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When energy efficiency is a healthy pursuit

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Abstract

Getting the most bang for your energy buck can be a matter of real importance, particularly when there aren't too many bucks. The South East Councils Climate Change Alliance set out to discover effective ways to implement energy efficiency in low-income households in the south-eastern suburbs of Melbourne. The study recruited and supported 320 householders from 6 local councils who were receiving Home and Community Care services. Households were audited and energy use data collected to record energy use. The majority of the homes were old and owner occupied. They were inefficiently designed or built, or poorly maintained.

Providing retrofits plus behaviour change support achieved a 10% improvement in energy efficiency and improved indoor temperatures by 1.6^{o}C. Retrofitting improved energy efficiency by 7% and winter indoor temperatures by 1.9^{o}C. Providing behaviour change support alone did not produce significant results.

Low income householders face barriers to improving energy efficiency including poor physical and/or mental health. They may have acute health conditions, limited knowledge of energy efficiency, limited English and often need approval from landlords to undertake work on the home.

Protecting health, saving money and mitigating climate risk is what you get when you improve energy efficiency in low income households.

Keywords: energy efficiency; residential; comfort; low income; health

1. Introduction

In Australia's increasingly variable climate, our reliance on energy for comfort, health and well-being is pretty near complete. If you can't afford to modify your domestic environment, what can you do? Can you flee to an air conditioned shopping mall to escape a blistering run of forty degree days or does a cold snap leave you huddling in the one room in your house that you can afford to heat?

Getting the most bang for your energy buck can be a matter of real importance, particularly when there aren't too many bucks. The South East Councils Climate Change Alliance (SECCCA) set out to discover effective ways to implement energy efficiency in low-income households in the south-eastern suburbs of Melbourne.

The majority of the participating homes were old and owner occupied. They were inefficiently designed or built (in terms of energy) or poorly maintained. These low income householders with generally less than $450 per week face barriers to improving energy efficiency including little access to money and poor physical and/or mental health. 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.

2. Methods

2.1. Location

The study occurred in 6 of the local councils to the south east of Melbourne's central business district i.e. Bayside, Casey, Mornington Peninsula, Cardinia, Baw Baw and Bass Coast (Figure 1).

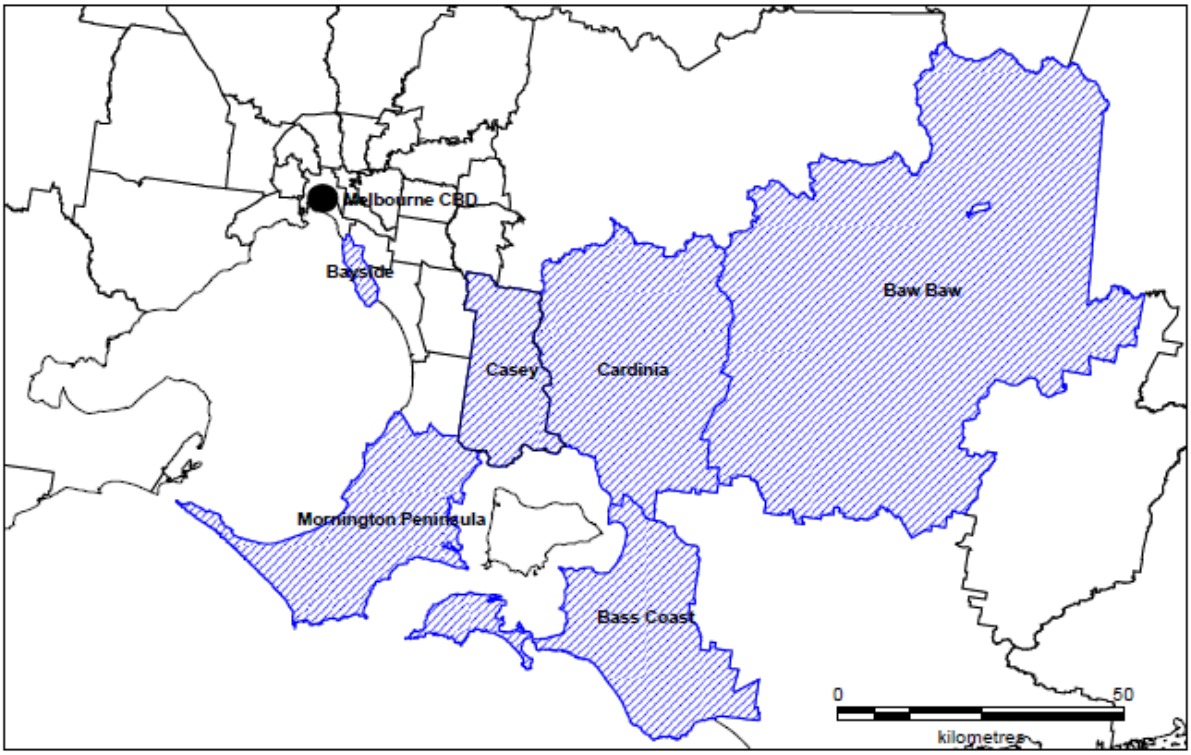

Figure 1: Participating local council areas

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.

2.2. Householder recruitment

The study employed and trained 6 Energy Liaison Officers (ELOs) from late 2013 – March 2016 to recruit and support 320 eligible householders that received Home and Community Care (HACC) services. Households were quasi-randomly recruited from HACC client lists to take part in the Energy Saver Study (the study) i.e. possible householders were firstly identified as suitable based on their physical and mental health and the likelihood of them participating in the entire study (2013-16). Participants were then randomly recruited from each local government's list of possible HACC clients and allocated to one of the following 4 study groups:

- Group A: receive home improvements/retrofits (80)
- Group B: receive behavior change information and support (80)
- Group C: receive home improvements plus behavior change information and support (80)
- Group D: no support during the research period i.e. this was a scientific control group (80)

2.3. Data monitoring and storage

Energy monitoring devices were fitted into 120 of the participating households (30 from each study group) so the study could establish normal patterns of energy use before any interventions started, with the data collectedby CSIRO for recording and analysis. The energy use data from all homes was also provided to the study by energy distributors. The monitoring devices and energy distributors recorded energy use prior to and following the study's interventions.

Internal temperature recording and logging equipment were installed in living rooms and bedrooms. Temperature data was also downloaded to CSIRO's database for analysis and reporting.

Draught testing of homes was done using a technique known as 'blower door testing'. This indicated the level of air leaks and 'draughtiness' of the home. It compared draughtiness before and after draught sealing was done and this data was provided to CSIRO.

2.4. Interventions

Households were audited with over 100 points of data recorded at 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.

Energy-smart retrofitting and/or behaviour change information and support were provided to 240 of the participating homes. The remaining 80 homes received no support during the intervention monitoring phase of the study. Altogether 1,043 individual interventions were made during the monitoring phase: 622 retrofit interventions, and 421 behaviour change interventions. The interventions were carried out between 5/12/2014 and 9/11/2015.

2.4.1. Retrofits

The project provided 160 householders with at least $2500 each of home retrofits. This was to test the effectiveness of the retrofits to improve energy efficiency. The home retrofits 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. Home retrofits included replacing inefficient light globes with LED globes, draught sealing, topping-up insulation in the ceiling or under floors, replacement of old appliances with more efficient models (heaters, coolers, hot water services, TVs or fridges) and providing window furnishings.

2.4.2. Behaviour change

The project developed a robust framework, tools and training. This included a guide to the ELO training (*House In Order*)[2] focussing on the delivery of the home retrofit and support services to clients.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 design of the behavior change program received advice from an expert reference panel [3] which included:

- Designing the delivery around the householders' interests. The program was 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 other
- Having a suite of approaches that can be adapted to householder diversity.

The behavior change program included an ELO meeting 2-3 times with each household. The first visit was to identify the householder's values/priorities/interests, to learn what the householder would like to improve in their life and to support them with opportunities and guidance. The second visit was to monitor progress and

continue to support householders. The third meeting was a group session to hear what the householders had learnt and done and the barriers that householders had identified to progress.

3. Results

3.1. Householders

The low income householders in the study were predominantly older people with 83% being at least 70 years old and 78% of participants being female. The majority of households in this study (55%) were single person households with 39% being a two person household. The majority of participants were retired or not working full time with 84% of houses occupied all day [4].

3.2. House characteristics

Almost 80% of the houses in the study were separate houses, with 14% being semi-detached townhouses and the remaining 6% were flats or apartments. Many of the houses (41%) had a concrete slab on the ground. Half the houses had raised timber floors. The dominant external wall type was brick veneer (71%)[4]. Window frames were mostly aluminium (60%), whilst 39% of houses had timber window frames.

Most homes had a tiled roof (67%). The remaining roofs were nearly all metal clad (31%). Almost half the houses inspected had some form of ceiling batt insulation, while 31% had some form of loose fill insulation. Only 7% of ceiling insulation inspected was considered to be in good condition (majority of coverage consistent - only minimal gaps), while 67% was deemed to be in average condition (majority coverage consistent - some gaps to ceiling perimeter, around downlights, under heater platforms & tight corners). 26% was in poor condition (inconsistent insulation coverage - lots of gaps or large gaps, thin, degraded or ripped)[4].

3.3. Energy efficiency and indoor air temperatures

The study found that by providing retrofits plus behaviour change information and support to low income householders we achieved an improvement of 10% in their energy efficiency and improved indoor temperatures by 1.6^{o}C. Just retrofitting homes delivered an energy efficiency improvement of 7% and improved winter indoor temperatures by 1.9 ^{o}C, while behaviour change delivered no benefits of statistical significance during the study[4].

3.4. Draughtiness and draught sealing

Many but not all low income homes were very draughty (air changes/hour [ACH] of 10+ $m^3/hr/m^3$@ 50pa)[1]. The study found that draughtiness can be significantly reduced for between $50 - $2500/home. Homes that were draught sealed had a pre-intervention average ACH of 22.6 $m^3/hr/m^3$. Following draught sealing they were retested for draughtiness and had an average ACH of 16.2 $m^3/hr/m^3$, an improvement of 28%.

Many of the clients that received retrofits reported to the project that their comfort increased as a result of retrofits (84% of retrofits included draught sealing). These retrofits generally also included ceiling insulation (89%) but many clients commented specifically about the improvement due to draught sealing as illustrated above. It is possible draught sealing received high praise from householders because it was visible to them and they can directly feel draughts.

3.5 Council feedback

The study was successful in the councils' overall view [3]. They indicated that both council and the householders benefited from the project and had increased knowledge and capacity as a result of participating in the project.

4. Discussion

Council HACC teams provide a highly effective context to identify, recruit, retain and support low income householders to improve their energy efficiency. The HACC teams did indicate that they have limited capacity to add energy efficiency support to their existing HACC services, even though energy efficiency services fit very well with the aims of HACC i.e. supporting vulnerable persons to age in place, maintain independence, safety, health, comfort and wellbeing. It also became clear that some HACC staff's willingness and/or capacity to provide different (energy efficiency) services is limited/non-existent.

The study identified that some of these 'low income' HACC clients have the financial capacity to improve elements of their home and make it more energy efficient, comfortable and healthier. Low income householders can be asset rich and may have ready access to cash, but due to the fact they have a low declarable annual income, they are eligible to receive HACC services.

Some participating 'low income' householders were very forthcoming to spend their own money ($1000-5000) on energy efficiency upgrades (ranging from new heaters, blinds, ceiling fans to fridges, TVs and hot water services). This was when they had a greater awareness of residential energy efficiency and how they can reduce their energy costs (with additional awareness provided to them by the study). This was unexpected and happened late in the study. In late 2015 SECCCA discovered many clients had arranged and completed many energy efficiency improvements in their homes during the project at their own cost, based on their increased awareness of energy efficiency (assumed as a result of the project).

A recommendation from the project is that, for a project like this in the future, as part of the assessment of each client's eligibility to receive support services, both the client's income and the value of their assets and investments are taken into account to determine eligibility. This will be critical to ensure that the most vulnerable and those with the lowest incomes and capacity to improve their wellbeing are supported by future programs as a first priority. Those with available funds may just need energy efficiency advice and direction from an existing trusted (not for profit) organisation to trigger them to take actions to improve their energy efficiency.

Most low income people that participated in the study were already implementing many behaviours or actions that improve their energy efficiency. Details of these actions can be found in the training manual House in Order.

The study has identified that targeted energy efficiency retrofits combined with behaviour change measures can deliver significant energy (between 10-11%) and cost savings ($113/year) in low income Victorian homes.

The results suggest that society could change the way it views energy efficiency and household comfort. It is more serious than comfort. Participants are more likely to turn on their heaters and air-conditioners when they're not scared of the resultant bill. They report less illness in their warm, dry and less draughty houses. They keep their cool in summer and they invite in their family, friends and neighbours. Staying healthy and improving social connectedness which assists ageing in place were perhaps surprising consequences of the energy efficiency study.

The home improvements that were rated highest by recipients were shade, new heaters and coolers, insulation and draught sealing. This order is in contrast to the home auditor's Nationwide House Energy Rating Scheme (NatHERS) retrofit recommendations, which recommended generally improvements to lighting, draught sealing, insulation, then heating appliances and hot water services in approximately that order (depending on the case in question), based on achieving the shortest payback period. Shade/window furnishings were not recommended at all by home auditors as it is not recognised by the NatHERS software as effective to improve energy efficiency.

Replacement of existing halogen and incandescent lighting with LEDs was an effective way to reduce electricity consumption for lighting. LEDs also made significant savings in the associated electricity bills and greenhouse gas emissions. Many clients commented favourably about the improved performance of the LED lights compared to existing incandescent and halogen lights. LEDs were welcomed especially by clients with poor eyesight.

The draught sealing could either be completed relatively cheaply by people that buy the materials themselves and install them too. Alternatively, well trained/experienced carpenters, handypersons or insulation installers can complete some draught sealing at a cost to householders/investors. The main draughts that are a priority to seal are external doors, exhaust fans, wall vents, chimneys, holes in walls/floors, gaps between building materials, internal doors between conditioned and unconditioned rooms, windows and above windows by installing pelmets.

It is recommended that homes with poor and average condition and/or insufficient ceiling insulation (less than R3.5/4) are actively supported to top up their ceiling insulation. Topping up the missing or existing sub-standard insulation (especially in ceilings where it is critical, plus under suspended floors) can be done for approximately $10-20 per square metre. This is very likely to improve the comfort, health and affordability of low income homes.

Many of the large homes could be internally zoned to reduce the size of the heated/cooled living areas i.e. install additional doors/partitions between areas. The need/opportunity for zoning was identified and confirmed in the study and was done successfully in up to 5 homes. Zoning modifications are sometimes not practical/affordable due to the old age or design of the home.

Of particular note, the success of internal zoning generally depends on occupants actively managing internal doors/other structures to zone the conditioned spaces. For some low income earners, especially those with mental and/or physical health issues, it may be more effective support to relocate/rehouse them into appropriately sized homes than to introduce internal zoning to the existing home. For people with good health, physical and mental capacity, installing zoning doors is an effective way to reduce the area of conditioned spaces, energy use and cost.

Heating systems in the study's homes were predominantly gas but there are increasingly electric heaters/coolers (split systems) being installed in homes as gas prices rise and split systems become very efficient.

Many people tend to use an air conditioner before they turn on a fan, or they don't own a fan. Fans can operate for only 2 cents/hour and are good to use before and with an air conditioner. The project provided pedestal fans to householders to assist them keep cooler for little cost and they were well received.

Installation issues, operation of and type of hot water systems (HSW) have been the main HWS issues that require future attention, noting that hot water is typically 25% of home energy use. Many HWS are installed without much/any insulation on the pressure relief valve and pipe coming from it, or the hot water outlet pipe. Both can and should be insulated with products that are available in the retail market. Many homes had inefficient electric storage HWS. The type of HWS to replace existing HWS with is critical to improving residential energy efficiency. Ensuring replacement HWS are either suitably sized, high efficiency: i) heat pumps ii) continuous gas units or iii) solar units is a reliable way to improve energy efficiency in homes and reduce energy costs.

A lot of homes had more than one fridge, with those other than the main kitchen fridge often left on all year for social events that are few in number i.e. summer barbeques, birthdays etc. There is a large opportunity to improve energy efficiency by encouraging householders to turn unused/infrequently used fridges off most of the time and just turn on the extra fridges when they are required.

There were old inefficient TVs in 9% of homes which could be replaced with LED TVs to reduce running costs and energy use.

Households which underwent behaviour change only interventions did not show a noticeable improvement in any of the energy efficiency quantitative measures. In contrast, self reported feedback from householders about the targeted behaviour change support they received was very positive and the self-reported number of actions taken to save energy increased during the project.

From both the ELOs' and householders' perspectives, the behaviour change program was effective at increasing the number of actions householders took during the project to improve the energy efficiency at their homes. Participating householders indicated a high degree of satisfaction with their involvement in the behaviour

change program i.e. it's likely to be politically advantageous for government to provide this support to low income householders. Most (over 70 percent) indicated it improved their understanding of saving energy and that it was useful in helping them reduce their energy consumption.

One of the new actions which householders undertook to reduce their energy costs was to investigate their gas and electricity supply contracts, their bills and seek a better deal from the retailers. Prior to the project many clients were not comfortable or aware that they could call their energy retailer and say "would you please look at my energy use over the past year and tell me if you can offer me a better deal" or, use an online portal/website e.g. *SwitchOn*, *Victorian Energy Compare* to find out if a better deal existed, based on their situation. When householders were made aware and/or supported to investigate their energy supply contracts and other deals that were available, some were very happy to get better energy deals including energy cost savings. Other clients with physical or mental health issues will need one-on-one support to implement this action.

5. Conclusion

This study has tested and evaluated a range of trial approaches to assist low income households to implement sustainable energy efficiency practices. It has recruited 320 low income householders through local government community care services and assisted these households using different combinations of home retrofits, behaviour change and combinations of both to become more energy efficient. The project has captured and analysed pre- and post-intervention data and information. It has determined statistically significant findings regarding energy efficiency, householder-reported feedback and other valuable outcomes. These findings and evidence can be used to inform future energy efficiency policy and programs.

The project has identified and reported how low-income households have benefited from the range of support services it provided. The project has demonstrated findings of improved indoor temperatures and comfort in winter, optimum ways to improve the draught sealing of homes, as well as some interventions leading to more efficient energy consumption, reduced energy bills and greenhouse gas emissions. The project has contributed to greater knowledge and capacity in the energy efficiency industry including client engagement, services, technology and equipment.

Benefits from the project have included:

- assisting low-income households to implement sustainable energy efficiency practices
- helping households to manage the impacts of increasing energy prices
- improving the energy efficiency of low-income households
- supporting people to:
    - age in place
    - maintain/improve safety in the home (safer indoor temperatures during heatwaves and cold weather)
    - maintain/improve comfort in the home
    - reduce cold-related pain/inflammation/stiffness
    - receive more visits from family/friends etc after the home and living conditions are improved and may minimise social isolation
    - develop pride in their home
- increasing the knowledge, experience and capacity of consortium members to facilitate long-term energy efficiency among their customers or clients e.g. working and sharing information collaboratively with other consortium members to develop a wealth of new knowledge, capacity and experience
- increasing the capacity of Australia's energy efficiency technology and equipment companies by providing opportunities for them to participate in the project e.g. calling for, assessing and awarding competitive works contracts for energy efficiency goods and services.

This success of the project from the householders' point of view in all three intervention groups was demonstrated by their strong endorsement of the Energy Saver Study in the post-intervention householder survey. Over 95 percent of householders would recommend a similar program to others. When asked why they would recommend it, the major reasons given were that the project helped lower energy bills, they enjoyed the visits by project staff to their home, it helps to keep people in their own homes, they trust the home care service and it was awareness raising and educational.

Protecting health, saving money and mitigating climate risk is what you get when you improve energy efficiency.

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