
- Hot water
- Heating and cooling
- Windows and shading
- Passive design
- Appliances, energy rating labels and standby energy use
- Solar power

This energy efficiency training content was later summarised to create the *House In Order*: *How to achieve energy efficiency and performance in your home* training/information manual and is available via http://energysaver.seccca.org.au/ . This is designed to be used in the following ways:

- as a reference document for future programs for HACC/environment/other staff that have a role to support householders to improve their energy efficiency/productivity, comfort, health and wellbeing and/or reduce energy bill costs
- for householders to improve their energy efficiency/productivity, comfort, health and wellbeing and/or reduce their energy costs
- for building designers and tradespeople to increase their awareness of things that can be included and done in sustainable building design, renovation and construction.

2.7.3 Monitoring, evaluation, feedback and improvement of training

The external evaluator observed over 90% of the staff training and information sessions, surveyed ELOs about the training, then evaluated the sessions and provided written feedback to the Project Delivery Team.

2.8 Householder recruitment

2.8.1 Background

Recruitment of volunteers to participate in projects can be done in many different ways, many of which are successful e.g. inviting members of established groups to participate through their leader/mentor, inviting respected people to invite their stakeholders one at a time, writing personally to target persons and social media campaigns. Other methods are often unsuccessful e.g. letterboxing householders with generic/impersonal addressing, emailing and phone calling. Participants can either be recruited successfully and retained until the project ends, can be recruited but they drop out during a project, or recruitment can be unsuccessful in the first instance and miss its potential target audience.

2.8.2 Recruitment method

This project recruited participants through already trusted and somewhat well regarded organisations: the local council Home & Community Care teams. The HACC clients already received support from these council service providers and often had high levels of trust in the staff that provided the personalised service. The process for SECCCA and member councils to recruit householders to participate in the project is shown in

Figure 4.

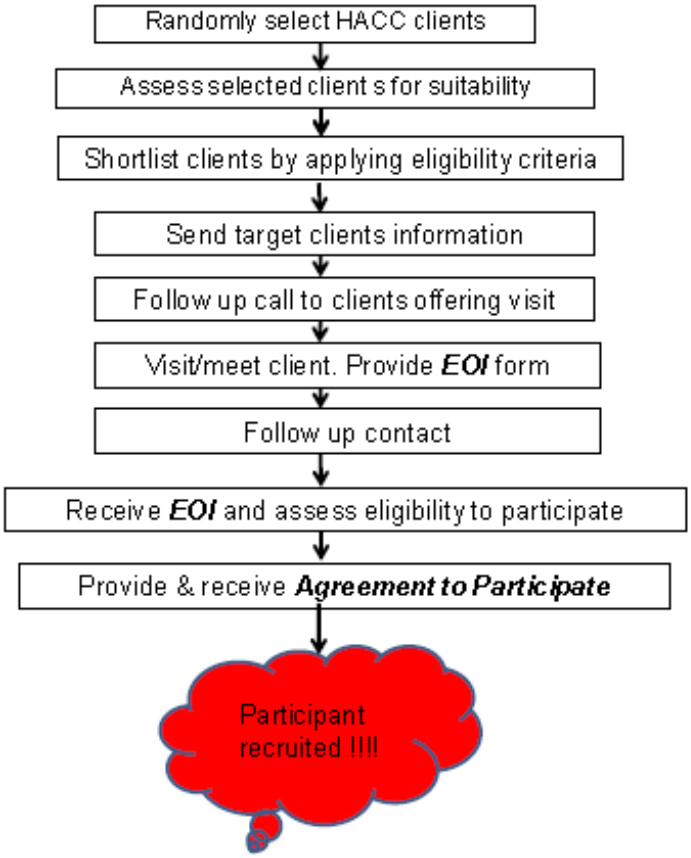


Figure 4: Householder recruitment process

The target householders that were invited to participate in the project were selected by random selection of 100 clients from the HACC clients at each of the participating councils using an online random number selection tool. Each of the randomly selected clients were then assessed by an Energy Liaison Officer for their eligibility to participate after consulting with the council HACC client database, the HACC client assessors and existing direct care workers. The clients needed to have the physical and cognitive capacity to participate in this 3 year project until it ends including being able to receive numerous visits from a wide range of staff and contractors and answer a series of questions about self, living arrangements and actions. A further 100 clients were randomly selected at each council to achieve the required number of participants if the first list was exhausted and more clients were still required.

An introductory letter was sent to suitable HACC clients (see Appendix 2). A phone call was provided to target clients by the ELO indicating they are from the HACC team, asking if the client is interested in the ELO visiting and describing the project to them. At the visit the ELO provides:

- a flyer about the project (see Appendix 3)
- an *Information sheet,* describing the project in more detail
- an *Expression of Interest* form, plus a reply paid envelope
- discussion about the project and questions to the HACC client to learn about them and their suitability to participate in the project.

The client could then submit an *Expression of Interest* form and if this was approved, they needed to complete an *Agreement to Participate* form.

2.8.3 Allocation of participants to study groups

The 320 recruited householders were allocated to one of four study groups. The study groups were designed to allow cross comparison of different intervention strategies to try and determine the effectiveness of the intervention techniques. The four groups were:

A. Home Retrofits (80) – providing energy efficiency upgrades to the house and appliances, such as insulation or draught sealing, appliance repair or replacement.

B. Behaviour Change (80) – providing information and support to householders which aimed to improve their residential energy efficiency, comfort, health and wellbeing.

C. Retrofit and behaviour change (80) – provide both the home retrofits and behaviour change program.

D. Control group (80) – these households only partook in the surveys and monitoring and received no other intervention program. They can be considered the "business as usual" households.

Households were allocated to a study group using a random number selection tool. Exceptions to this process occurred to maximise the participation of householders until the end of the study so that as much data as possible could be collected. For example, householders that were judged by ELOs as most capable to receive high numbers of visits and contact were placed in the retrofit and behaviour change study group, and/or the sub-groups that received the installation of onsite energy monitoring equipment.

Those householders that appeared to be less inclined to receive a high number of visits and contact were allocated to either the control group or to another study group, but did not receive energy monitoring equipment. This process recognised that all householders were not comfortable to receive high numbers of visits and contact, and if they did, they would be less likely to complete the study. The allocation of each householder to a study group was a critical part of the project's experimental design to ensure that the project would produce scientifically credible and reliable data, findings and recommendations.

2.9 Energy Monitoring

Energy monitoring was a critical part of the project design. Three methods of monitoring and collecting energy use data (gas and electricity) were adopted in this project:

1. Bill data
2. Energy distributor interval data
3. Onsite monitored interval data.

These three energy monitoring methods were included so that if one method failed or was problematic, other methods could be used to get energy data. Baseline measurement of energy use in homes was an important part of the project method to inform interventions at each home. This also provided information for analysis of results.

2.9.1 Bill data

Home energy bills for the year before the project started were collected from 60 homes that were to receive a high level (120 point) energy audit (these are described below). This bill data informed the recommendations that auditors provided to SECCCA in their high level home audit reports. The recommendations in the high level audit reports informed the interventions that were made at each home.

2.9.2 Energy distributor interval data

Energy use data (30 minute interval data) for each participating house was requested from energy distributors e.g. United Energy, AusNet, Envestra and Multinet retrospectively for the 1-2 years prior to householders joining the project (2012 -13) and again until the energy use monitoring phase of the project ended (2014-15). This enabled the project to i) be aware of the baseline energy use of householders ii) use this information to inform interventions provided to householders and iii) to note the changes in energy use following interventions.

Electricity and gas distributor data provided an alternative measure of energy consumption in some of the households. The distributor interval data analysis was conducted using this data. 237 households had electricity distributor data, and 183 households had gas distributor data. As with the monitored data, there is little summer data to include in the analysis. The set of houses used in this analysis is not the same as the set of houses used for the monitored house analysis, although there is some overlap.

2.9.3 Onsite monitoring of energy use

Onsite monitoring of energy use at 120 homes commenced between December 2013 - August 2014 and continued until 31 January 2016. The commencement date depended on when each householder was recruited to participate in the project. This onsite data was collected to test and compare if the energy use reported by the energy distributors was close to or equal to the actual onsite monitored energy use. It also allowed analysis of energy use by circuit e.g. hot water, heating/cooling, lights.

An Ecofront Energy Monitor was installed by a licensed electrician at these homes to collect and record energy use data (see Figure 5). The Ecofront is usually installed in the existing electricity switchboard (if it, the required electronic and communications equipment will fit). If the Ecofront plus the extra equipment did not fit in the switchboard then a ‘remote enclosure’ (a suitable box with a hinged door) was mounted on a wall in a location that the homeowner agreed to (see Figure 6). This can be installed inside or outside the home or in the garage.

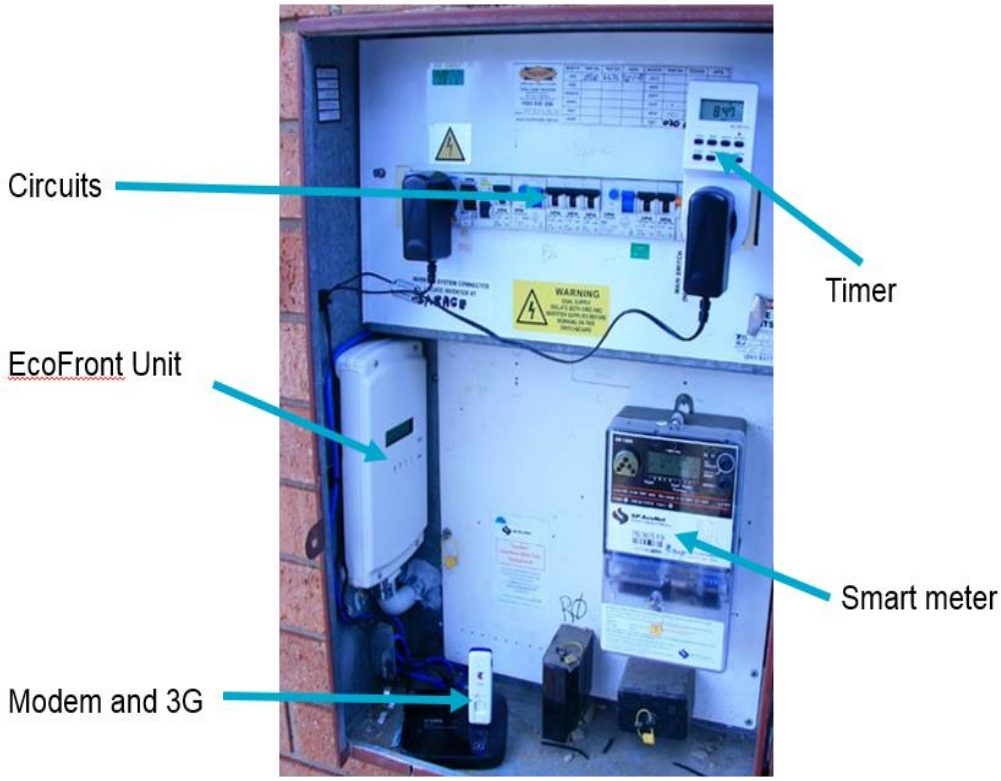


Figure 5: Ecofront Energy Monitor plus communications equipment installed in an existing electrical switchboard

Figure 6: Remote enclosure with Ecofront and communications equipment

The Ecofront Energy Monitor was connected to an inline gas meter to measure gas use (see Figure 7). The additional Accutherm diaphragm gas meter (either ZG4S or ZG6S; depending

on each home's gas appliance requirements) was installed by a licensed plumber between the existing gas distributor's meter and the home.

Figure 7: The existing gas distributor's gas meter (left) plus an additional gas meter (on right) which was installed to monitor gas use onsite

To measure and record electricity use onsite, current transformer sensors (commonly known as CT sensors) were installed by a licensed electrician around electrical wires in the switchboard. These sensors were not visible after installation, are non-invasive (they do not switch any circuits on or off) and monitor how much electricity is being used on each of the electrical circuits in a home and the total energy use on the main circuit.

The Ecofront Energy Monitor also included the use of a timer to reset the unit each day, a Wi-Fi router and a 3G modem with a data plan. This allowed remote access for data downloads and ongoing maintenance checks. The data was stored on an SD card in the energy monitor prior to CSIRO (Victoria) downloading the de-identified energy use data to a Postgre SQL database. A system health report was generated twice a day from the updated data to rapidly diagnose and manage network failures.

2.9.3.1 Selecting the homes to receive energy monitoring equipment

The process to select 120 homes that were eligible/suitable to receive energy monitoring equipment was used as described below (up to 30 in each study group).

Selection of homes to receive energy monitoring equipment involved consideration of the following factors:

i) Presence of asbestos – if asbestos containing materials (ACMs) were present/suspected to be present and likely to be mobilised during the installation of energy monitoring equipment, then a home was generally not eligible to receive the monitoring equipment. 'Federal' electrical switchboards and other asbestos containing switchboards prevented installation of onsite energy monitoring equipment. If disturbed, friable asbestos products may have been dangerous because the asbestos fibres can get into the air very easily and may be inhaled by people living or working in the area. NB: Bonded asbestos products

(e.g. old fuses) that have been damaged or badly weathered (including hail damage) may also become friable.

ii) Was the householder likely to be physically and mentally capable/receptive to numerous home visits by project staff and contractors? If not, then the home wasn't eligible to receive energy monitoring equipment.

iii) Access: does suitable access exist to allow installation and possibly removal of energy monitoring equipment? If not, then the home wasn't eligible to receive energy monitoring equipment.

iv) Was removal and reinstatement of the home to its previous condition likely to be practical and affordable at the end of the project? If not, then the home wasn't eligible to receive energy monitoring equipment.

Energy Liaison Officers together with the supplier and installer of energy monitoring equipment identified households that were suitable to receive the equipment and offered it to them. An information sheet about the equipment and terms of installation was provided to homeowners. If the homeowner agreed for the equipment to be installed they were required to sign an *Energy Monitoring Equipment Agreement*.

2.10 Temperature data

2.10.1 External temperatures

External temperatures were obtained from local Bureau of Meteorology (BoM) weather stations. Due to the spread of house locations in the study, data was obtained for four BoM stations. The location of the four BoM stations that were used are shown in Figure 8. Each council area was then assigned to one of these BoM stations (

Table 2) and then houses were linked to the BoM station assigned to their council.

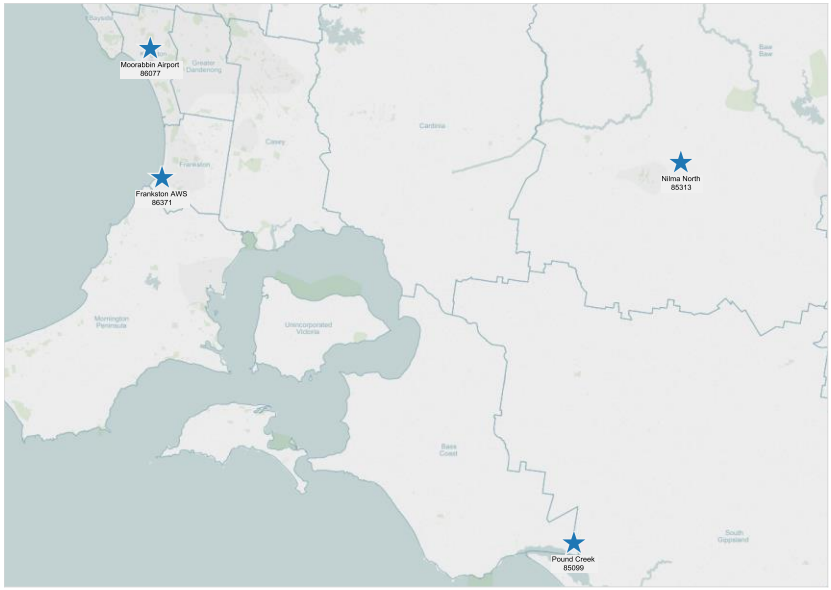


Figure 8: Bureau of Meteorology weather station locations

Table 2: Council assigned BoM station

Council	Postcode	BoM Station
Casey City Council	3805	Moorabbin Airport
Bayside City Council	3191	Moorabbin Airport
Cardinia Shire Council	3809	Moorabbin Airport
Mornington Peninsula Shire Council	3931	Frankston AWS
Baw Baw Shire Council	3820	Nilma North
Bass Coast Shire Council	3995	Pound Creek

2.11 Collection of data about the homes

A range of data was collected about the homes that were participating in the project both before the project provided support/interventions at the homes and following interventions.

The data about participating homes was collected in separate tasks as follows:

1. Home energy audits:
    a. High level
    b. Low Level
2. Draught testing
3. Internal temperature monitoring

2.11.1 Home Energy Audits

A home energy audit was done at each home by an energy auditor from Energy Makeovers. Each home received either a high or low level audit. The high and low level audits took approximately 1-2 hours each.

2.11.1.1 High level audits

High level audits were undertaken during visits to 60 randomly selected homes. 120 points of data were recorded about each home including the building materials, number of bedrooms, insulation and presence/absence of draught sealing, the appliances present and their approximate amount of use. The size of all the rooms was measured and a house plan created.

The National House Energy Rating Scheme (NatHERS) computer software was used with the high level audit data to calculate the star rating for each of the 60 homes. The star rating was recalculated at 28 of these homes after they received retrofits (draught sealing and insulation).

A high level audit report was produced for each home using the high level audit data. This report listed the characteristics of the home and its current energy use estimates by energy use type i.e. lighting, heating, cooling, hot water, cooking, other appliances etc. The report recommended a list of priority works that were affordable for approximately $2250 to improve the energy efficiency of the home. The recommended home improvements also had their projected payback period stated in years i.e. the length of time it is likely to take to recover the cost of the works due to reduced energy use and the projected cheaper energy bills. Prioritisation of recommended home improvements from high to low placed short payback period works first, followed by works with longer payback periods.

SECCCA used this information when deciding which home improvement works and support it offered to householders/owners.

High level audit report data was made available during the project to householders that are in the Behaviour Change study groups (B & C). The reports provide householders with facts which may help them either improve the energy efficiency at their home, reduce energy costs or lead to improved occupant comfort, health and/or wellbeing.

High level audit report data was made available to householders that are in the home retrofit only and control study groups (A & D) towards the end of the project in 2016. This was after the scientific monitoring period of the project had ended.

2.11.1.2 Low level audits

Low level audits were done for the remaining 260 homes. 100 points of data were recorded including the building materials, number of bedrooms, insulation and presence/absence of draught sealing, the appliances present and their approximate amount of use.

A summary of useful data collected during low level audits was produced for each home and made available to homeowners in 2016 towards the end of the project after the scientific monitoring period. This summary listed the characteristics and materials of the home.

SECCCA used the low level audit information when deciding the home retrofit works and support it offered to these householders/owners.

2.11.2 Draught testing

2.11.2.1 Background

Air draughts can move in and out of most Australian homes after they are built, even when the doors and windows are closed. Householders often struggle to keep their home at a comfortable temperature all year round as a result, due to the air (and energy) movement in and out of their home.

Homes can either be built to be relatively air tight, or existing homes can have existing air draughts better sealed. This can result in homes being relatively draught proof or air tight, much more energy efficient, comfortable and healthier to live in with lower energy costs.

Common air draughts in homes are through exhaust fans, wall vents and chimneys, around doors, windows, architraves, skirting boards and wall penetrations (plumbing and /or electrical) and between gaps in building materials. Many of these draughts can be sealed in most (but not all) existing homes. The design, condition and structure of existing homes determines firstly, if draught sealing can be done successfully and secondly, the cost of draught sealing.

2.11.2.2 Draught testing and sealing process

This part of the project aimed to test the air exchange rate of 60 homes to see how draughty they were. It also aimed to identify what it costs to draught seal homes and what are the most cost effective draught sealing actions.

Draught testing was done using a technique known as ‘blower door testing’. The technique is described in the *Draught Testing Information Sheet* that was provided to homeowners of homes that were offered draught testing (see Appendix 4).

Following draught testing, draught sealing specialists identified the homes from the 60 tested that appeared to be of a design, condition and structure that could be sealed more effectively for an average budget of approximately $1600 per home. Before the proposed homes to be draught sealed were identified, homeowners were informed about the draught testing, sealing and retesting process and asked to sign a *Draught Sealing Works Agreement*.

26 homes were then draught sealed. After this draught sealing their air exchange rate was retested and re-calculated. The average change in air exchange rate was then determined.

2.11.3 Internal temperature monitoring

Internal temperature data in both the main living area and inside the main bedroom was monitored separately from February 2014 until at least November 2015. House selection for internal temperature sensors was based on study group, with all houses in groups A and B being temperature monitored, as well as the houses in study groups C and D that had energy monitoring equipment installed. Initially this was to determine the internal temperatures in homes at different times of day and in different seasons and inform the interventions offered to homeowners. Internal temperature monitoring was continued until the project ended after interventions to determine if internal temperatures changed significantly following interventions to either the home or changed householder behaviours. The temperature data could also be compared with post-intervention householder feedback regarding comfort levels in the homes. Changed internal temperatures may have impacts on the comfort and health of householders and their wellbeing.

The temperature sensors installed by SECCCA were the Hobo UX100-003. These are capable of holding a year's worth of temperature data at 30 minute intervals. The data from each sensor was downloaded to a data logger approximately twice per year and transferred to CSIRO's database.

2.12 Collection of data from householders

As a research project it is critical that data about the householders was collected at the start, during and end of the project. The data collected was to provide a basis for comparison of changes achieved during the project and the effectiveness of the project to support householders and improve the energy efficiency of their homes. Householder surveys were developed by the Data Committee to collect data about the householders.

2.12.1 Pre-intervention householder survey

The pre-intervention householder survey took into account the project's objectives and the requirements of DIIS (see Appendix 5 for the survey). The Data Committee had access to a large number of questions from previous similar surveys - many of these questions were used. The pre-intervention householder survey was trialled and ELOs were trained to administer it. The ELOs used computer tablets to record the householder's responses and the results were sent to CSIRO and collated.

The pre-intervention survey data was used to design and provide support to householders in the Study Groups B & C (Behaviour Change component). The Behaviour Change program (described in detail in the 'Interventions' section below) aims to improve the energy efficiency at homes by providing targeted support to each householder i.e. providing relevant information about energy efficiency, energy supply plans, appliances, time of use, energy monitoring. This in turn aims to increase householders' interest in and awareness of energy efficiency and actions they can do to improve energy efficiency/costs, comfort etc.

2.12.2 Post-intervention survey

The post-intervention householder survey was developed by the Data Committee (see Appendix 6). It contained most of the questions asked on the pre-intervention survey[1] as well as a range of questions that asked the householders about their views on various aspects of their involvement in the project. This survey of 272 householders was administered by the ELOs in late 2015. The householders were from all four of the study groups.

[1] A few extra responses to a small number of questions that clarified the 'Other' category were included in the post-survey and these minor changes were taken into account during the analysis.

In the post-intervention householder survey the householders were asked whether the home improvements met their expectations. In addition, on both the pre- and post- survey, all householders were asked to rate the comfort of their home on a five-point scale from uncomfortable to very comfortable. These questions provided a way of assessing the views of the householders to the retrofits and enabled a comparison of their opinions about comfort levels before and after the intervention, and against those who we not given retrofits.

2.12.3 Householder survey about IHDs

Householders that were given IHDs were surveyed in late 2015 about the IHDs. At the time of writing this report, 23 of the householders that had been supplied with the custom designed android tablet (deluxe IHD) and 21 householders that were issued with the Watt's Clever (standard IHD) had been interviewed.

The householders were asked a number of questions that explored:

- how many people used the device
- how they used the device
- how easy they were to use
- how often they used the IHD
- whether they were still using it
- has the IHD influenced their energy/appliance/lighting use

2.12.4 Analysis of the householder survey data

Analysis of the householder survey data aimed to help answer some of the research questions that were posed during the project's design e.g. What is the householder feedback about the various aspects of the program? What views do the household participants hold regarding energy efficiency pre intervention? How do the views change? Does the use of IHD assist in changing behaviour of low income households to reduce energy consumption?

On both the pre- and post-intervention surveys, all householders were asked to rate the comfort of their home on a five-point scale from uncomfortable to very comfortable. On the post-survey these householders were asked whether the home improvements met their expectation and had it led to improvements in comfort. These questions provided a way of assessing the views of the householders to the retrofits and enabled a comparison of their opinions about comfort levels before and after the intervention, and against those who were not given retrofits.

The householder survey data was evaluated and analysed statistically. As well as simple statistics, tables and graphs, this analysis used two measures, when appropriate, to help interpret the data collected from the pre and post surveys: Statistically significance to the $p < 0.05$ level and 'effect size'.

A statistically significant result (usually a difference) is a result that is not attributed to chance. Analysis of variance (ANOVA) was used with the numerical data to see if there were any differences between groups. The Chi Square test was used with the data that could be split into groups. The effect size is a way of quantifying the magnitude, or size, of an effect and was applied to relevant numerical data. An effect size of 0.2 can be interpreted as 'small', 0.5 as 'medium' and 0.8 as 'large'.

Other tests used were T-Tests and the Bonferroni correction, which were applied to counteract the problem of multiple comparisons; while the measure of internal consistency (Cronbach's alpha) was applied to determine the reliability of combining the results from four

survey questions to create an index. An alpha of 0.7 indicates acceptable reliability and 0.8 or higher indicates good reliability.

2.13 Collection of data about householders from ELOs

Energy Liaison Officers were expected to develop a significant body of knowledge about participating householders from recruiting, supporting and surveying them between late 2013 and early 2016. Focus groups were held in each of the six councils that participated in the Energy Saver Study near the end of the project during November and December 2015. A relevant HACC staff member, a council staff member and their Energy Liaison Officer (ELO) met with the project evaluator to discuss how they viewed the project (Appendix 7 lists the questions used to frame the discussion).

2.14 Interventions

Of the 320 households recruited to the study, 230 underwent one or more interventions designed to improve the efficiency of energy consumption including:

- 75 houses received retrofit interventions only
- 74 houses received behaviour change interventions only
- 81 houses received both retrofit and behaviour change interventions.

The 80 remaining houses did not receive any intervention and were used as a control group. 10 houses withdrew from the study before interventions were implemented. The number of houses in each study group, the interventions they received and whether onsite energy monitoring occurred are shown in Figure 9 (houses which withdrew before study completion are excluded).

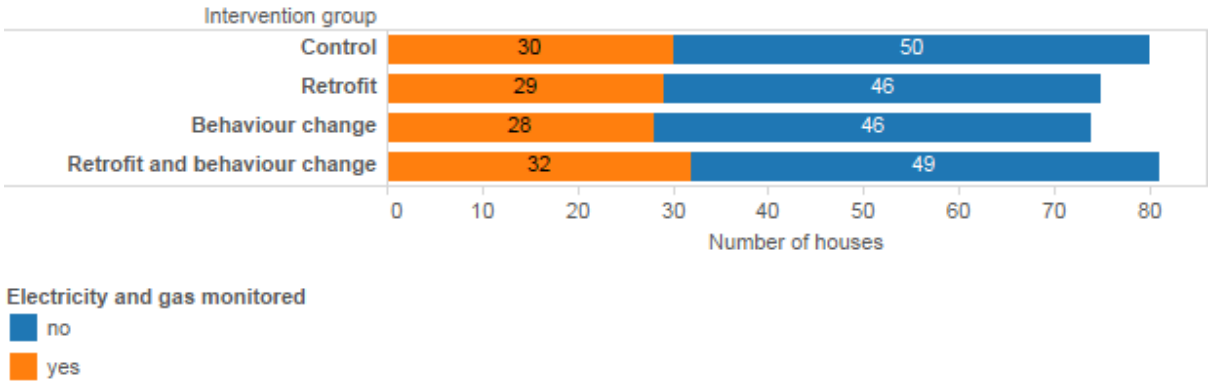


Figure 9: Household interventions

Altogether 1,043 individual interventions were made during the monitoring phase on 230 houses: 622 retrofit interventions, and 421 behaviour change interventions. The interventions were carried out between 5/12/2014 and 9/11/2015 (Figure 10).

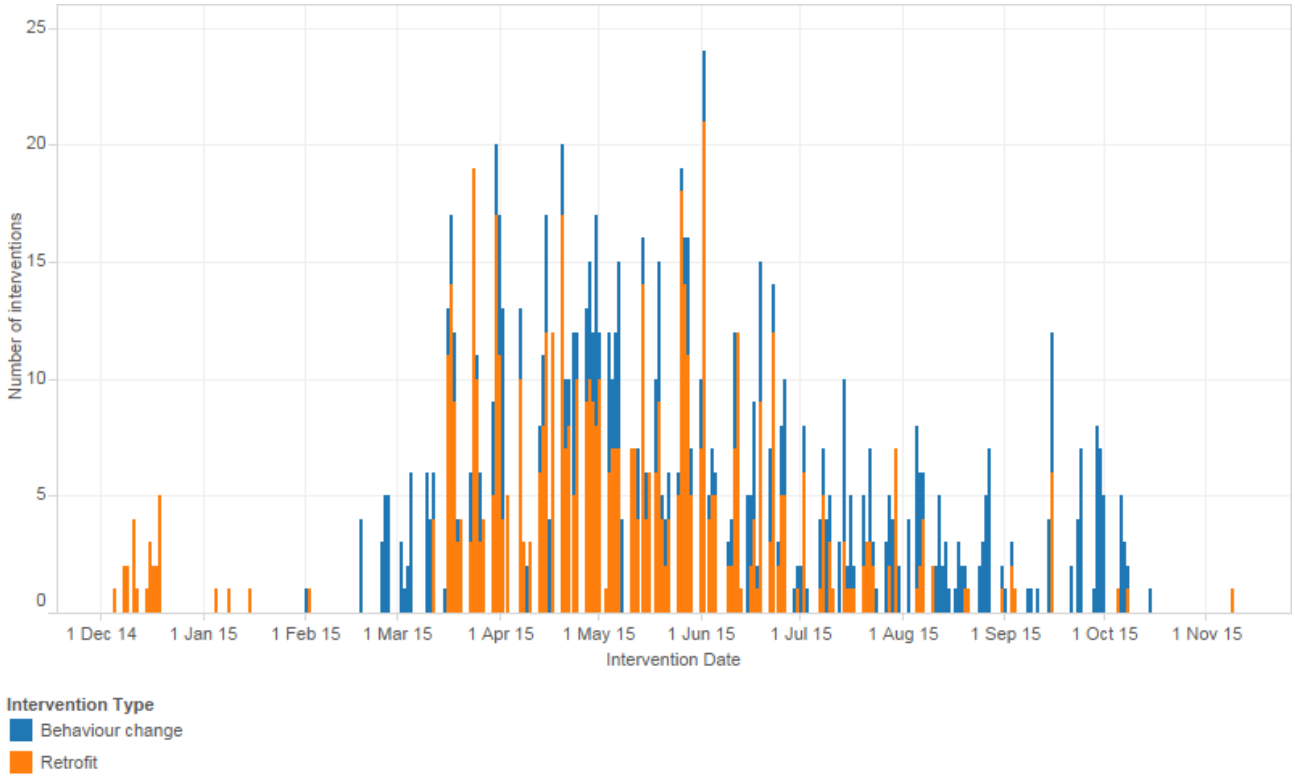


Figure 10: Intervention dates and numbers

2.14.1 Intervention subtypes

Houses which received retrofit interventions received one or more of eleven different retrofit intervention subtypes (Table 3). Houses which received behaviour change interventions received one or more of five different behaviour change intervention subtypes (Figure 11). Houses received a tailored package of interventions resulting in many house receiving different combinations of intervention subtypes. The number of houses receiving each intervention subtype varied (Figure 11). For instance, 67 of the houses in the retrofit group received draught sealing, whilst 35 received LED lighting, and 7 received appliance upgrades.

Table 3: Intervention subtypes

Intervention type	Intervention Subtype	Description
Retrofit	Appliance upgrade	Replacement of existing appliance (e.g. plasma/CRT TV) with energy efficient equivalent appliance
Retrofit	Draught sealing	Sealing gaps in the thermal envelope of a home to minimise unwanted air and energy flow in and/or out
Retrofit	Heater/cooler maintenance	Servicing a heater/cooler so it operates as efficiently as possible
Retrofit	Heater/cooler upgrade	Replacing an existing heater/cooler with a more energy efficient heater/cooler
Retrofit	Hot water service insulation	Insulating the pressure relief valve and hot water outlet pipes of a hot water service with lagging/similar material
Retrofit	Hot water service maintenance	Servicing a hot water service so it operates as efficiently as possible
Retrofit	Hot water service upgrade	Replacing an existing hot water service with a more energy efficient hot water service
Retrofit	Insulation	Installing insulation to the thermal envelope of a home
Retrofit	LED lighting	Replacing existing low efficiency lights (e.g. halogen/incandescent) with LED lights
Retrofit	Window treatment	Installing materials (e.g. blinds, curtains, perforated foil, additional glazing) to existing windows to minimise energy flow through the window
Retrofit	Zoning	Installing an internal door in a home to minimise the size of the conditioned space
Behaviour change	EAP first visit	One to one meeting to discuss motivations and choice of energy actions
Behaviour change	EAP second visit	One to one meeting to discuss motivations and choice of energy actions
Behaviour change	EAP group session	Group meeting to discuss energy actions taken, challenges and share learnings
Behaviour change	IHD install Standard	Watts Clever EW4500 In Home Display
Behaviour change	IHD install Deluxe	EMS Ecofront energy monitor In Home Display

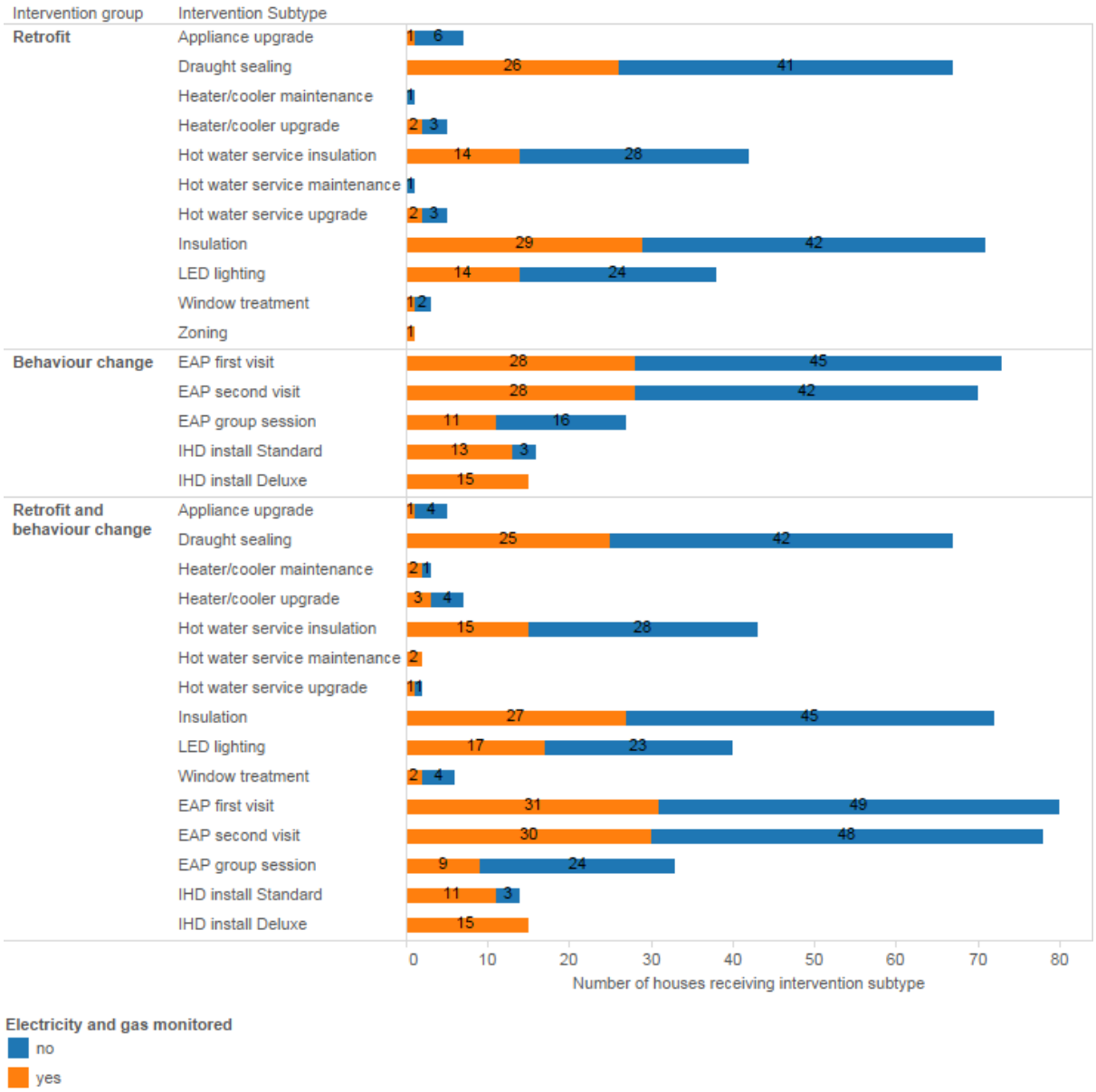


Figure 11: Intervention subtypes

2.14.2 Home Retrofits

Home retrofits were provided to 156 homes. The range of specific home retrofits and related products, brands and models were selected based on market research, product testing, reviews, staff experience and advice provided by SECCCA's Research and Training Officer and are listed in Table 4 below.

Table 4: Home retrofit works and related products

Home retrofits	Brand	Model	Description
Replacing incandescent light globes with LED globes	Mirabella	9w G70 Warm 2700k & Cool 4000k BC ES	General LED light globes
LED downlights replacing halogen downlights	Ledified	EVA	An efficient, remote controllable LED downlight with adjustable light colour and brightness made to replace MR16 downlights
	Primsal Brilliance	6w MR16 PM166WWHPF	A non-dimmable LED MR16 downlight that is compatible with approximately 90% of existing transformers
	Ledified	Gen 1 - 6W 360 (2700K)	An efficient, non-dimmable LED MR16 downlight supplied with a new driver
	Ledified	COB800	An efficient, dimmable downlight that can replace MR16 downlights
Increasing downlight safety	Tenmat	FF130 Flanged Loft Cone	Cone ensures that insulation and combustibles are kept away from the downlight when installed in ceiling spaces.
Draught sealing	Raven	RP3 RP78	Door flap Door perimeter seal
	ecoMaster	Range of products	Doors & window, ceiling fan and other seals
	Fullers	UltraClear	Water based gap sealant that is white when applied and clear when dry (not invisible)
	Advantec	DraftStoppa ®	Self-seal casing for ceiling exhaust fans
	Various, including EcoMaster	Invisible Pelmets	Acrylic clear plastic pelmets installed on top of window curtain tracks that manage airflow and heat transfer
	Various	Pelmets	Wooden or other box pelmets above window architraves that manage airflow and heat transfer
	Various	Internal	Internal doors to zone/reduce the area of the conditioned space
Insulating hot water service components	Valve Cosy	Valve Cosy™	Covers pressure relief valve and pipe unions to reduce heat loss
	Thermotec	E-Flex 13mm Wall	Hot water pipe lagging to reduce heat loss
	Fletchers	Armaflex Pipe Insulation	Hot water pipe lagging to reduce heat loss
Insulation	Knauf	Earthwool	R4, 195mm thick, bio soluble ceiling batts and R2 underfloor batts
	Fletchers	Pink Batts	R4, 195mm thick, bio soluble ceiling batts
	Enviroflex	R2.0 Cellulose Fibre insulation	Insulation that is blown into the desired space where access for batts is not feasible (i.e. skillion / flat roofs, cathedral ceilings)

Table 5: Home retrofit works and related products (continued)

Home retrofits	Brand	Model	Description
Hot water services	Quantum	Heat pumps (Domestic 150, 200, 270 litre units)	Efficient, quiet, electric
	Rinnai	B16, B20, B26	Efficient, external, gas, continuous flow
Heaters/cooler	Daikin	Various 2.5kW, 3.5kW, 6kW units	Efficient, split system air conditioners
	Braemar	Various including TH420 WF 25 & WF30	Gas ducted heaters Flued gas wall furnace
	Bonair	Pyrox 30 & 40 Mj	Flued gas space heater
	Various	Various	Ceiling or portable pedestal fans
Window furnishings	Various	various	Awnings Curtains Blinds
Wren Industries	Renshade	Framed, or affix to inside of windows using Velcro dots	Perforated aluminium foil to reduce heat transfer through windows/skylights whilst letting light in and retaining view
Electricity standby switch/energy savers	EcoSwitch	EcoSwitch	Easy to reach power switch
Replace existing plasma/ cathode ray TVs	Various	Various	LED TVs
Replace old fridges	Various	Various	Modern fridge with 3.5 or more stars

2.14.2.1 The Home Improvement/Retrofit selection process

Following householder recruitment, home audits and householder surveys were completed. SECCCA received the high level home audit reports and took these into consideration when deciding the works to be proposed to the relevant 60 homeowners. SECCCA looked at the gas and electricity bills for homes to see what the historical energy use profile was and checked, for example, if summer/winter energy use peaks occurred, a high baseline of energy use or frugal energy use for most of the year.

SECCCA proposed recommended retrofit works to homeowners, negotiated the agreed works and when the owner agreed they signed a *Home Improvement/Retrofit Works Agreement* and the works were scheduled and completed.

2.14.3 Behaviour Change/Energy Action Program

2.14.3.1 Background

Developing a behavioural change program and testing its impact and effectiveness to improve energy efficiency with low income householders was a key component of the project.

In SECCCA's 2012 application to the Low Income Energy Efficiency Program (LIEEP), the development of a behavioural change program was proposed with a general format and clear purpose: *A behavioural change program that is effective at assisting the low income households in this demographic improve their energy efficiency – including a range of technological, software and hardware solutions that facilitate behavioural change to improve energy efficiency.* (Application form, December 2012).

By mid-2013, the concept of the behavioural change program had evolved: *Householders will participate in a behavioural change program provided by Energy Saver Direct Care workers that will highlight 'lifestyle' ways of reducing energy consumption. (Evaluation plan, June 2013,* from Sharpley, 2016*).* The framework for the Energy Saver Study was also clearer and around half of the 320 participating householders were designated to take part in the behavioural change program (half of these would also receive retrofits).

During 2014 the behavioural change program began to really take shape. In February 2014 SECCCA staff attended Les Robinson's 2-day 'Enabling Change' workshop, and during that year the ESS staff brainstormed possible approaches, tools and activities that could be used. They also discussed its design with the Project Reference & Advisory Committee, the members of which were highly regarded experts in their field. Although there were different views about the nature of the program, a number of general principles emerged from these discussions. They included:

- Designing the delivery around the householder interests. The program to be framed around the individual. Understand the individual, what they value and their core motivations
- Focusing on outcomes rather than products
- Providing active social learning experiences, grab their attention, make it fun
- Having regular and ongoing contact with the householders, be it face-to-face, telephone or email
- Having a suite of approaches that can be adapted to householder diversity.

By the start of 2015, the behaviour change program had been developed, trialled internally by the ESS staff and documented (*Behavioural Change Program for ESS,* SECCCA 2015). It was badged as the 'Energy Action Program' (hereafter EAP) in order to:

- Focus householders on actions that will help them to improve their lives;
- Avoid the use of the word 'behaviour' when dealing with participants as it could be misinterpreted in a negative way (NB: Three words were used interchangeably in this report to describe householder activities – behaviours, actions and practices).

The Project Delivery Team developed the program after much consultation and discussion, and facilitated the training of the ELOs to deliver it. The ELOs presented the program to householders in the behavioural change study groups (B and C).

The ELOs varied in their previous experience of delivering community education programs. Some were highly experienced while others had little or no experience. This made it difficult to prepare a training program that would cater for their differing needs and is reflected in their mixed views and comments about the training and the resources made available to them.

2.14.3.2 EAP Aims

The aim of the Energy Action Program was to trial and test a package of interventions to see if they could produce permanent change in householder behaviour, resulting in more productive energy use in homes.

The EAP also aims to see if providing targeted energy action support to householders, or providing it to householders in addition to home retrofit works, is the most effective way to support householders to improve the efficiency of their energy use, reduce costs, improve comfort, health and wellbeing.

2.14.3.3 EAP Design

Behaviour change programs can have varied results. Changed behaviours can be temporary or permanent and can result in small or significant reductions in energy use. The EAP has been designed to attempt to deal with common failings of behaviour change programs, such as the target audience not being interested in the program's aims, short term/no behaviour change, small reductions in energy consumption and behaviours being short term and not owned by the program participant.

It was identified early in the design of the EAP that it was very important for the EAP to focus on what each householder values, their current and future priorities, use of time, desires and aspirations. It was decided that rather than make the EAP just about energy efficiency, it was a priority to identify how the EAP could best support householders so that they were more likely to adopt, own and continue to do actions that benefited them in their home i.e. to offer them support to do things that they chose as relatively important or that were linked to the householders priorities and values.

A tool/game titled *'the cake game'* was used at the first EAP visit to each home. The game was used to provide a fun and non-threatening context for ELOs to try to identify householder priorities and values and get to know them. Householders were asked before the visit what sort of cake they liked. The ELO took this type of cake to the house (or 'magic sand' in the shape of a cake if they didn't want cake) and asked the householder what they do each week and how much time they spend doing these things. 'Activity labels' were placed on the cake representing the householders' priorities/current activities and the cake

was cut into suitably sized pieces to represent the time spent on each activity as exemplified in Figure 12 below.

Figure 12: The cake game: indicated householders priorities and future priorities/desires

This indicated to ELOs how the householder spends their time and the proportion of their time they spend on each activity/priority. Householders were then asked how they would change things in an ideal world with no limits. Householders either added new activities, or placed a '+' or '-' symbol on existing activities. This gave ELOs an indication of what was important to the householder in the future. Householders' responses to the pre-intervention householder survey were also noted i.e. the actions they already did to use energy efficiently.

The ELO then focussed on suggesting one or two targeted, relevant, new energy efficiency actions to the householder from a 'Top15 actions list' or 'other actions list' that were developed by the project delivery team. Information and support was provided to householders which was related in some way to the householder's preferences where possible, rather than simply providing generic energy efficiency information to improve householder awareness. It was recognised early in the EAP design process that householders are more likely to own and adopt new actions and continue doing the adopted actions if the action may achieve some progress to their priorities/desired outcomes, rather than if they are just told what to do.

Behaviour change in this project's context can also be thought of as supporting householders to operate their home in a way that minimises costs and maximises its performance and comfort. Many people are not aware/shown how to operate a home efficiently. Consequently they do not always achieve the best performance that they could in their home efficiently.

Another important EAP design element is that the recommended actions were only offered by ELOs progressively to householders i.e. the householders were given the opportunity to succeed with 1-2 early efforts and gain confidence/receive positive feedback from ELOs, so that more actions can be added through the EAP, but only when householders were ready.

2.14.3.4 Theory of change

The EAP involved incremental change. The program needed to deliver the following elements to achieve lasting impact and significant energy savings:

- Shift in thinking – motivates the householder by trying to establish a link between personal motivations and energy efficiency in the home
- Personalisation - identifies actions that may achieve improved energy efficiency and progress towards each householders' priorities, values, desires etc

- Support - schedule of up to three visits to support the householder to progressively adopt actions, record progress and sustain the change
- Introduction of measurement of behaviour – create a *Fridge Action Magnet* log sheet, plus encourage the monitoring of energy bills
- Provision of information – provide factsheets, energy videos and targeted presentation of the list of energy saving actions to householders
- Improvements to technology and equipment – offer a thermometer, In-home Display (IHD), control devices for appliances, pedestal fans, easy to access power switches
- Operational adjustments to the way people use their home – provide information to inform householders of opportunities so they can change what they do in their home to improve energy efficiency/save money/improve comfort etc
- Peer to peer information – facilitate group workshops for householders at which they can share their experiences and learning with other householders. This was to help householders adopt new actions and sustain behavioural changes.

2.14.3.5 Summary of Energy Action Program

The **Energy Action Program** has a three step delivery process:

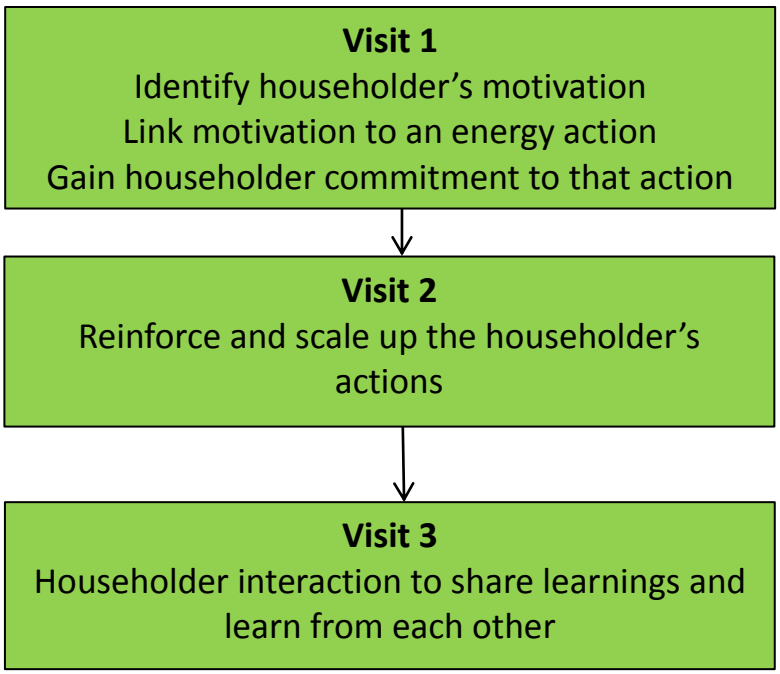


Figure 13: The Energy Action Plan process

Detail of the tasks that Energy Liaison Officers implemented for the EAP are listed in Appendix 8.

Scripts for Visits 1, 2 and 3 are in Appendices 9, 10 and 11. They provide a detailed list of how the project planned to provide each visit to EAP householders.

Other EAP tools were the *Top 15 Action Cards, Other 30 action cards,* and a *Fridge Action Magnet.* These are available in Appendices 12, 13 and 14. The 8 Energy Efficiency information sheets are available by going to www.seccca.org.au

2.14.3.6 In Home Displays

In Home Displays (IHDs) are an electronic device that shows current and historical information about the energy use in the home i.e. when energy was used and how much. IHDs come in a range of shapes, sizes and levels of functionality. The aim was to determine the effectiveness of 30 custom android tablet (deluxe IHD) against 30 'Watt's Clever' off the shelf devices (standard IHD) and in turn, compare the homes with IHDs with houses in the study group who were not issued with IHDs. This was to compare of costs and benefits of the two different IHDs.

The deluxe IHDs were linked to homes that had onsite energy monitoring undertaken using EcoFront energy monitoring equipment. They have specifically designed energy-use monitoring software that is linked to the EcoFront equipment. The deluxe IHDs show the following information for energy use:

- current energy use for gas, electricity and the total energy use

- how much energy has been used today, this month and year
- electricity use by circuit (up to 8 circuits i.e. total energy, hot water service, lights, heater/cooler, others)
- how much extra energy is used when a device is turned on/up.

The deluxe IHDs also provide energy saving tips to help improve the energy efficiency of homes, reduce energy costs and they provide information about the project.

A collaborative research and design process was undertaken for the deluxe IHDs which considered cost, the poor eyesight of some people (particularly the elderly participants) and device readability, useability for physically impaired users, access to the device, its size and operating energy use and cost.

A 10" touch screen android tablet was selected, plus a rigid, plastic, purpose-designed and manufactured tablet stand. The energy monitoring software was loaded to each tablet with a home screen display such as Figure 14. Householders were provided with a *deluxe IHD user manual* and ELOs tried to show each householder how to use the IHD.

Figure 14: Deluxe IHD home page

Source: Energy Monitoring Solutions

The 30 standard IHDs (see Figure 15) were supplied and installed to 30 other EAP homes and householders were shown how to use them and supplied with a manual.

Figure 15: Watts Clever Wireless Energy Monitor – Smart Meter: EW 4500 (standard IHD)

Source: Watts Clever

2.15 Energy use analysis

Several different measures were used to assess the impact of the interventions on households. These measures fall broadly into four main categories: savings in energy consumption, savings in energy bills, savings in greenhouse gas emissions, and increased comfort in households.

House daily energy consumption values were used to calculate for each house an average daily value for each month pre-intervention and an average daily value for each month post-intervention. The average daily value post-intervention was compared against the average daily value pre-intervention for equivalent months. The difference between these two gives the change in consumption for a house for a month. For control houses, daily averages were calculated for months in 2014 and compared against equivalent months in 2015.

Bill savings were calculated by applying a $/kWh and $/MJ rate to daily electricity and gas savings respectively (Table 6).

Table 6: Constants used in calculations. Greenhouse gas emission data obtained from National Greenhouse Accounts 2015 (Department of the Environment).

Constant name	Constant value
Cost of electricity	29 cents per kWh
Cost of gas	1.8 cents per MJ
Electricity greenhouse gas emissions	1.26 kg CO2-equivalent per kWh
Gas greenhouse gas emissions	0.0039 kg CO2-equivalent per MJ

Greenhouse gas emissions savings were calculated by applying a kgCO2-e/kWh and kgCO2-e/MJ rate to electricity and gas savings (Table 6).

Changes in household comfort levels were calculated using monitored thirty minutely indoor temperatures.

The energy data was analysed using a combination of the following tools: R for statistical analysis; Tableau for visualisation of the data; PostgreSQL for aggregation of data; Microsoft Access for aggregation and manipulation of data.

For each dwelling, the electricity and gas usage data was first aggregated (or in the case of distributor billing data, disaggregated) to a daily total, and then to an average daily total for each month so that the comparison pre- and post- intervention could be based on similar weather conditions.

To calculate total energy use, gas use was converted from MJ to kWh (using 1 MJ = 0.278 kWh), and then added to electricity use (in kWh).

For each study group for each month, the changes in electricity, gas, and total energy daily averages for the dwellings in the group were averaged (mean). Each study group's mean was compared against the control group mean using a t-test. Statistical significance and 95% confidence intervals were calculated.

The differences between the study group energy means were tested for statistical significance (at the 0.95 level) using t-tests. Each intervention group was compared against the control group. Intervention groups which showed statistically significant differences in their means to the control group are noted in the *Intervention Impacts* section with an asterisk.

2.16 Additional research

2.16.1 RMIT Health Study

The Health Study, a PhD research project by Nicola Willand, supplemented the Energy Saver Study (ESS). In the context of housing as a determinant of health, the study of the social impacts of residential energy efficiency is gaining interest. Previous research has indicated that residential energy efficiency improvement programs may mitigate greenhouse gas emissions and lead to benefits in terms of physiological, psychological and social health. While improved winter warmth, affordability of fuel and householder satisfaction have been suggested as likely mediating factors, causality remains unclear due to the complex interplay between the technical quality of the building, householder situation and practices, and the delivery of the interventions. Evidence for the Australian context is poor, summer conditions have scarcely been investigated and the householder lived experience of interventions is under-researched.

Using a systems based framework, the purpose of this Health Study was gain to a better understanding of how householder practices and experiences contributed to the impacts of the ESS on the mediating factors along the pathway from improved energy efficiency of the building to health outcomes and on final health outcomes. The objective of the study was to identify and describe householder practices that seemed to explain outcomes in indoor temperatures, energy use, energy costs and householder health.

2.16.1.1 Method

In this mixed-methods quasi-randomised controlled trial, an experimental set-up was combined with an inquiry into the householder experience to inform future energy conservation programs and Ageing in Place policy. The study accompanied 13 control (Group D 'control') and 16 intervention (Group A 'retrofit only') households over the course of one year from September 2014 to September 2015.

The study captured objective indicators, such as indoor temperatures and energy consumption as well as subjective indicators such as comfort, satisfaction with the home, difficulty of paying bills and self-rated health. In addition, four waves of householder interviews sought to provide a better understanding of householder practices. A social practice approach was adopted to provide an understanding of how the material entity of the dwelling, householder capabilities and the meaning of householder routines and preferences shaped changes in the vulnerability, resilience and health outcomes of householders.

The holistic nature of this study required multiple layers of data analysis, synthesis and interpretation. Analysis of quantitative and qualitative data was performed for each wave of data collection. Standardisation of the indoor temperatures, energy consumption and vapour pressure excess against daily mean ambient temperatures were performed to control for the variability in weather conditions and data sets between the baseline and follow-up years. Qualitative data assisted in identifying householder practices, their nature, meaning and developments. Pre- to post-intervention changes in the quantitative indices were calculated, and explanations for the results were sought through the verification of quantitative and qualitative results and inference. Due to data limitations, outcomes for summer conditions were not explored.

2.16.2 Swinburne University investigation of Social Influence

Social influence on participating householders' residential energy practices is being researched by Swinburne University Masters student Lucy Allinson (who was also the Team Leader in this project). The Masters research aims to explore the range of influences impacting the householder's decision to change an action and to sustain a practice.

These influences are framed around Social Practice Theory and categorized into 3 domains:

- Infrastructure and material influence
- Competency, skill, attitudes and beliefs
- Social influence

Particular emphasis will be placed on social influence and the specific influence patterns for successful and failed change in household energy based practices.

The researcher is completing this as a longitudinal, mixed methods study which is still in progress. Stage 1 interviews on social influence patterns on new and failed actions have been completed. The question that was asked of each householder is: "Who would you go to for advice on energy use in your home?" Each householder was then asked to plot their advisors by degree of importance.

Stage 2 interviews on social influence patterns on sustained practices and evaluation of stories of “Most Significance” were completed in April 2016.

The methodology uses data from the Energy Saver Study, with themed interviews and a technique called Most Significant Change.

The Most Significant Change technique is used in complex scenarios to find out what influences are evident in areas of successful change.

The Most Significant Change technique involves collecting participant stories of ‘significant change’ and these stories are then evaluated by participants groups under key influence domains and overall.