3 Results

3.1 Council Delivery Frameworks

Although the project was instigated by the environment teams, the project's delivery was based within the HACC area. Each council hired an ELO (for the LIEEP project only) into their HACC teams and supported them to recruit, retain and support householders to participate in the project. HACC teams provided ELOs with in-kind supervision, induction, training and support where required throughout the project.

In all of the councils the project improved the relationships between the Environment and HACC teams, their awareness of what each other do and how they do it. Participation in the project improved councils' capacities to deliver energy efficiency services in the future i.e. some of the council staff now have a better knowledge of the role that energy efficiency plays in low income householders lives, the barriers to energy efficiency, the opportunities to improve energy efficiency, and how and who can deliver goods and services to deliver this support.

Three somewhat different models were used to establish and deliver the project across the six councils.

Five councils appointed an ELO and placed them within the councils' HACC team. In the first stage of the project (recruitment of the householders) the ELOs were provided with the HACC database of clients from which they were to randomly select the project participants. There was some variation in the ELOs access to the householder databases and to the level of support given to them by the HACC team to use it. All ELOs were able to identify eligible clients and recruit householders to the project. Recruitment of participants was effective because ELOs were either able to i) be introduced to existing HACC clients by an existing HACC direct care worker and 'trust' was handed to them, or ii) ELOs approached clients as a HACC staff member and inherited/built rapport with clients in good faith as a HACC team member, possible due to the value many clients have for HACC services and staff.

A second model was that one council had outsourced their HACC services. Cardinia is one of only two councils in Victoria that don't have a HACC team. The not-for-profit organisation 'mecwac*are*' is a service provider in its own right. They work for council and hold the clients' personal data. To establish this project there needed to be agreement between the council and mecwac*are*. As a result an ELO was employed by SECCCA but reported to staff at the council and at mecwac*are*. It took some time to establish the project at mecwac*are* because of this government-private partnership. Privacy rules were all important. The difficulty was that the data was held by mecwac*are* and it was to be provided to a non-council outsider (the ELO). To use the database, the ELO relied on two mecwac*are* administration staff to do the search to find suitable clients. Following client identification and recruitment, the project was successfully delivered through this public-private partnership.

The third model was that Mornington Peninsula Shire Council (MPSC) was willing for their HACC Home Maintenance team to provide home retrofits to participating householders and be reimbursed for the labour cost, with SECCCA pre-purchasing the majority of materials. Mornington Peninsula council already offered draught sealing services to its clients prior to the project. SECCCA determined the retrofits that were offered to each LIEEP household and passed lists of works to the MPSC ELO. The ELO gave work requests (that included light globe changing, draught sealing and hot water service insulation) to the Home Maintenance team and they completed the works. This was a very cheap way to deliver a limited range of home retrofits. Other retrofit tasks that MPSC was not trained/certified/willing to do such as installing insulation, draught sealing exhaust fans, electrical and plumbing works and window furnishings was outsourced by SECCCA to private contractors.

It has not been a priority for HACC assessment officers, team leaders, carers or Home Maintenance staff previously, but the HACC staff members are now somewhat more informed about draught sealing goods and services and their benefits to clients. MPSC may continue to offer and deliver this service. It may also enhance awareness amongst its staff and clients of this service and council may consider adding other energy efficiency support services to the range of available home maintenance services following this project e.g. window furnishings and insulating hot water services (pressure relief valves and hot water outlet pipes).

"We had a (home) maintenance team consisting of a leader and 3 officers. In the past they did draught sealing. They attended some (draught sealing) training and it helped them see the big picture and where they fitted in. It was good for them. It validated what they were doing and introduced them to new products. They did lighting upgrades to LEDs, draught sealing and insulating hot water systems (lagging and valve cosy). They were challenged but adjusted to it." They believed the quality of the maintenance team work was better than that provided by external contractors, but they still need to embed it into their existing range of work so it won't add to costs significantly.

Casey council HACC team identified an opportunity to further investigate and trial the provision of energy efficiency support services by HACC to its clients as a result of this project. Casey put a proposal to the Department of Health & Human Services in the 3rd quarter of 2015 (last year of the project) and was successful in receiving funding for a 6 month full time HACC project officer role to investigate and trial community energy efficiency support opportunities and provide a report to council by June 2016. The successful applicant commenced this role in late 2015 and is working in consultation with SECCCA to deliver the additional project.

3.1.1 Feedback from councils

The study was instigated by the environment team in each council but was based within the HACC area. In all of the councils there were sometimes tenuous links between the environment and HACC teams. In the initial stages of the project some of the HACC staff were suspicious and needed to be assured of the value of the study. *'It was difficult early on. The HACC team was told it was happening.'* Despite these initial concerns, everyone who attended six council focus groups agreed that it was worthwhile participating in the study, and, importantly, their involvement was key to the success of the study.

A range of other feedback was received from councils including:

- It was worthwhile participating in the study
- Helps council activate its plan. It was a strategic initiative.

- The learnings are going to be critical. It will provide evidence to our climate change committee.
- The study helped to improve the credibility of the council among the householders who received the retrofitting and behavioural change activities
- Council involvement was important to the success of the study: 'The barriers would have been huge if it wasn't for the council.' 'Council involvement was vital.'
- The involvement of the council greatly strengthened the legitimacy of the study
- The partnerships between HACC and environment teams improved communication and established links within the council
- It demonstrated ways that the (HACC) maintenance team could be involved in energy conservation (health and wellbeing)
- The study raised awareness and provided information and ideas to both council staff and clients
- As a pilot it was pretty well done. The roll out beyond the project should be far smoother.

Despite its many challenges the study was, overall, successful in the councils' overall view. 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.

3.1.2 Challenges noted by council staff

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. The most important challenges that needed to be overcome involved the complex nature of the study, the tight and changing timeframe and the workload of the ELOs who were all employed part-time. There was a general recognition, however, that despite these challenges the study was successful.

Specific challenges included:

- Involving householders in the project: ELOs needed to develop trust and overcome householder resistance to participate
- The initial home energy audit results were not always accurate and didn't always help the retrofitting process
- ELOs were on a steep learning curve and their employment contracts changed over time
- The project's time schedule was unrealistic/changed/could be revised/improved
- It was a challenge dealing with contractors and tradesmen, especially in vulnerable peoples' homes. Their work was often invasive of people's homes and lives

3.2 Pre-intervention data

3.2.1 Householders

The number of people living in a house impacts the amount of energy a house consumes. Likewise, the occupancy pattern of the household also influences energy consumption.

The majority of households in this study were single person households (55%), with a further 39% being a two person household as per Figure 16. Only 6% of households had more than two people and only 2.5% were classified as a family with children.

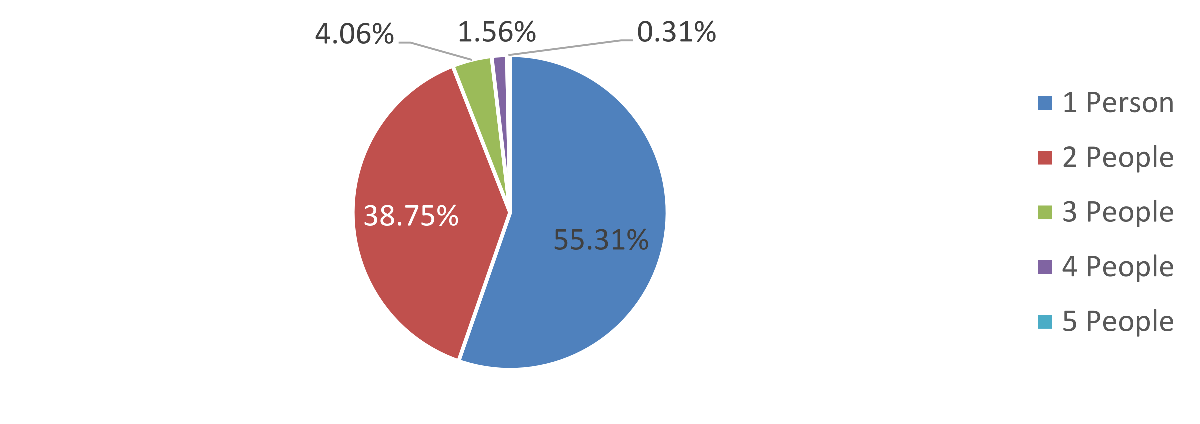

Figure 16: Number of people in a household

The age profile of the participants reveals that the households are predominantly older people with 83% being at least 70 years old (see Figure 17). This is also reflected in the household type where 50% of participants classified themselves as retirees while a further 42% classified themselves as a single or couple and it can be assumed that many in these groups were also retirees (see Figure 18). In addition, 78% of participants were female.

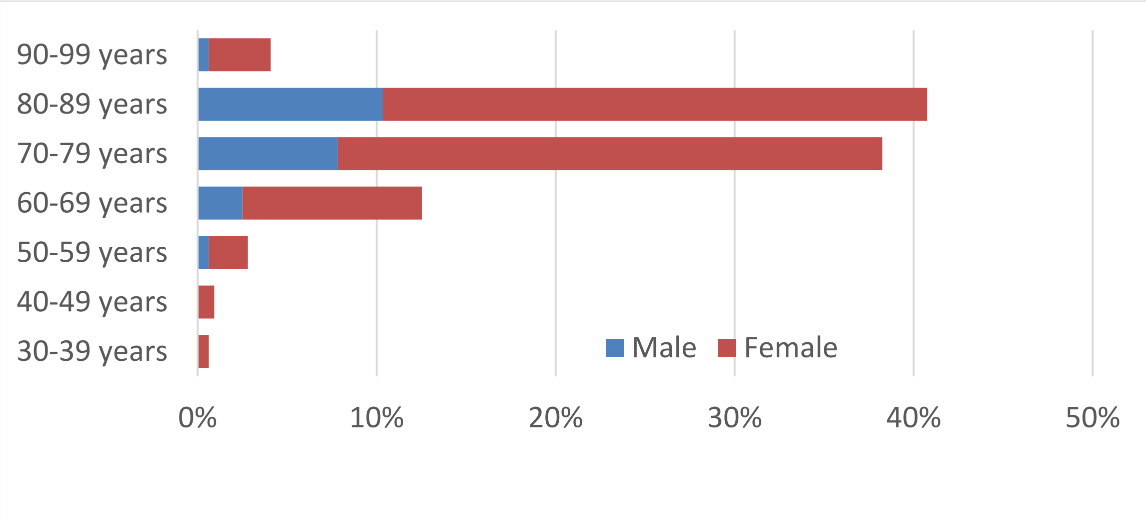

Figure 17: Age and gender of household participants

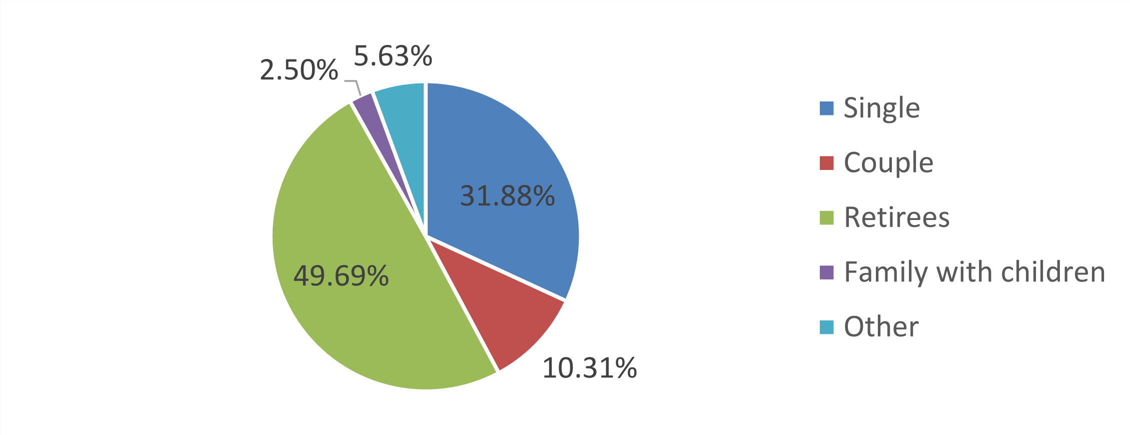

Figure 18: Household type

The occupancy profile of the households also shows that the majority of participants are retired or not working full time (see Figure 19). 84% of houses are occupied all day while only 1.6% are empty during the day. Around 12% of houses are occupied for half the day.

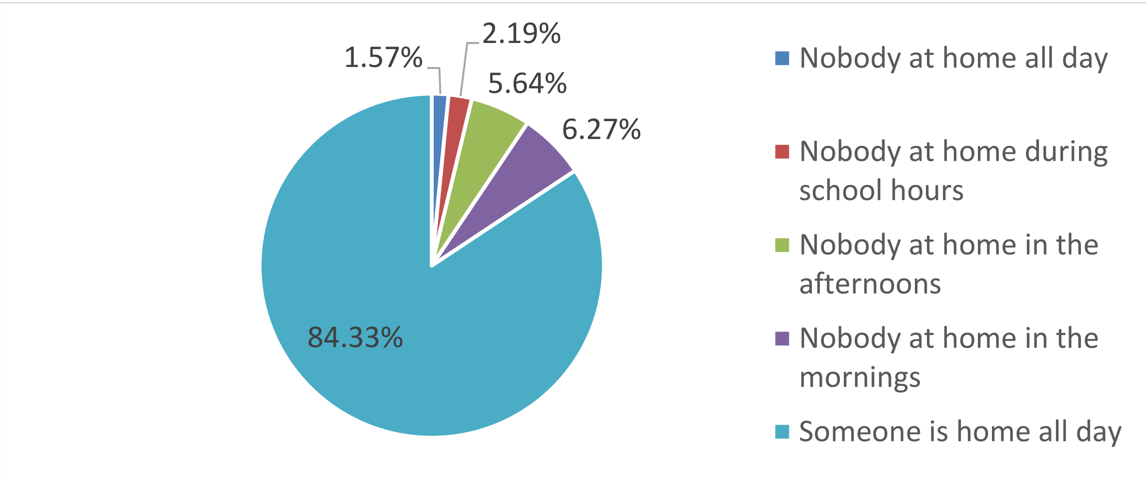

Figure 19: House occupancy

The study was focussed on low income households and for 69% of households their weekly income was less than $600/week as per Figure 20. Low income households are generally considered to earn less than $475/week while the average weekly income for Australian households is $998 (Australian Bureau of Statistics, 2015).

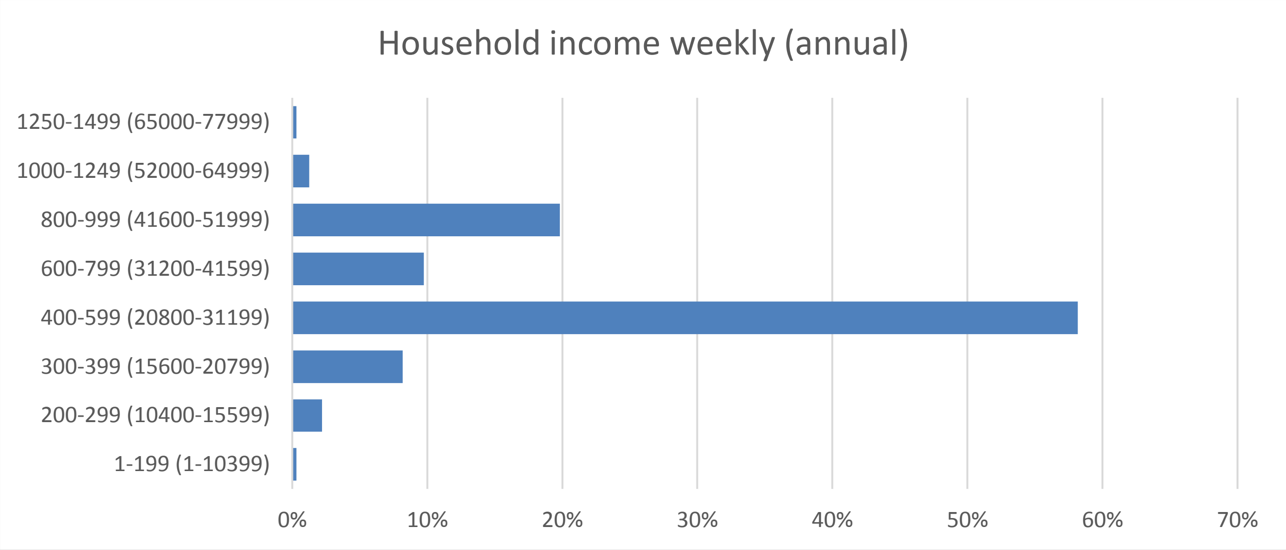

Figure 20: Household income – weekly and annual

Household ownership in councils varied between 80 and 90% of householders and 6.5% were tenants. This was a lower than average number of tenants against the national profile but consistent with this age profile.

Tenant numbers varied considerably across councils i.e. Mornington Peninsula has 6% of participants being tenants, whereas only 2% of participants in Bayside are tenants. Kingston has a large percentage of tenants but withdrew early from the project.

3.2.2 House energy audit data

3.2.2.1 House profile

Almost 80% of the houses in the study were separate houses, with the remaining being semi-detached townhouses (14%) and flats or apartments (6%) as per Figure 21.

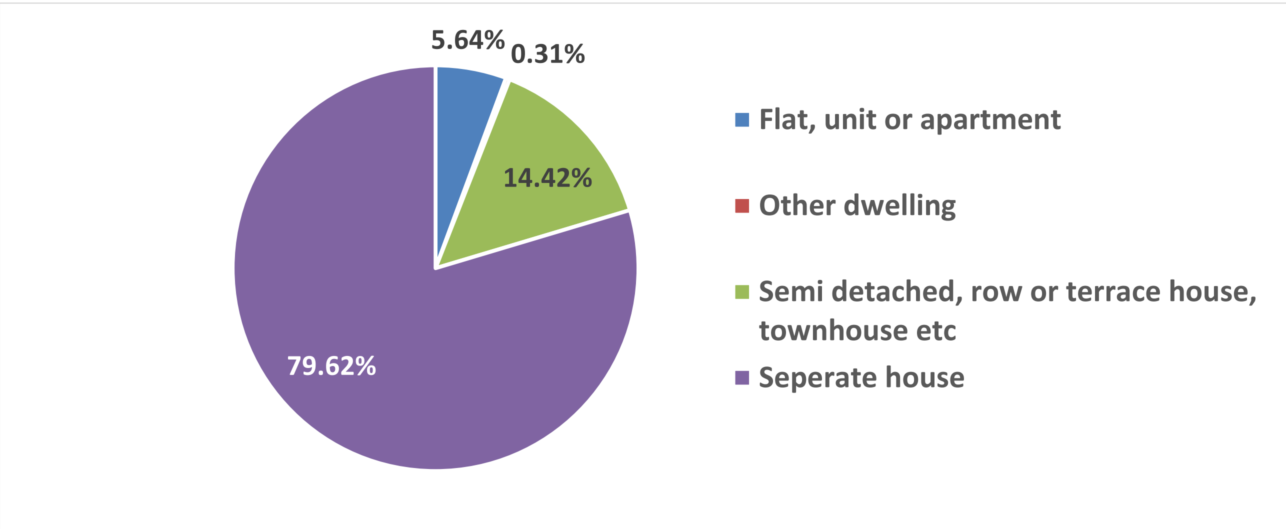

Figure 21: House type

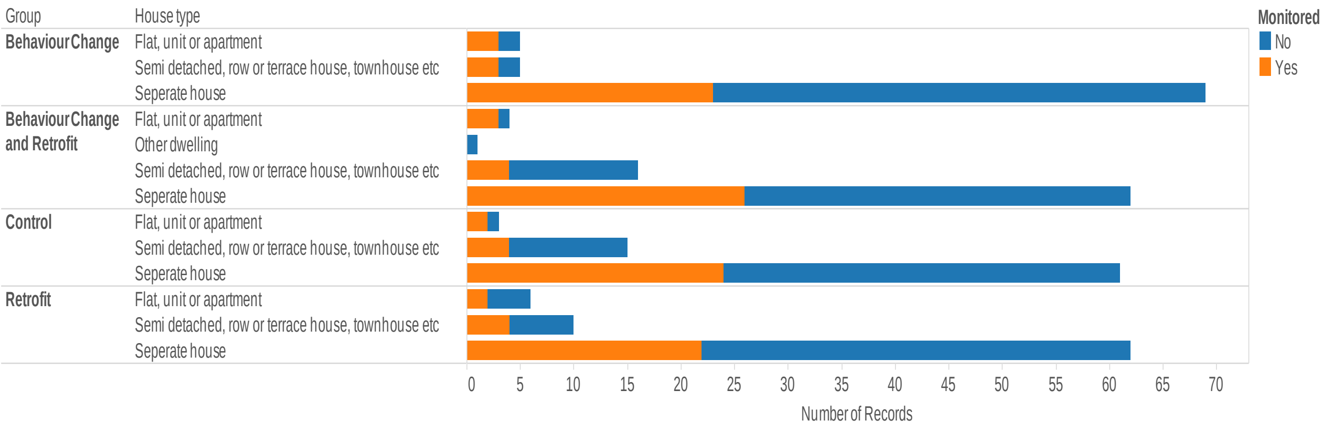

Figure 22: House type by study group

The age of the house can impact significantly on the energy efficiency of the house. Older houses tend to be draughty compared to newer houses and also would not have been subject to any energy efficiency provisions in the National Construction Code. In Victoria, the first requirements to include energy efficiency measures, such as ceiling insulation, were introduced into the building code in 2001. Before then no such requirements existed and consequently many older houses have minimal energy efficiency measures.

The majority of houses in the study are less than 50 years old. There is a fairly even spread of houses from the 1970's through to the current decade with a smaller number of post war houses. Houses that are older than 70 years comprise around 13% (Figure 23).

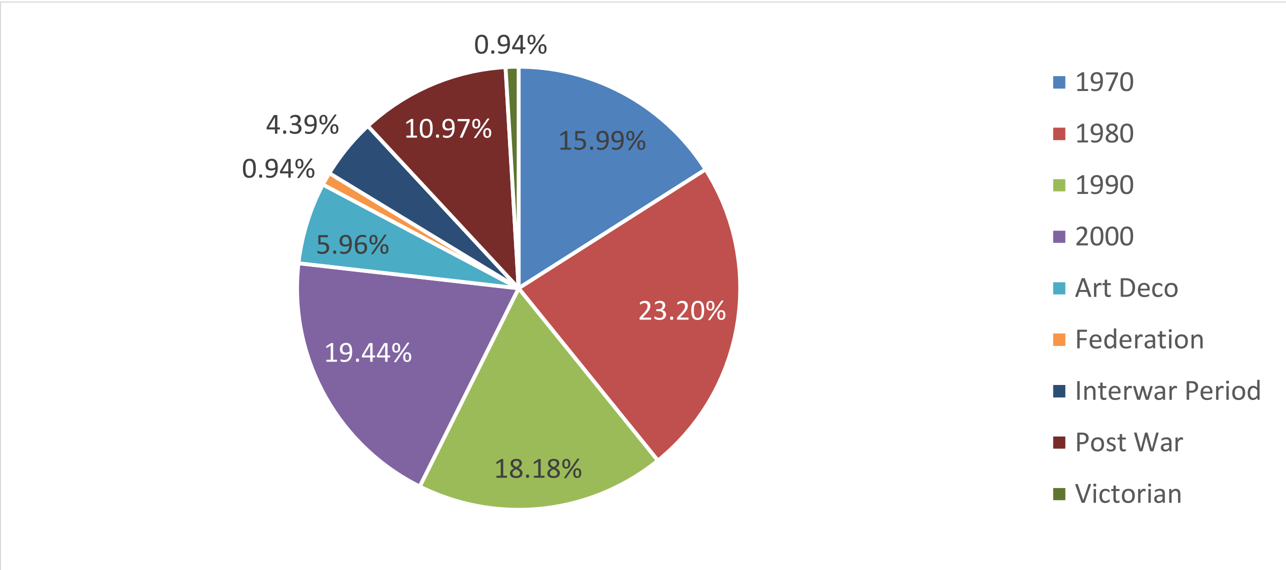

Figure 23: House age

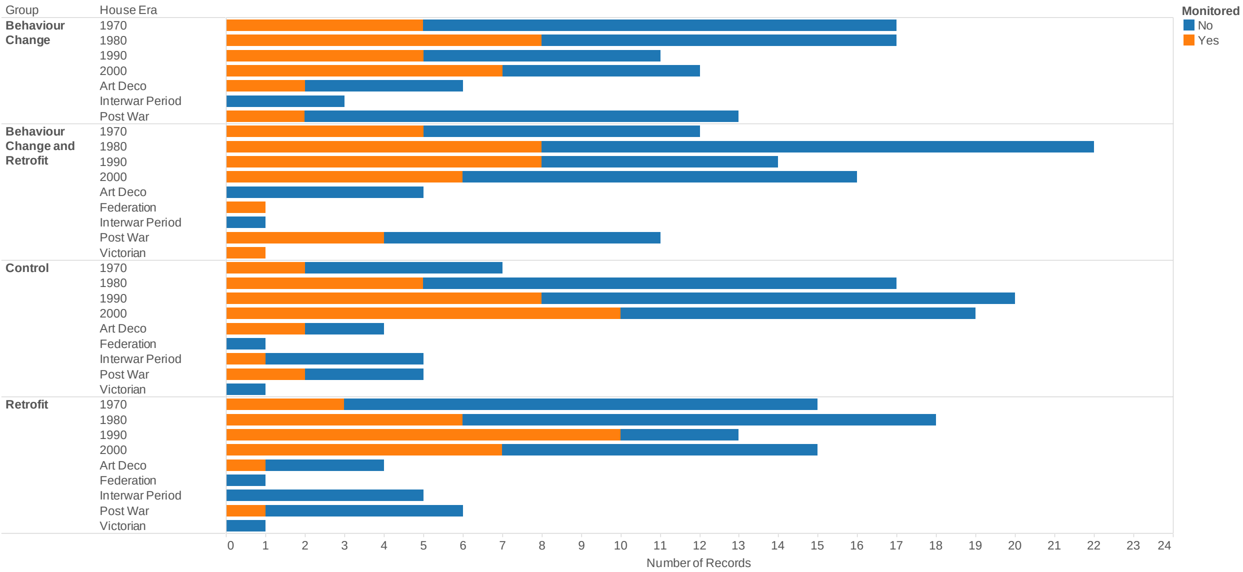

Figure 24: House age by study group

Although specific floor area for each house was not measured, the number of bedrooms was measured and this can be used as a measure for the size of the house. Figure 25 shows the breakdown by number of bedrooms and it is interesting to note that 16% of houses have four or more bedrooms. These would be considered large houses.

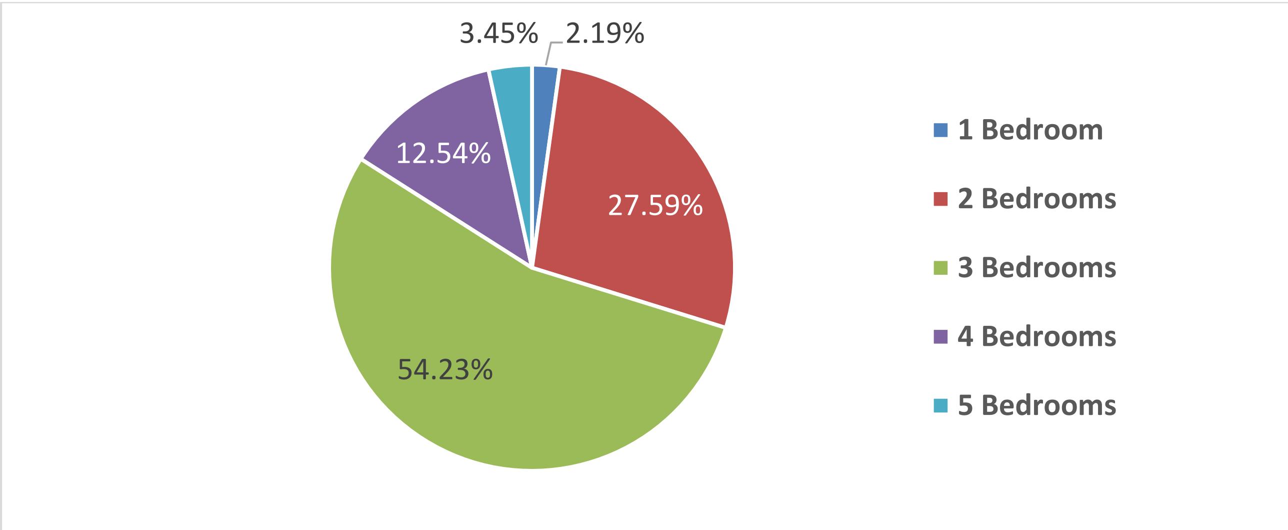

Figure 25: Number of bedrooms

3.2.2.2 House construction

The construction system used for a house can influence its energy efficiency potential and also dictates the types of retrofits that may be possible. For example, a house with a flat roof is more difficult to add insulation to than a house that has access to the roof cavity.

Many of the houses in the study (41%) had a concrete slab on the ground (Figure 26). This type of construction minimises air infiltration through the floor and generally improves the thermal performance of the house. Almost half the houses have raised timber floors (49%), although most have an enclosed sub-floor area that generally helps reduce air infiltration through the floor.

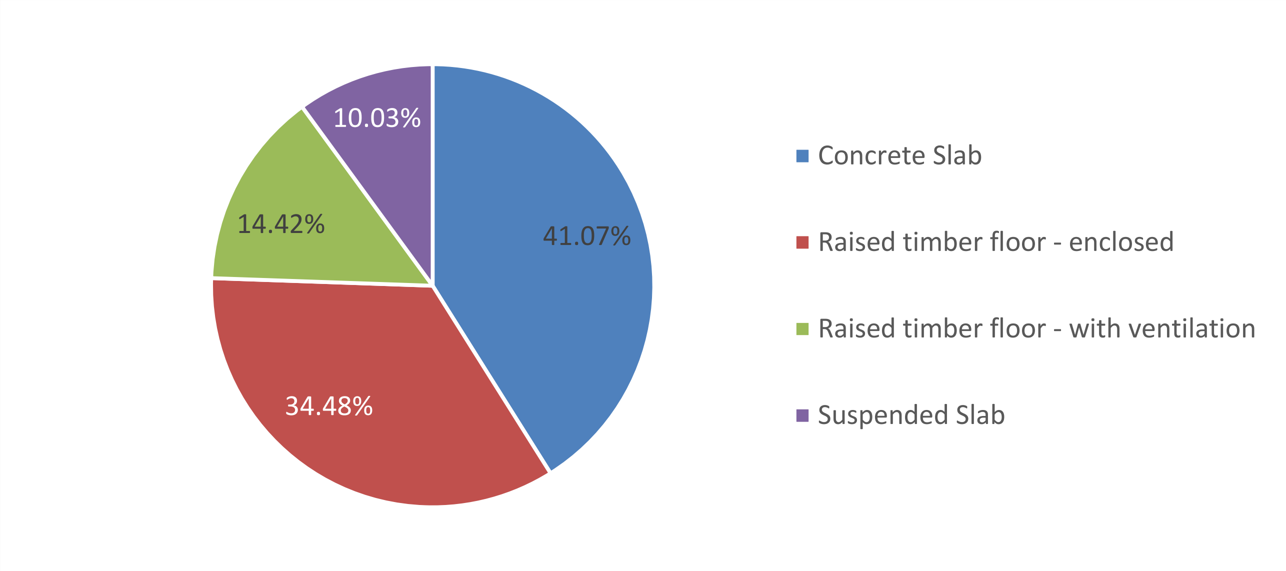

Figure 26: Floor type

The dominant external wall type is brick veneer with 71% of houses using this construction technique (Figure 27). Around 18.5% use a timber frame with an external cladding such as weatherboards or fibro cement.

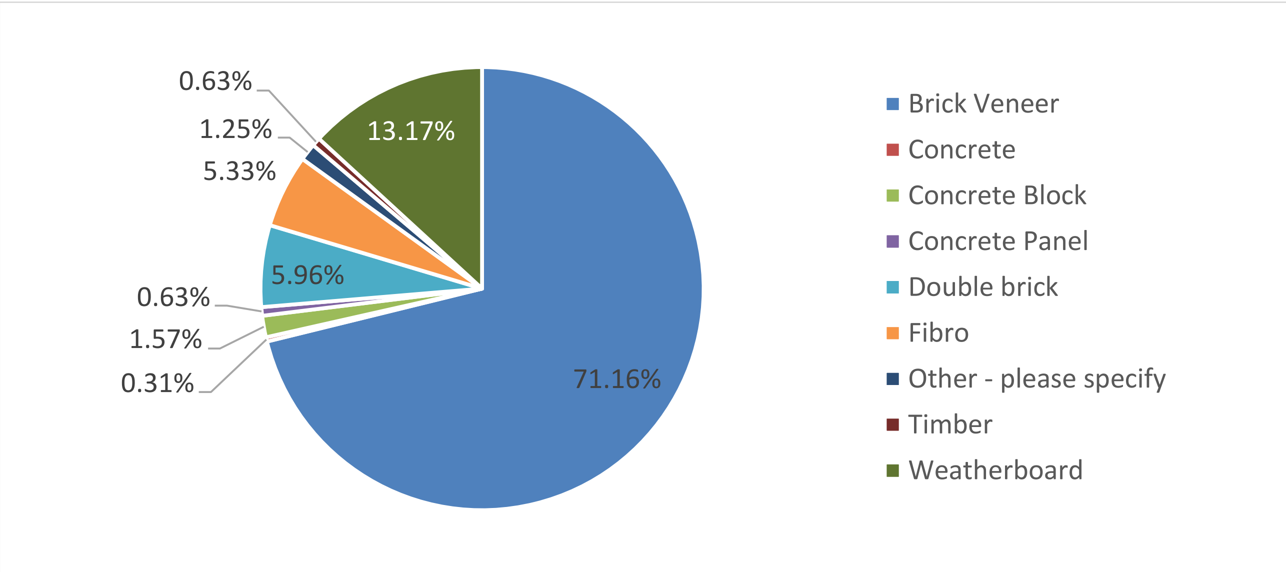

Figure 27: External wall type

Both brick veneer and clad houses have a wall cavity that allows for insulation, however, few house walls were accessible to investigate the existence of wall insulation (Figure 28). For 89% of houses inspected it was not possible to determine the presence of wall insulation. Nevertheless, it can be assumed that the majority of these houses would not have insulation in their wall cavity because until very recently (2006 onwards) the use of wall insulation in house construction was rare in Victoria.

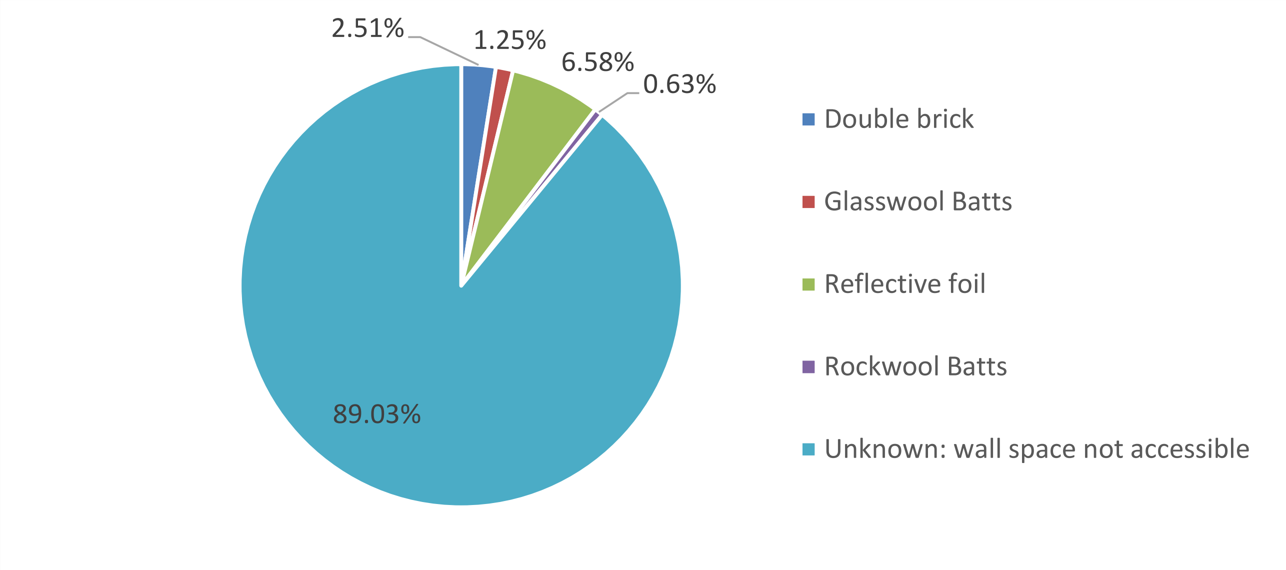

Figure 28: External wall insulation

Traditionally in Victoria tiled pitched roofs are the norm and the majority of houses in the project reflect this with 67% having a tiled roof (see Figure 29). The remaining roofs are nearly all metal clad (31%).

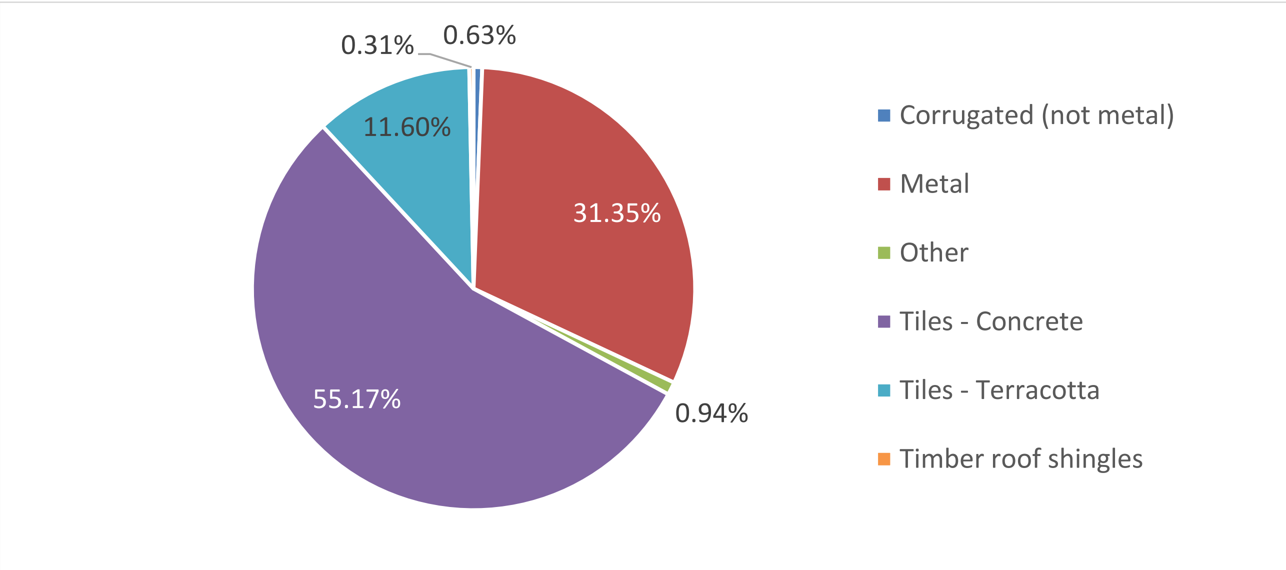

Figure 29: Roof cladding

Pitched roofs usually allow access to the roof space and consequently the house inspectors were able to inspect for the existence of ceiling insulation. Many of the houses in the project were built before ceiling insulation was required. Nevertheless, the addition of ceiling insulation has been encouraged by some government backed programs and consequently the number of houses with ceiling insulation has been increasing. Within this project 3.5% of houses were found to have no ceiling insulation, although for a further 15% of houses it was not possible to inspect the ceiling space. Almost half the houses inspected had some form of batt insulation (49%), while a further 31% had some form of loose fill insulation (Figure 30).

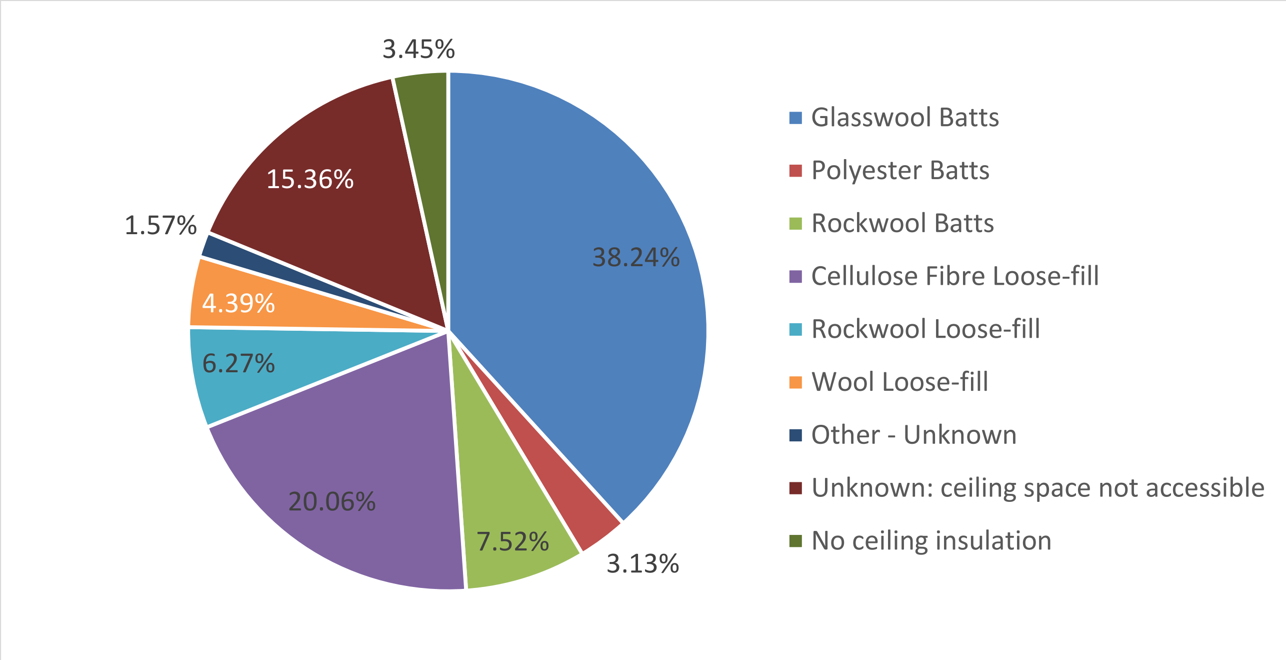

Figure 30: Ceiling insulation

The effectiveness of ceiling insulation is a factor of its thickness and general condition. Over time ceiling insulation compresses which reduces its effectiveness. Compression is particularly a problem with loose-fill insulation, but batts also suffer from compression. Insulation can also get damaged by animals, water infiltration and through the installation of other services that are located in the roof space such as ductwork and electrical cabling.

Overall, 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 regarded as in poor condition (inconsistent insulation coverage - lots of gaps or large gaps, thin, degraded or ripped). Figure 31 shows the assessed condition of the insulation for the general insulation types (loose-fill, batts and other). It is interesting to note that a higher percentage of the batt insulation was considered to be in poor condition than the loose-fill insulation (24% and 18% respectively). However, only 1% of the loose fill insulation was considered in good condition compared to 12% of the batt insulation. From the home audits, 70% of homes had ceiling insulation that was 90mm or less, with only 25% of homes having ceiling insulation greater than 90mm thick.

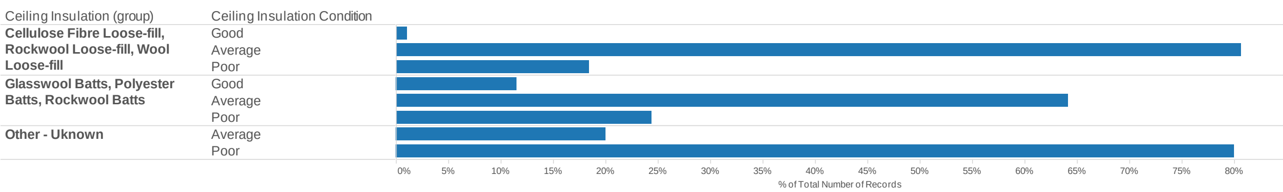

Figure 31: Ceiling insulation condition by insulation type

Windows are an essential part of any house, but they are also one of the major sources for heat loss and heat gain within a house. The type of window frame and the glazing system used can both help in reducing the thermal transfer between inside and out and vice versa.

Timber framed windows usually perform better in this respect than aluminium windows and when combined with double glazing can deliver a high performance window solution. 39% of houses in the project had timber window frames, but only around 1% had double glazing (Figure 32). Double glazing is increasing in popularity in new dwellings, but within existing housing stock it is rare.

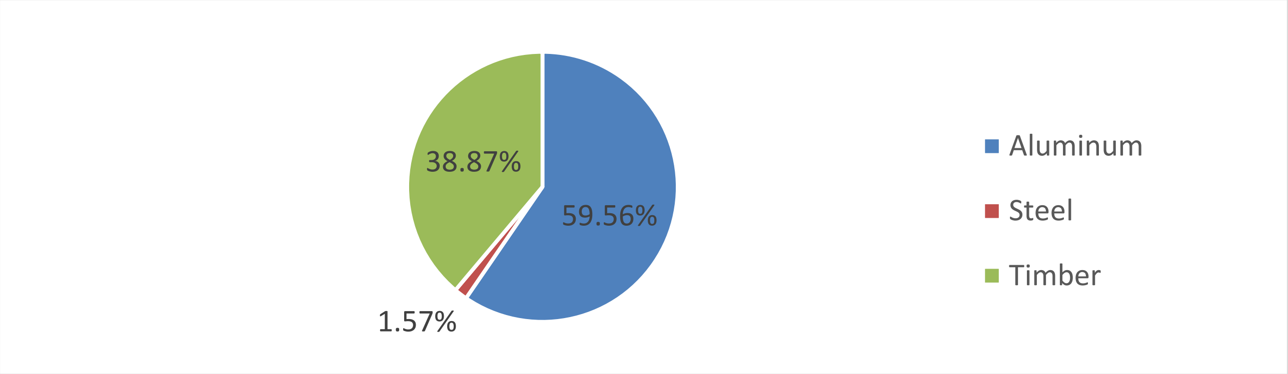

Figure 32: Window frame

3.2.2.3 House systems

Houses have a range of systems that are significant contributors to the overall energy consumption of the house. These include the heating/cooling systems, the hot water system and the lighting system. In addition, many households have installed PV systems which, of course, help reduce the amount of electricity that is taken from the grid.

Heating and cooling is usually the single biggest consumer of energy in Victorian households, with hot water systems being the second highest consumer (Figure 33). The efficiency of the systems that are installed can have a significant impact on the overall energy consumption of a house.

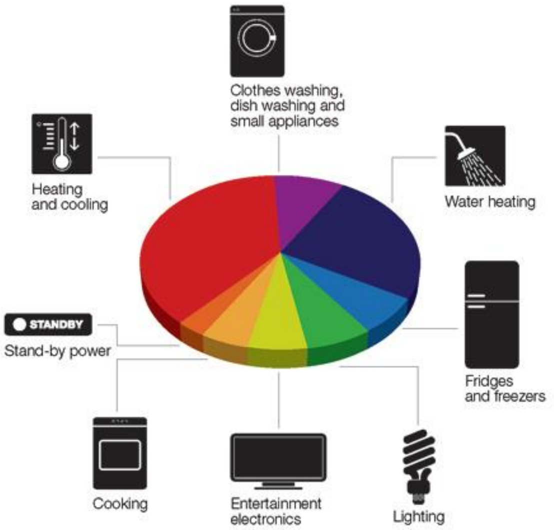

Figure 33: Typical energy consumption profile for Victorian households

In Victoria, a heating system is more common than a cooling system. All houses in the project had some form of heating system and mostly this was a fixed system rather than a portable system. Gas heating dominates with 70% of houses having some form of gas heating (Figure 34). Reverse cycle heat pumps had the next highest uptake being in 20% of houses. Within the gas systems, they are split between ducted (57%) and wall mounted space heaters (40%), while with reverse cycle systems the majority a wall mounted split systems (77%) with the remaining 23% being ducted (Figure 35).

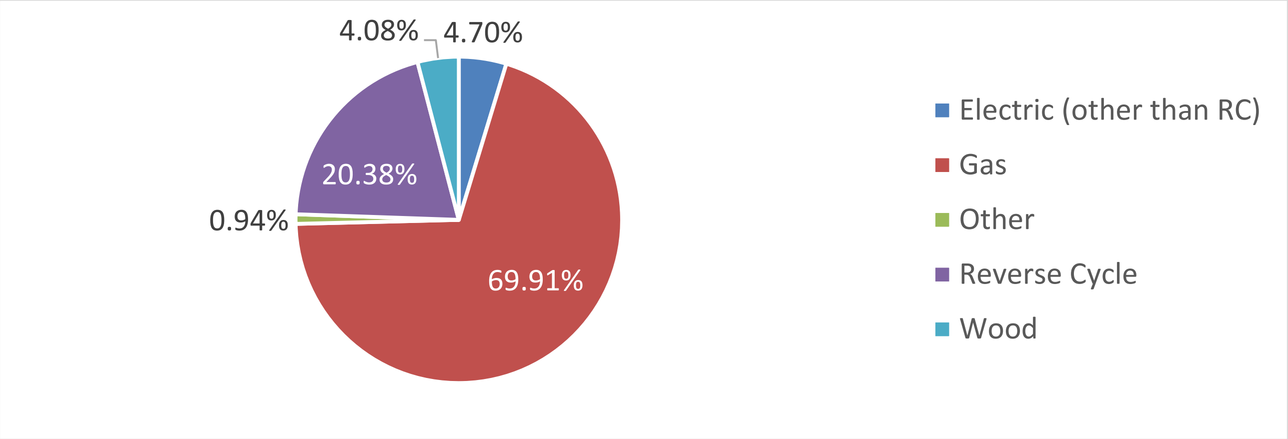

Figure 34: Heating systems

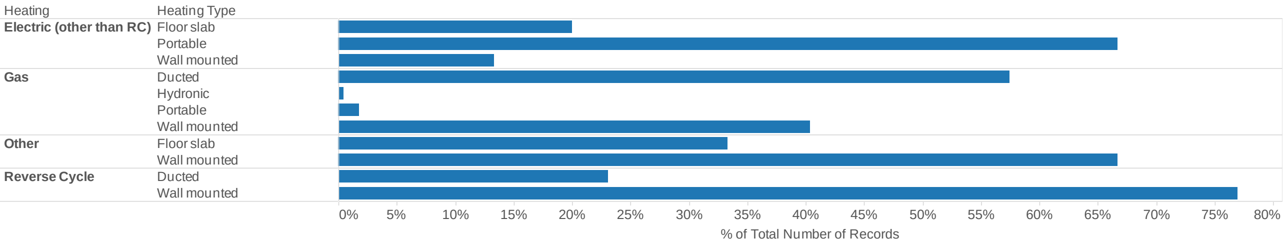

Figure 35: Heating system type

Most of the houses in the study had some form of cooling system with only 6% having no cooling system (Figure 36). The majority of houses used a reverse cycle heat pump (73%) and for 28% this was the same system they used for the house heating. Around 12% had evaporative cooling systems which are relatively low energy systems.

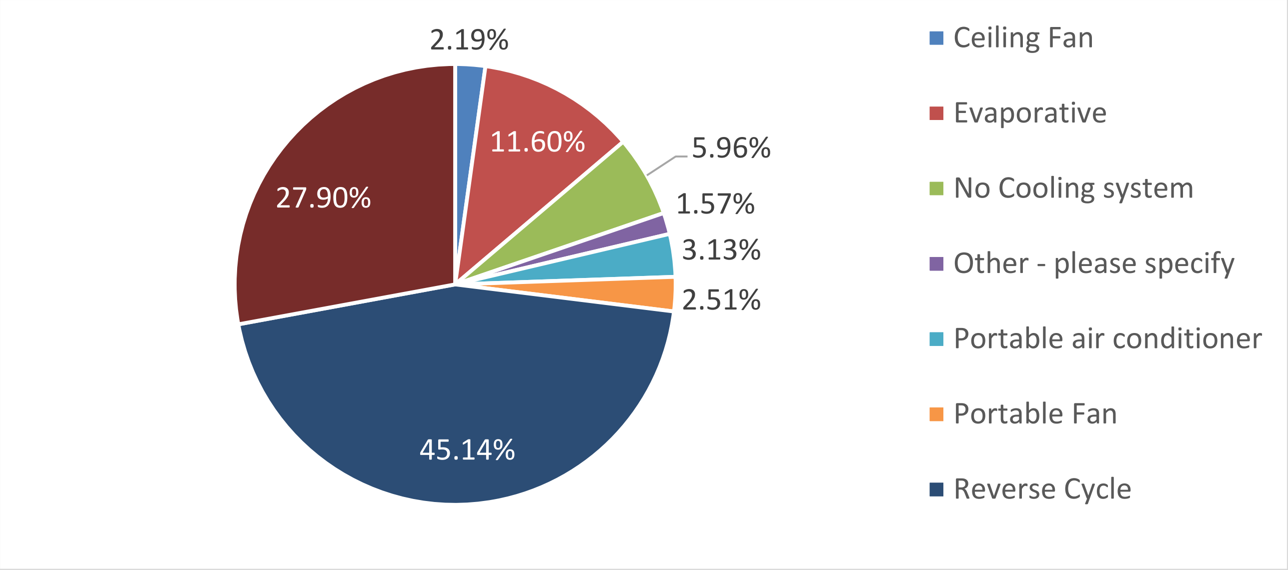

Figure 36: Cooling systems

Gas hot water systems were the dominant type of hot water system used accounting for 70% of all systems. Electric systems made up 24% while a surprisingly low 6% were solar systems (Figure 37).

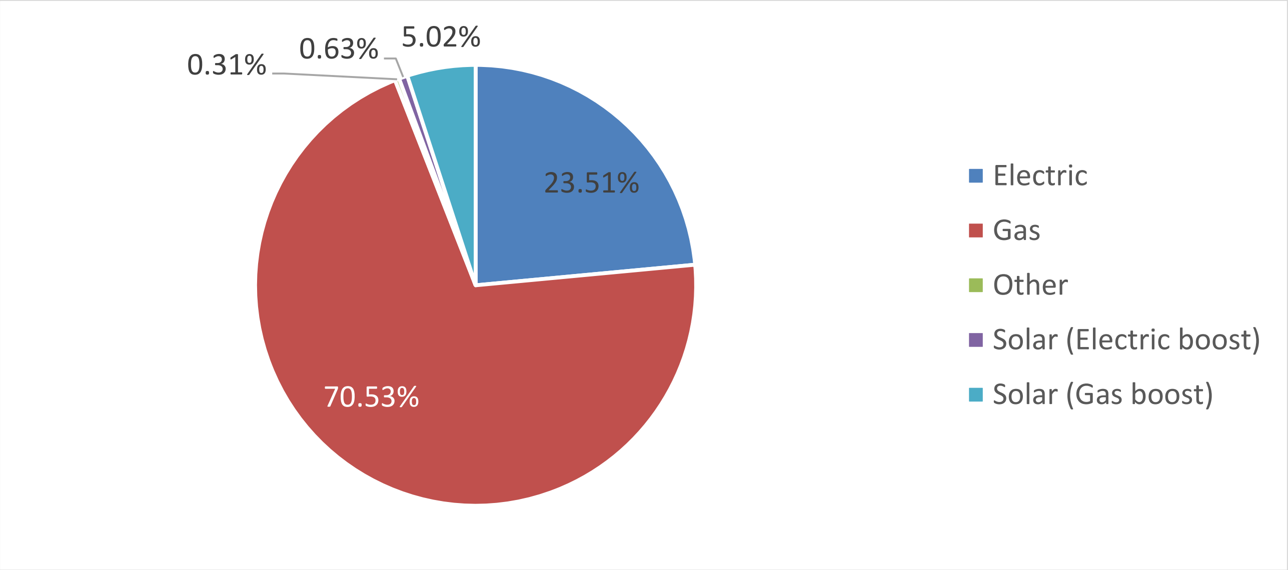

Figure 37: Hot water systems

The majority of hot water systems utilised a storage tank, but 18% of the gas hot water systems were instantaneous, non-storage type systems (Figure 38).

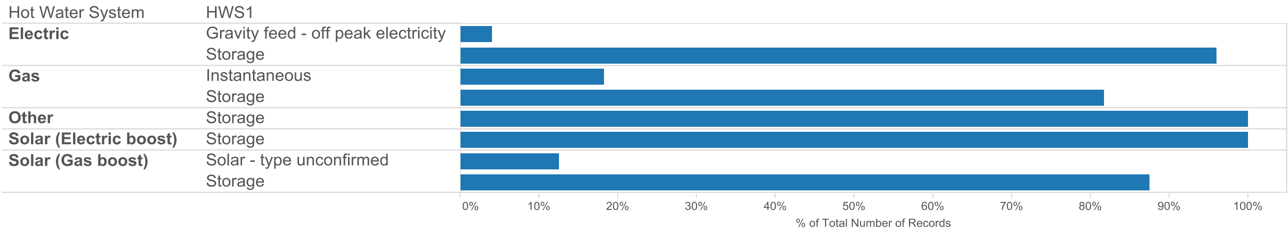

Figure 38: Hot water systems by type

Around 14% of the houses in the study had a solar PV system installed to generate electricity. Around half the PV systems installed were 1.5 kilowatts or smaller, but a surprisingly large number of big PV arrays were also installed. 26% of systems were 3Kw or bigger which for many houses would be large enough to meet the majority of their electricity needs.

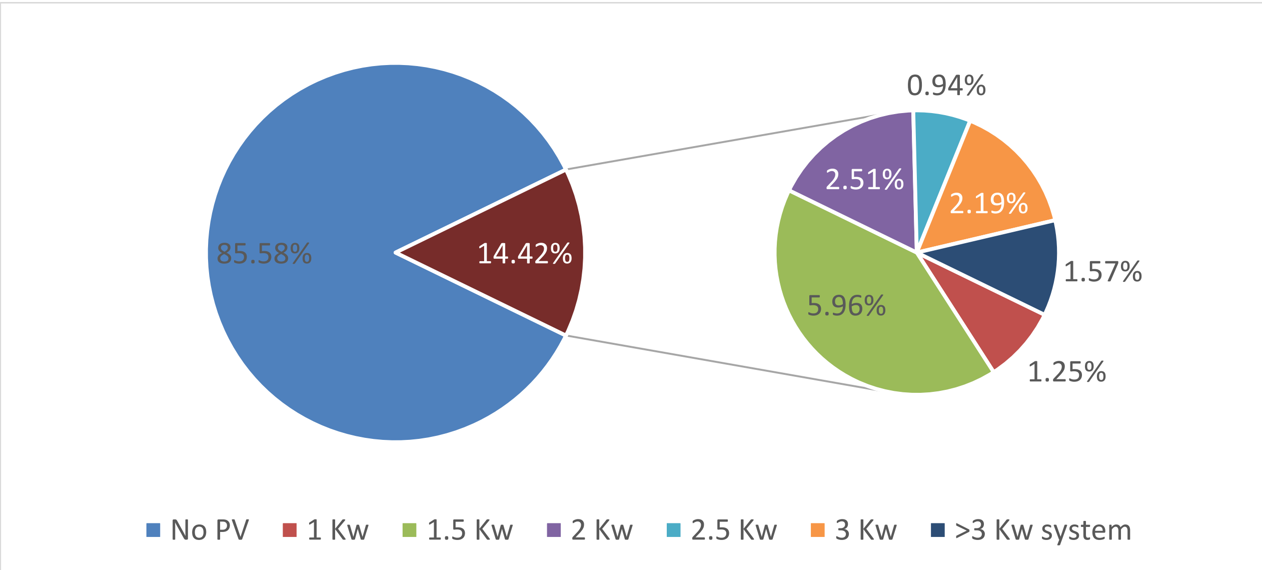

Figure 39: PV systems installed

3.3 Impact on air exchange rate/draughtiness

Draught testing was done at 60 randomly selected homes that were designated to receive retrofit interventions. Prior to interventions, these homes had average air exchange rate of 21.5 exchanges per hour per cubic metre at 50 Pascals of air pressure (ACH $m^3/hr/m^3$@ 50pa) (Figure 40). 34 of these homes were identified as being relatively less suitable/practical to draught seal within the allowable budget and these homes had an average air exchange rate of 20.6 ACH $m^3/hr/m^3$.

The 26 homes that were practical to draught seal within the budget had a pre-intervention average ACH of 22.6 $m^3/hr/m^3$. These 26 homes were draught sealed and then retested for draughtiness and they had an average ACH of 16.2 $m^3/hr/m^3$, a decrease of 28% (Figure 40).

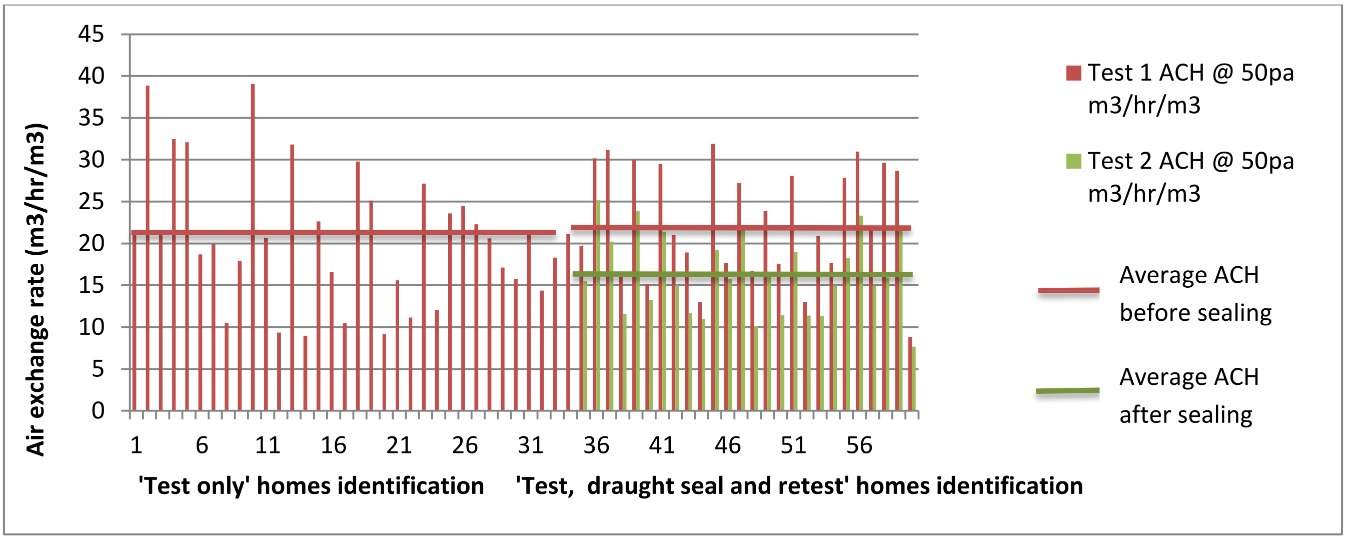

Figure 40: Air exchange rates of 60 homes before draught sealing and at 26 of these homes after draught sealing, noting average air exchange rates/hr are 28% less after draught sealing

3.4 Monitored Energy use

The average total energy use/day was 38.5 kWh/day for the 120 homes with energy monitoring equipment installed (Figure 41) with increases in consumption in the winter periods.

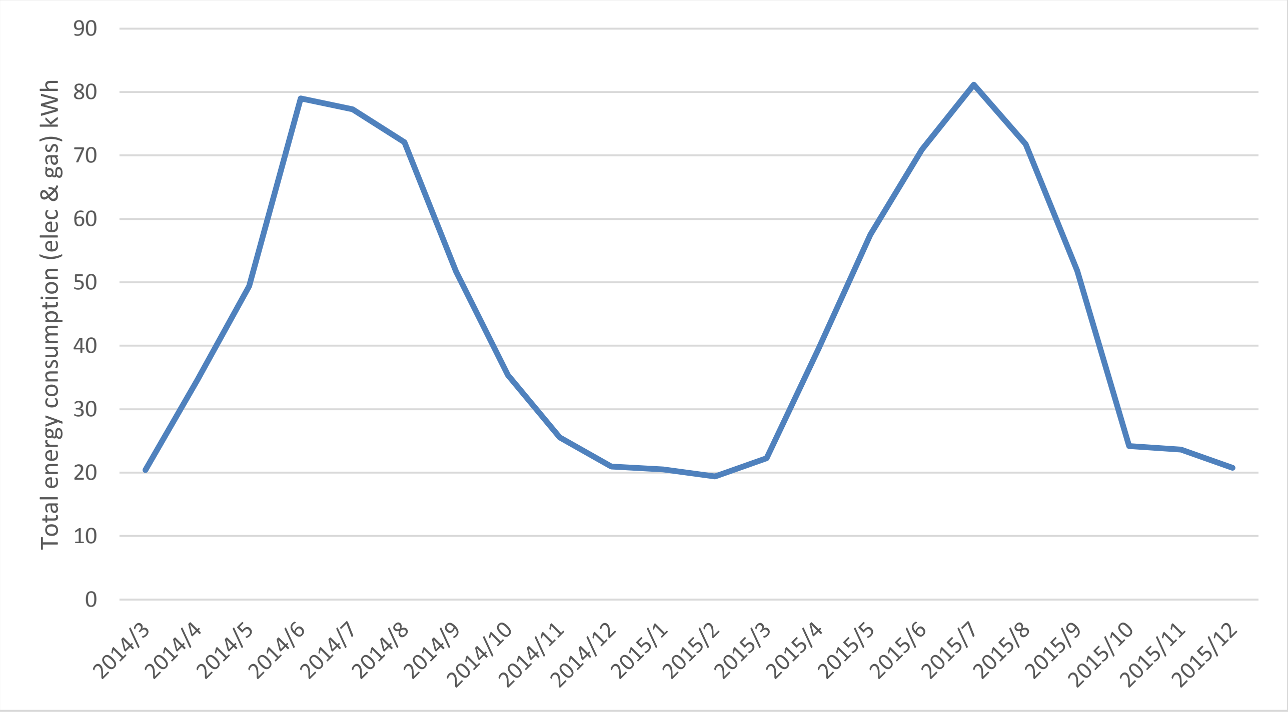

Figure 41: Average daily total energy consumption (electricity and gas) by month and year (kWh) (calculated using monitored data)

Gas consumption dominates the total daily energy profile, especially during the winter months. Over the monitoring period average daily energy consumption was 44.1kWh, but during winter the average daily was 75.4kWh of which gas consumption contributed about 90% of the total. Over the summer months when gas air heating is not being used the average daily energy consumption was only 20.4kWh.

Daily electricity use averages were 11.8 kWh/day and decreased slightly during the study period (Figure 42). Peak use is typically over winter due to heating and a mini-peak in use occurs during January-February each year due to cooling appliances.

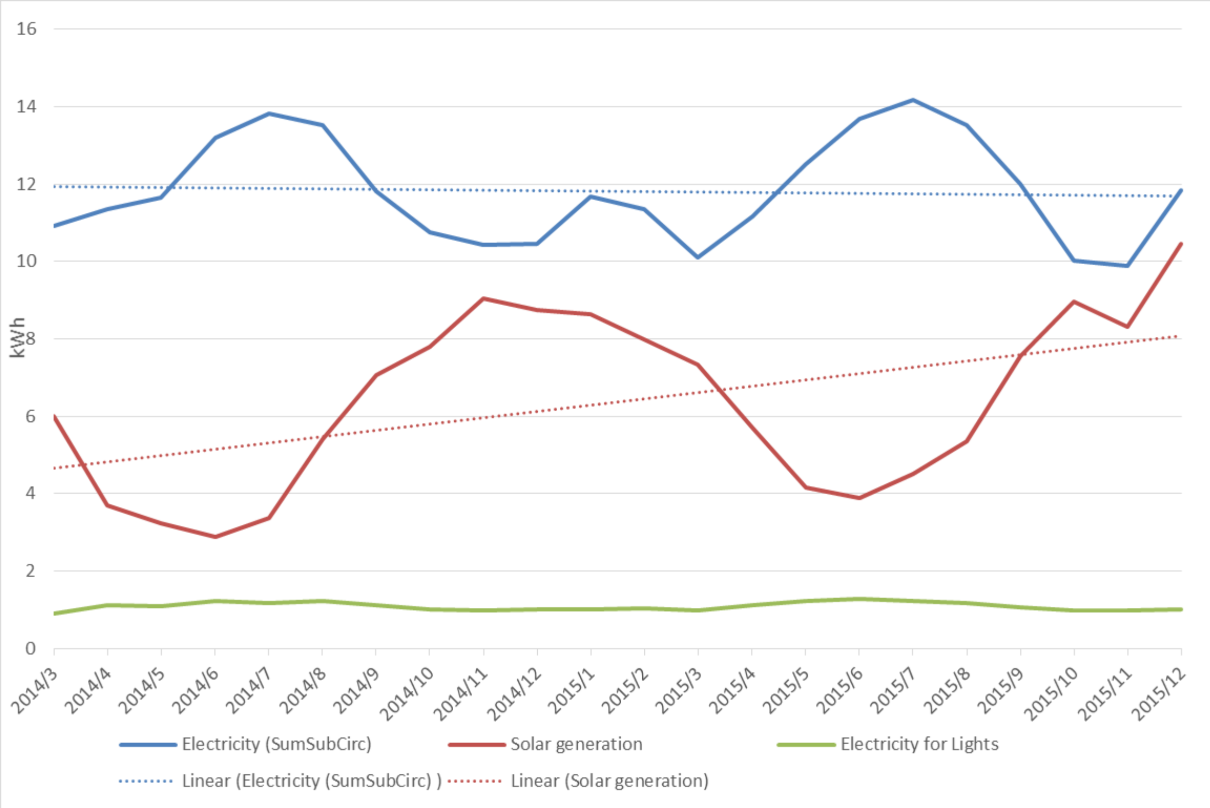

Figure 42: Monitored data average daily electricity consumption and generation by month and year

Gas use averaged at 127.7 MJ/day over the monitoring period, but it was highly variable depending on the time of the year. Over the winter months consumption averaged 243.6 MJ/day, while during the summer months consumption averaged 36.6 MJ/day.

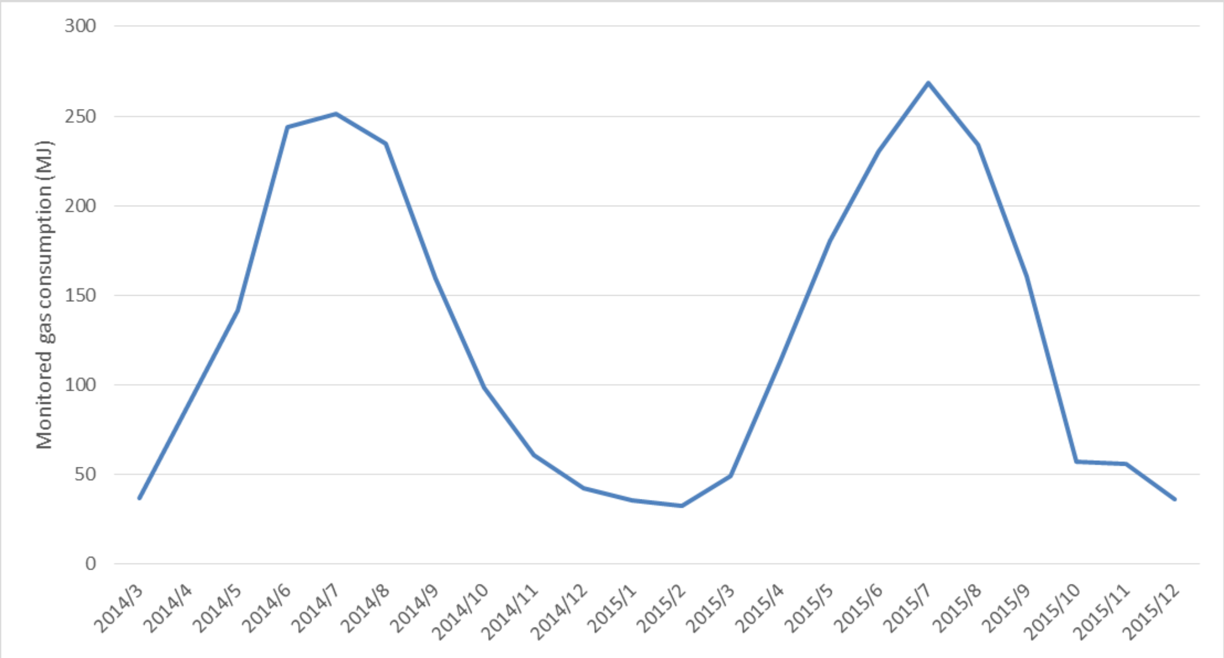

Figure 43: Monitored data average daily gas consumption by month and year (MJ)

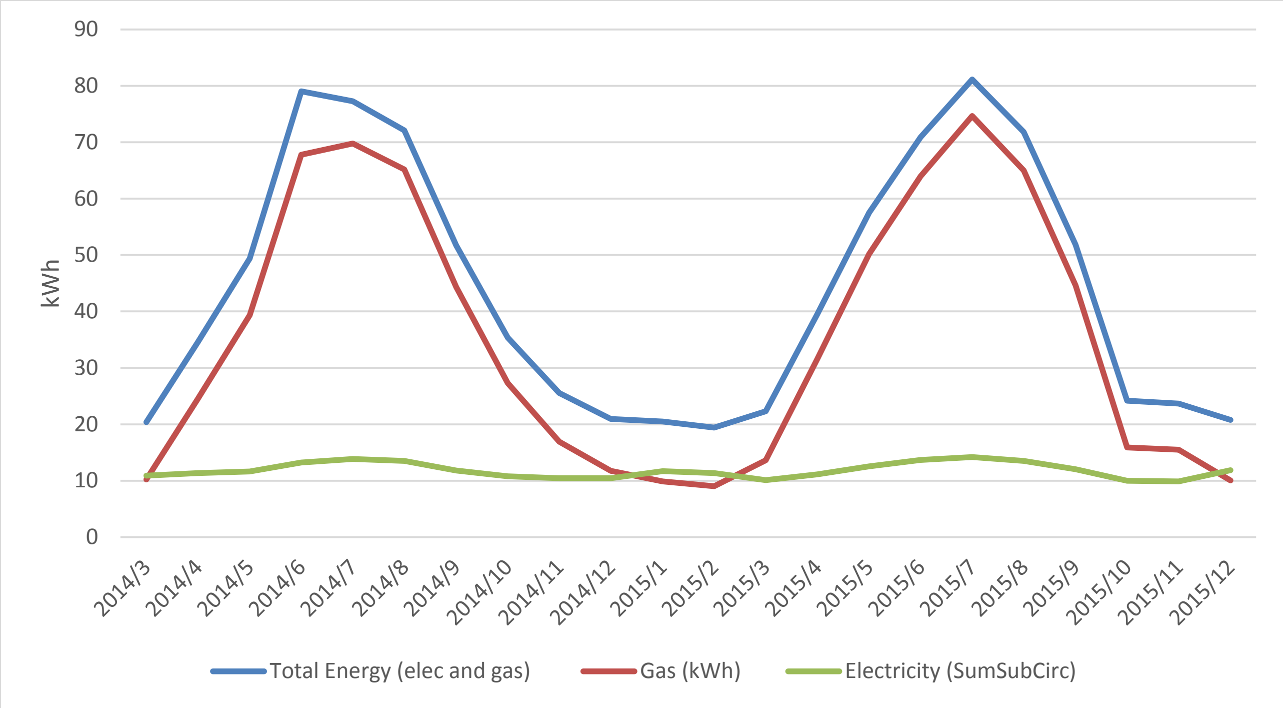

Figure 44: Average daily total energy consumption (electricity and gas) by month and year (kWh) (calculated using monitored data), and compared against electricity and gas consumption

At first glance it may appear that the dominance of gas consumption means that an all-electric house may be cheaper to run and more energy efficient. Certainly in energy terms an all-electric house would consume less kWh/day than a gas and electric house, but in cost this may not be the case. On a kWh basis gas costs 0.5 cents/kWh, whereas electricity costs 29 cents/kWh. In terms of greenhouse gas emissions, electricity in Victoria produces 1.26kg CO_2e/kWh compared to 0.20kg CO_2e/kWh for gas (Department of Environment, 2015).

3.5 Electricity data – smart meter

Electricity smart meters provide half hourly data on consumption from the grid and export to the grid if the house has a PV array. Figure 45 shows the average daily consumption and generation profiles over the years for those houses for which smart meter data was available. For the period it shows that the average daily consumption was 11kWh, but over the years the trend has seen a slight decline in the amount of electricity taken from the grid. In contrast, electricity that has been generated by rooftop solar PV systems and exported to the grid has increased over the period. On average, PV export has been around 3.7kWh/day. Increases in grid electricity are matched by a decrease in the amount of PV electricity that is exported to the grid. The amount that a PV array can generate decreases over the winter months due to a decrease in available sunshine and this decrease is offset by an increase in grid sourced electricity.

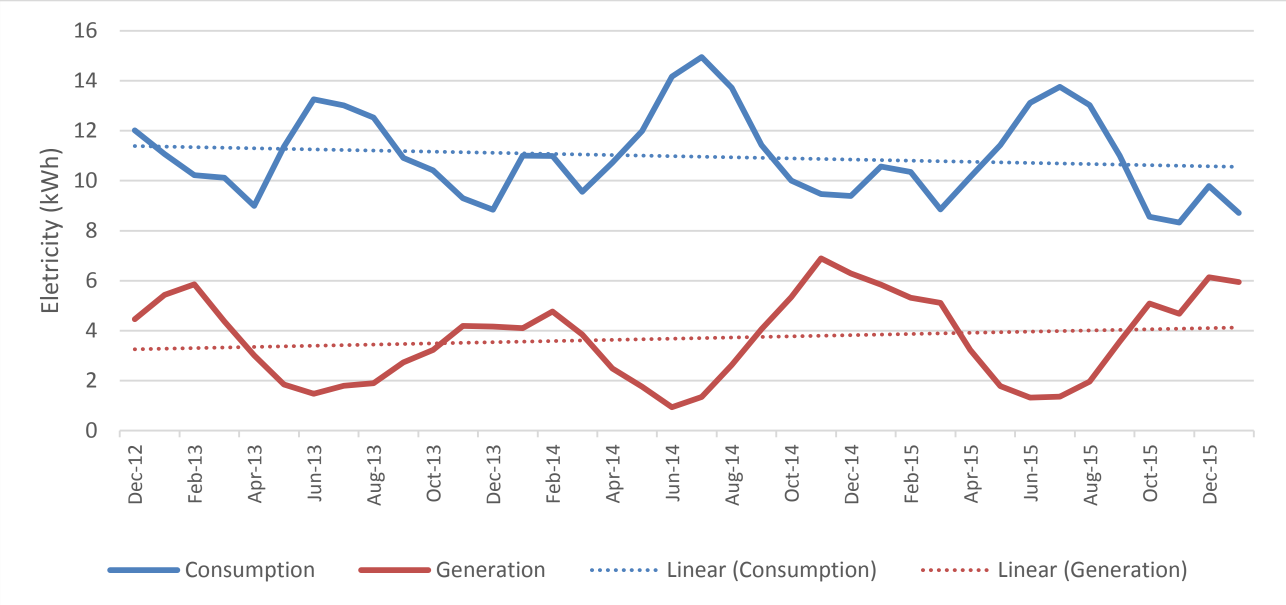

Figure 45: Smart meter average daily electricity consumption and generation by month and year

Figure 46 shows the average daily consumption profile for houses with PV arrays and those without as well as all the houses combined. It shows that generally the houses with a PV array take less electricity from the grid than houses that don't have a PV array and that this gap becomes more obvious in the summer months when the PV arrays are producing close to capacity. The initial higher consumption values being shown for the houses with PV systems is probably due to the PV systems not being installed until later in the data period. It would appear that by December 2013 all houses in the study that were identified as having a PV system actually had the system installed.

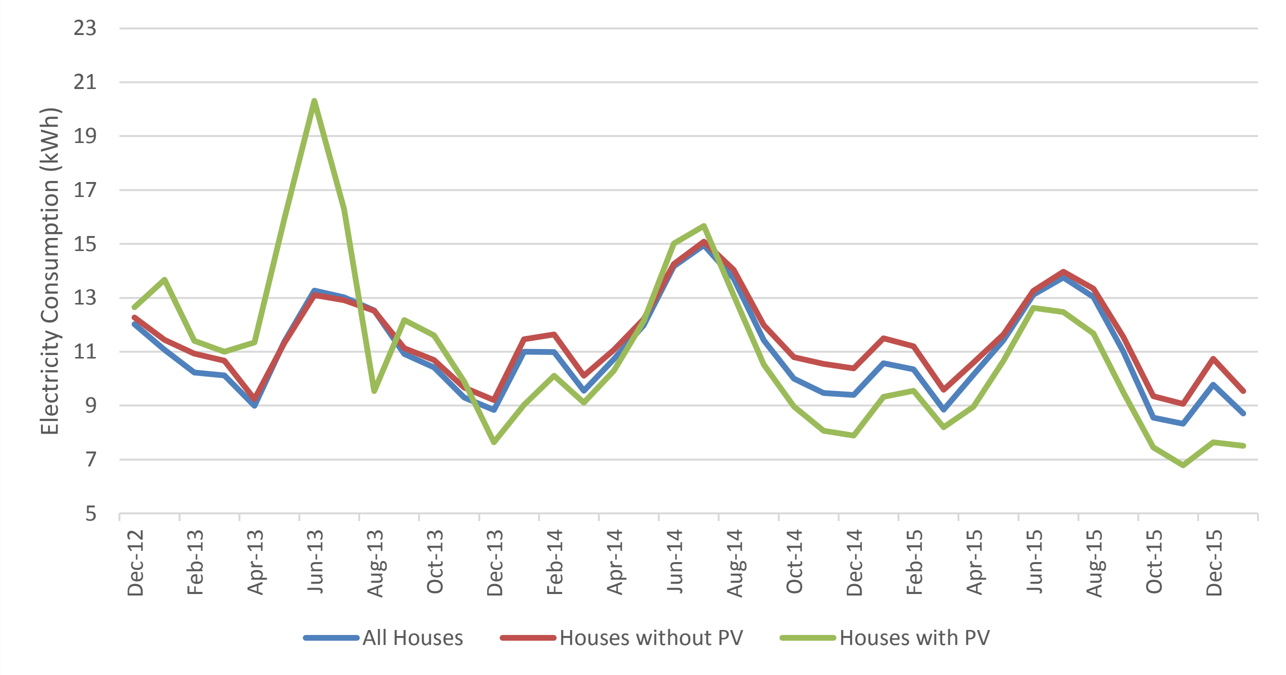

Figure 46: Average daily electricity consumption by PV system

The houses without PV averaged 11.4kWh/day compared to the average for all houses of 11kWh/day. This consumption rate is lower than the average rate of 15.2kWh/day that was reported in the Victorian Utility Consumption Survey (Roy Morgan Research, 2008) and very close to the 11.1kWh/day reported in the Electricity Bills Benchmark report (Acil Allen Consulting, 2015). It is interesting to note too that the Victorian Utility Consumption Survey also reported the average consumption for houses occupied by aged concession card holders which would be very similar in profile to the houses in this study. For these houses the reported consumption rate was 12.8kWh/day.

3.6 Natural gas consumption - billing

Gas consumption data was only available as billing data and consequently it was usually consumption over a period of 3 months. For analysis we determined the number of days in each billing cycle and then divided the total consumption by the number of days to calculate an average daily consumption value. In Victoria, gas consumption is primarily used for hot water heating and air heating in the winter months. Figure 47 shows the average daily natural gas consumption by month. It clearly shows the seasonal nature of gas consumption with the winter daily consumption averaging around 250MJ/day compared with the average summer daily consumption of 40MJ/day.

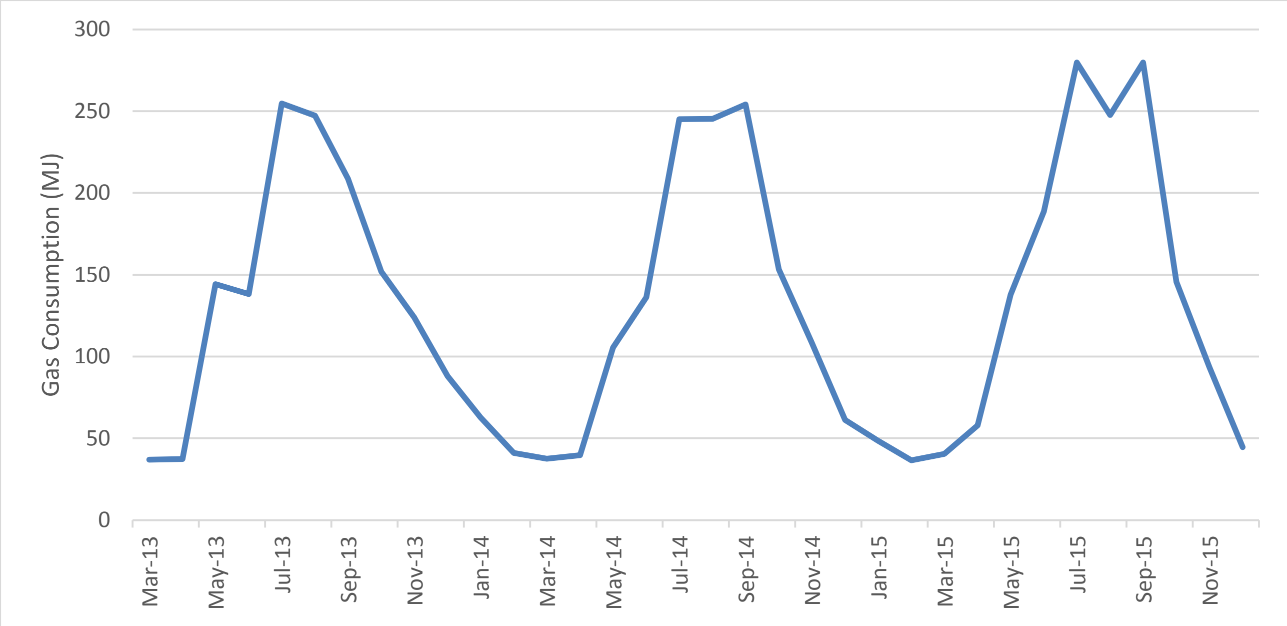

Figure 47: Average daily natural gas consumption by month and year

3.7 Comparison between monitored and distributor data

Average daily electricity and gas use data from monitored and distributor data was very similar as can be seen from Figure 48

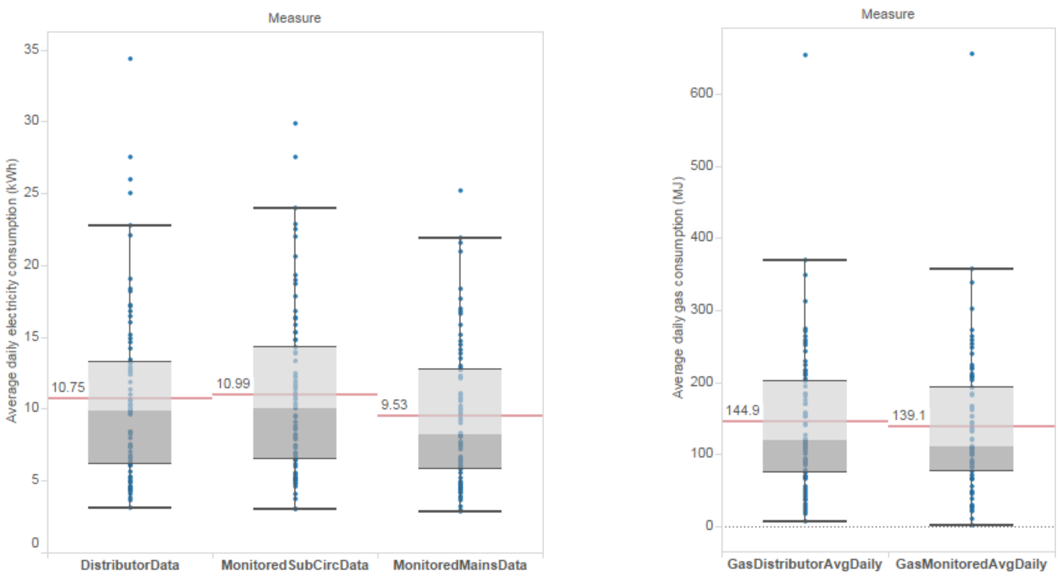

Figure 48: Comparison between monitored and distributor data for average daily electricity and gas use

3.8 Temperature

3.8.1 External temperatures

Figure 49 shows the average, maximum and minimum temperatures for each BoM station for each month from January 2014 to December 2015. It shows that the monthly average and maximum temperatures for each station followed very similar profiles. The highest average monthly temperature of 22°C was recorded at Nilma North in January 2014 while for the entire period the average temperature was 14.7°C. January 2014 also recorded the highest maximum temperature of 43.1°C at Moorabbin Airport. The average maximum temperature for the entire period was 28.2°C.

It is important to note the unusually high temperatures recorded in October 2015. Maximum temperatures for this month ranged from 29.9°C to 34.5°C and the average temperatures ranged from 15.0°C to 17.1°C. Comparison temperatures from October 2014 are around 2°C cooler with average temperatures ranging from 13.6°C to 15.0°C. October 2015 was one of the hottest Octobers on record and the temperature spike is reflected in the energy consumption for this month.

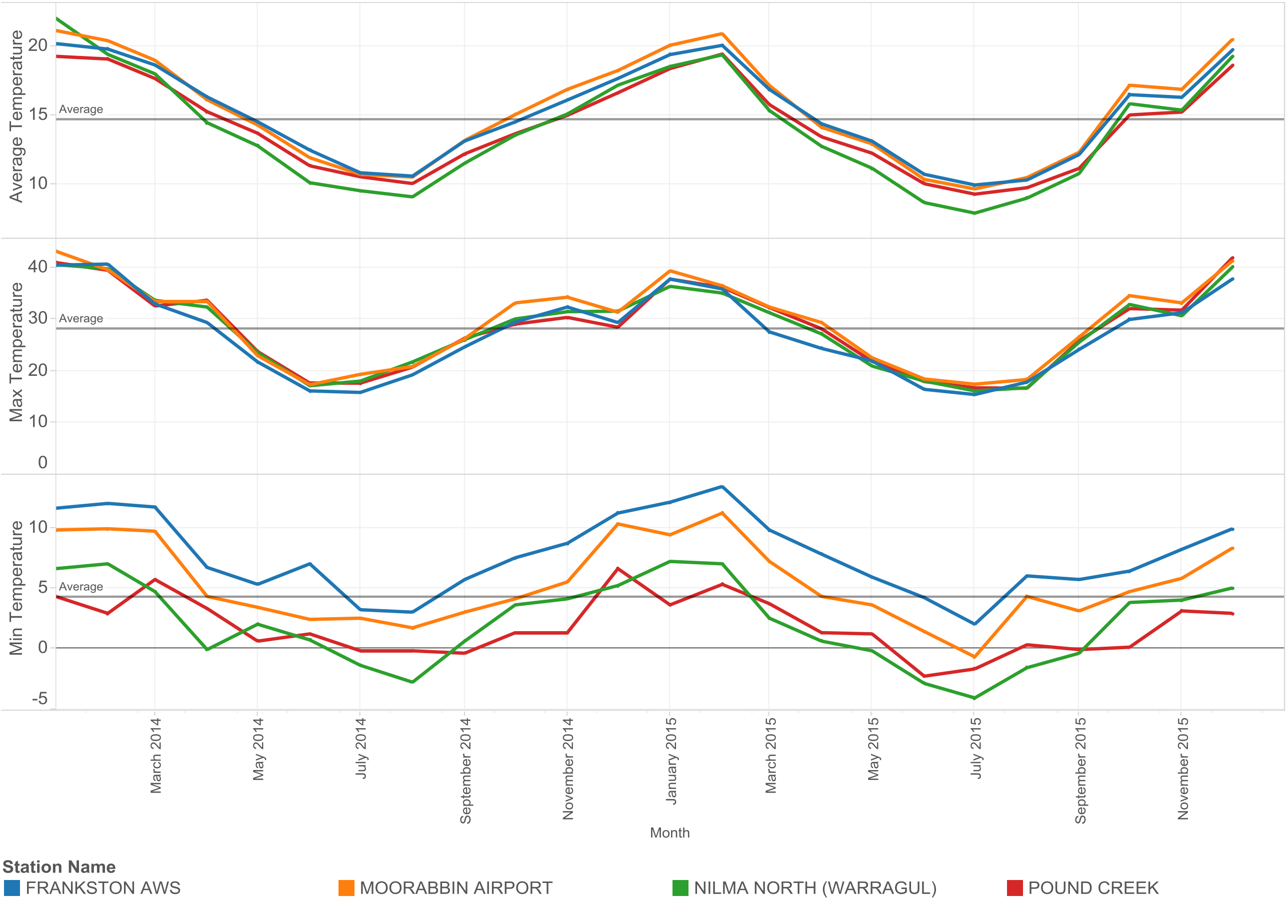

Figure 49: Monthly temperatures (°C) for BoM stations for 2014-2015

3.8.2 Internal temperatures

Figure 50 shows the average, average maximum and average minimum temperatures for all houses by the location of the temperature sensor. Generally bedrooms were slightly cooler than living rooms by up to a degree during the winter months. Over the study period the average internal temperature was 19.7°C for living areas and 19.3°C for bedrooms. The highest monthly average temperature was 23.2°C for February 2015.

Averaging the minimum and maximum temperatures recorded in each house also revealed the extremes experienced for each month. September 2014 to February 2015 saw an extended period of high maximum temperatures being experienced. Over this period each month had a maximum indoor temperature in excess of 30°C. In winter, the average minimums were not as extreme as the summer maximums. The coolest period was August 2014 where an average minimum of 10.1°C was recorded.

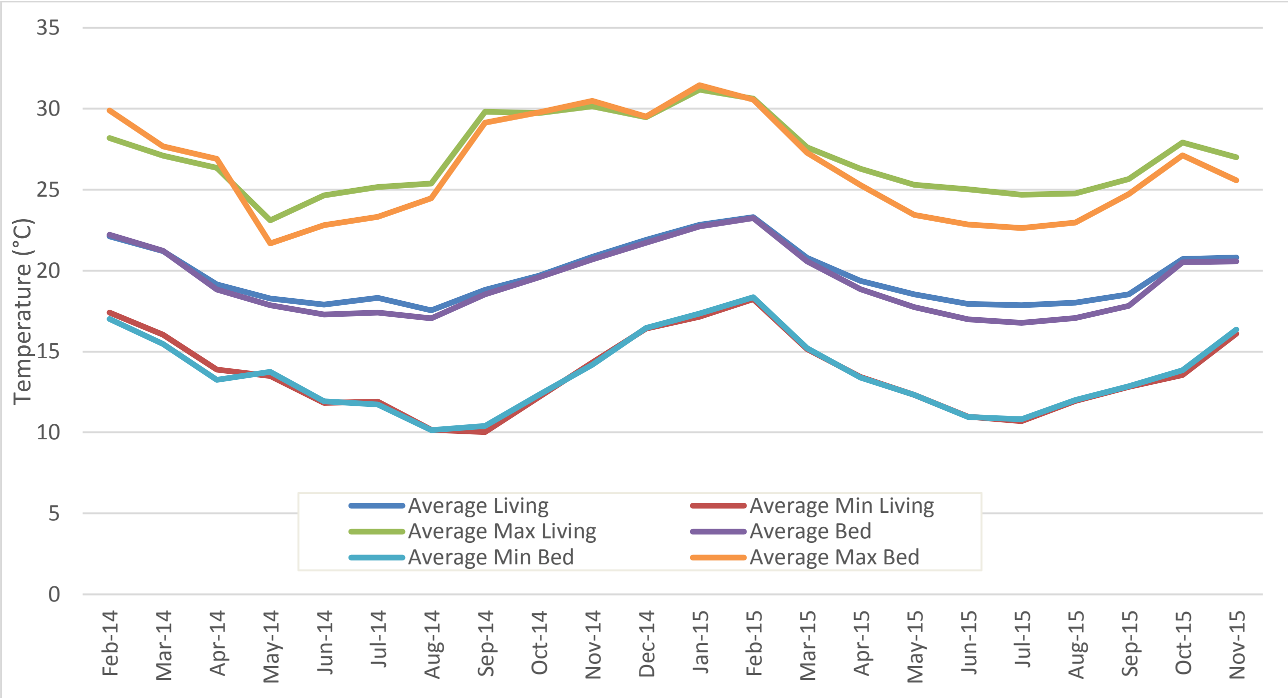

Figure 50: Monthly internal temperatures (°C) by location

3.9 Cost of interventions

Intervention costs varied from house to house (Figure 51), depending on what combination of interventions the house underwent. Retrofit interventions varied from $469 to $4,450 with a mean of $2,348. Behaviour change only interventions varied from $85 to $2,586 with a mean of $711. Retrofit combined with behaviour change interventions cost between $1,086 and $6,840 with a mean of $2,885.

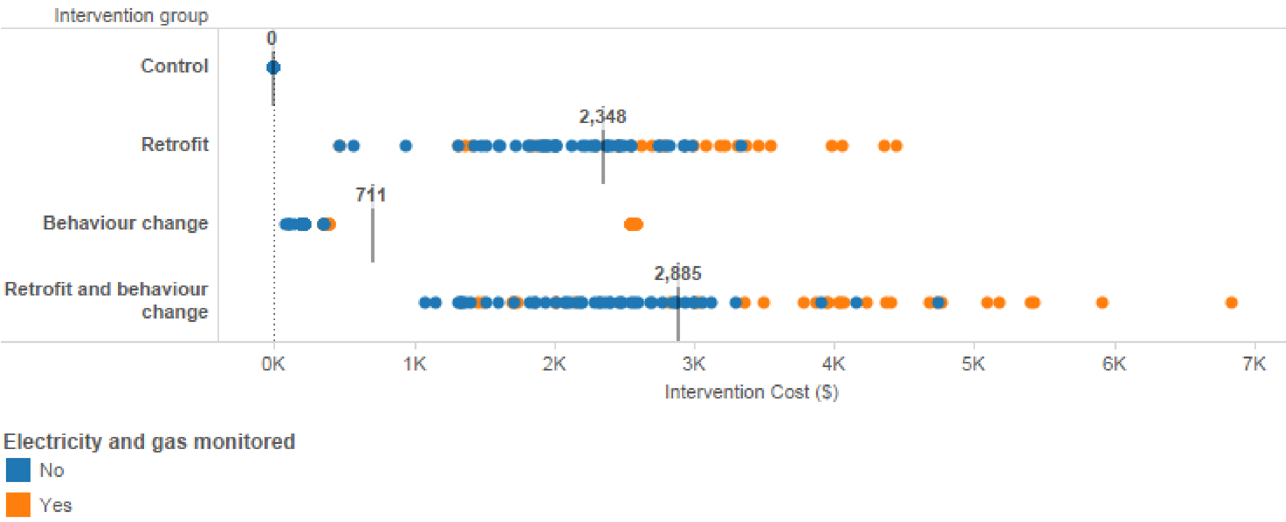

Figure 51: House intervention costs

Figure 52 shows the mean intervention costs for the intervention sub-groups (and separated into monitored or not monitored).

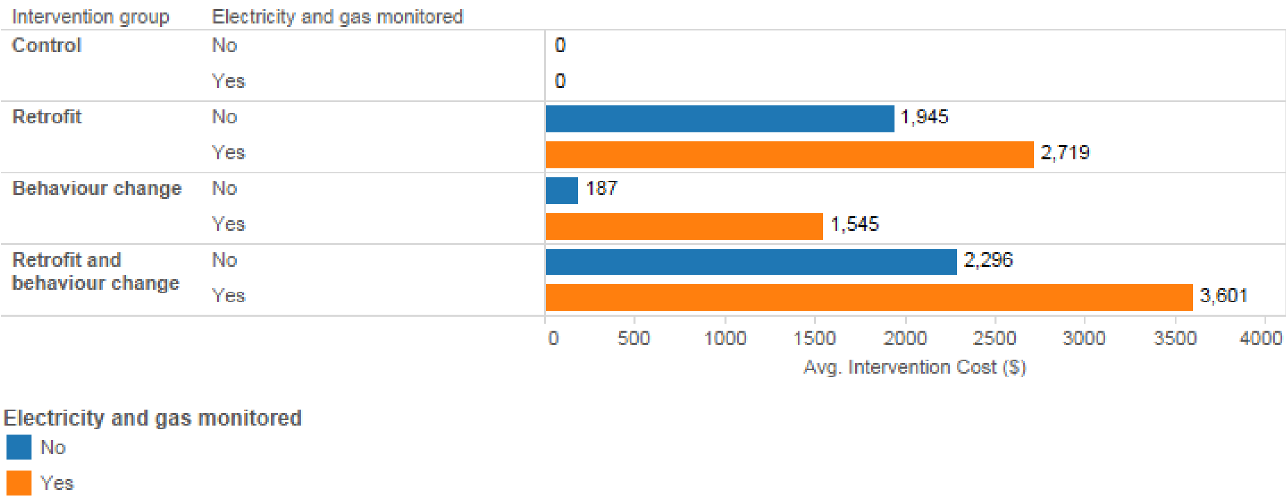

Figure 52: Intervention group average intervention cost

For houses which had LED lighting interventions, the mean cost of this intervention was $308.21 for the retrofit group and $212.18 for the retrofit and behaviour change group.

Table 7: Cost of LED lighting interventions

Study Group	Mean cost of house LED lighting interventions
Retrofit	$308.21
Retrofit and behaviour change	$212.18

Draught sealing at the 26 homes which were blower door/draught tested cost an average of $1673 per home. Some of these homes received draught sealing for as little as $400, whereas other homes received $2400 of draught sealing.

The building envelope retrofits at homes which were star rated and reassessed for their star ratings after retrofits cost an average of $2129 per home. The retrofit costs at these homes ranged from $901 to $3190.

From this data, the cost to increase the star rating of participating homes by 1 star averaged at $2661 per home.

3.9.1 Cost of providing the project at different levels

The costs to provide this project at 4 cost levels are provided in Table 8. Supply and install of home retrofits, plus home audits plus behaviour change support cost over $4000 per participant. Recruitment cost approximately $170 per participant and retention around $30 each. Running the project at an organisational level cost approximately $1.3 million dollars or nearly $4000 per participant over the 3 years and providing this project as a trial cost an additional $2 million, or over $18,000 per participant including in-kind contributions.

Table 8: Cost of providing this project at 4 cost levels, plus the cost:benefit ratios (taking into account 10 years of benefits)

Cost level	Cost level description	Cost ($)	Benefit/10 years ($)	Cost/benefit ratio
1	Direct trial approach i.e. delivery of the trial approach to a participant including: -Retrofit supply & install $2348 -Home audit $979 -Behaviour change & education coaching $711	4038	1642	2.5
2	Delivery of the trial approach to a participant **plus** recruitment and retention @ $198/participant	4236	1642	2.6
3	Delivery of the trial approach to a participant including recruitment and retention **plus** running the organisation to do the actions @ $3930/participant	8166	1642	5.0

4	Delivery of the trial approach to a participant including recruitment and retention and running the organisation **plus** participating in a government funded trial @ $10428 /participant	18594	1642	11.3

These costs are based on the facts/assumptions that:

- Participants all receive home retrofit and behaviour change support
- Benefits per year = $164.25 (derived from largest statistically significant $bill saving resulting from the intervention)
- Energy Liaison Officers cost $32 per hour plus 30% oncost (vehicle, desk, computer, superannuation etc) = $41.60/hour.
- Project management staff including coordinators, team leaders, administration costs = $50-55/hour
- Recruitment of participants takes approximately 1.75 hours each including background checks, applications, eligibility, engagement, visit to home and phone calls
- Retention of participants takes 45 minutes each during the project
- Running the organisation to support and facilitate the project cost $1,001,800 over the 3 years
- The extra costs to provide this program as a trial cost $1,958,600 for the 3 years
- In-kind contributions of $1.5 million were provided to the project

3.10 Retention of householders

This project retained 93% (or 299) of the 320 householders that were recruited to participate in the project at project end.

3.11 Data limitations

Ideally we would have a full year's worth of data pre-intervention and another full year's worth of data post-intervention. There were a number of reasons why this was not possible: the project started later and took longer 4 months longer to recruit householders than was originally planned; following on from this, later timing of interventions than originally planned; withdrawal of some volunteers before the end of the study period; and finally, earlier 'draft report' and final reporting deadlines than were in the project contract.

As the project did not have a full year's worth of data pre- and post-intervention, it was unable to calculate household average daily consumption over the year prior to intervention and then compare it against the household average daily consumption in the year after the intervention. Instead, we have used the available data to calculate average daily consumption for each month prior to intervention and again for each month after intervention. Only months where there was at least twenty days' worth of data were used. Where a house had pre- and post-intervention data for the same month (different year), the difference between the daily averages was calculated.

Although households received multiple interventions over a range of dates, the date of the first intervention was used as the dividing line between the pre-intervention period and the post-intervention period for each household. This was done in order to maximise the amount of data we could use for analysis. This may have resulted in the impact of interventions being greater in the later post-intervention months.

Some households had data covering more months than others. Due to this, the study group averages are weighted towards the houses and months where there was more data (Figure 53). There is no change data for January or February for any households, and there is data for only one household for March. This data limitation means that the impact of interventions on summer energy use is not properly gauged by this study and that the results are weighted to indicate winter outcomes.

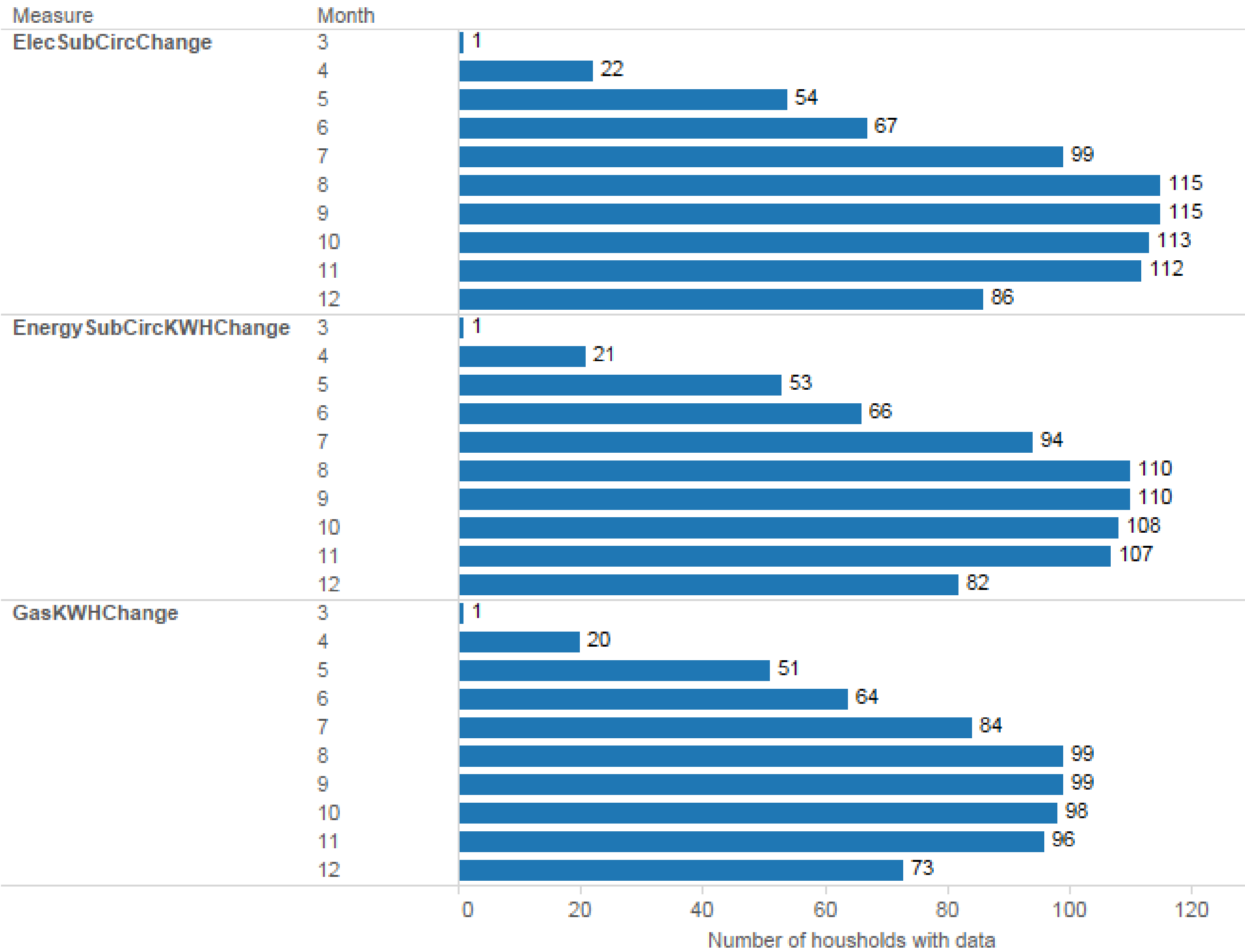

Figure 53: Number of households for which change data was available for each month

3.12 Intervention Impacts

3.12.1 Impact on energy consumption (monitored households)

The mean change in average daily energy consumption varies between study groups. For total energy, the mean change in average daily consumption was +0.05 kWh for houses in the control group, +1.70 kWh for houses which underwent retrofit, -0.95 kWh for houses which underwent behaviour change, and -4.31 kWh for houses which underwent a combination of retrofit and behaviour change. Thus, relative to the control group, retrofit houses had a mean change of +1.65 kWh, behaviour change houses had a mean change of

-1.00 kWh, and retrofit & behaviour change houses had a mean change of -4.36 kWh (Table 9).

Table 9: Intervention group change in average daily energy consumption relative to control group. Values marked with an asterisk (*) were statistically significant at the 0.95 level.

Intervention group	Change in average daily energy consumption relative to control group (kWh)		
	Total energy	Electricity	Gas
Retrofit	1.65	-0.82	2.28
Behaviour change	-1.00	-0.41	-0.91
Retrofit & behaviour change	-4.36*	-0.39	-4.80*

By comparing the changes in average daily energy consumption against the levels of consumption pre-intervention (Table 10) we can see that the retrofit and behaviour change intervention led to a saving of 10.0% in energy consumption, and a saving of 13.1% in gas consumption over the period of the analysis.

Table 10: Household average daily energy consumption pre-intervention and post-intervention (kWh)

Intervention Group	EnergySubCircKWH		ElecSubCirc		GasKWH	
	Pre-intervention	post-intervention	pre-intervention	post-intervention	pre-intervention	post-intervention
control	55.68	55.73	12.65	12.99	47.78	47.70
retrofit	50.43	52.13	12.68	12.19	39.20	41.40
behaviour change	51.62	50.40	10.88	10.80	45.19	43.92
retrofit & behaviour change	43.83	39.52	12.33	12.28	36.59	31.71

3.12.2 Impact on energy bills (monitored households)

The savings (or additional expenditure) on daily energy bills (Figure 55) associated with the change in energy consumption varied from house month to house month. The mean change in total daily energy bills was +3 cents for the control group, +1 cent for the retrofit group, -8 cents for the behaviour change group, and -30 cents for the combined retrofit/behaviour change group. Thus, relative to the control group, the retrofit group had a mean daily change of -2 cents, the behaviour change group had a mean change of -11 cents, and the combined retrofit/behaviour change group had a mean change of -33 cents. Changes in daily energy bills associated with electricity and gas consumption separately are shown in Figure 54, Figure 55 and Table 11. Only the change in gas bills for the combined retrofit/behaviour change group was statistically significant.

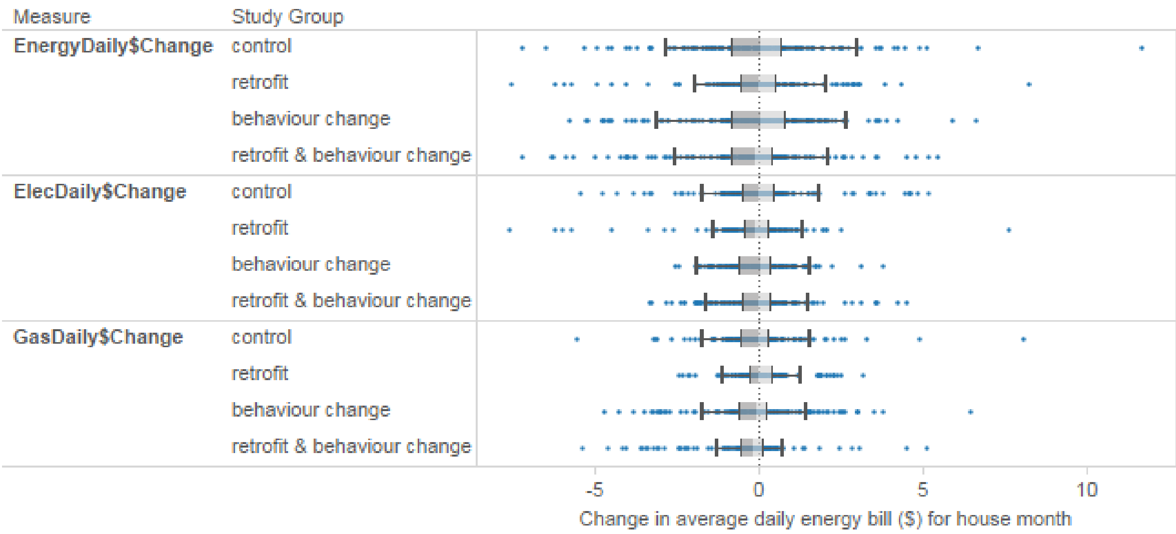

Figure 54: Change in average daily energy bills for house months (using monitored data, and sum of sub circuits for electricity)

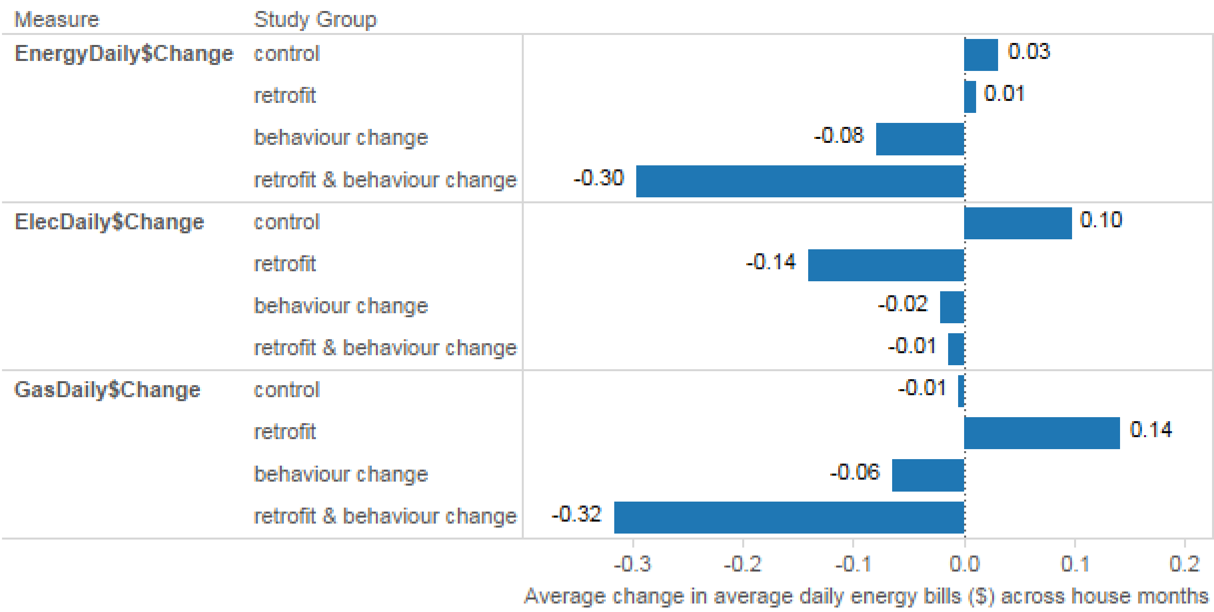

Figure 55: Mean change in average daily energy bills for houses in each study group (using monitored data, and sum of sub circuits for electricity)

Table 11: Intervention group change in average daily energy bills relative to control group

Intervention group	Change in average daily energy bills relative to control group ($)		
	For total energy	For electricity	For gas
Retrofit	-0.02	-0.24	0.15
Behaviour change	-0.11	-0.12	-0.59
Retrofit & behaviour change	-0.33	-0.11	-0.31*

By comparing the changes in average daily energy bills against the costs associated with gas consumption pre-intervention (Table 12) we can see that the retrofit and behaviour change intervention led to a saving of 13.1% in costs for gas consumption.

Table 12: Household average daily spend on energy consumption pre-intervention and post-intervention ($)

Intervention Group	EnergySubCirc$		ElecSubCirc$		Gas$	
	Pre-intervention	post-intervention	pre-intervention	post-intervention	pre-intervention	post-intervention
control	6.38	6.41	3.67	3.77	3.09	3.09
retrofit	6.04	6.05	3.68	3.54	2.54	2.68
behaviour change	5.80	5.70	3.15	3.13	2.93	2.84
retrofit & behaviour change	5.57	5.27	3.58	3.56	2.37	2.05

3.12.3 Impact on Greenhouse gas emissions (monitored households)

Table 13 show the changes in average daily greenhouse gas emissions for houses in each study group. Only the change in greenhouse gas emissions due to gas consumption for the combined retrofit/behaviour change group was statistically significant, with a mean daily savings of 0.95 kg CO2-e, when compared against the control group.

Table 13: Intervention group change in average daily GHG emissions relative to control group

Intervention group	Change in average daily GHG emissions relative to control group (kgCO_2-e)		
	For total energy	For electricity	For gas
Retrofit	-0.27	-1.03	0.46
Behaviour change	-0.42	-0.51	-0.18
Retrofit & behaviour change	-1.09	-0.48	-0.95*

By comparing the changes in average daily GHG emissions against the GHG emissions associated with gas consumption pre-intervention (Table 14) we can see that the retrofit and behaviour change intervention led to a saving of 13.0% in GHG emissions for gas consumption.

Table 14: Household average daily GHG emissions for energy consumption pre-intervention and post-intervention (kg CO_2-e)

Intervention Group	EnergySubCircKgCO_2		ElecSubCircKgCO_2		GasKgCO_2	
	Pre-intervention	post-intervention	pre-intervention	post-intervention	pre-intervention	post-intervention
control	24.16	24.31	15.94	16.37	9.53	9.51
retrofit	23.12	22.99	15.97	15.36	7.82	8.25
behaviour change	21.86	21.51	13.71	13.61	9.01	8.76
retrofit & behaviour change	21.59	20.65	15.54	15.48	7.30	6.32

3.12.4 Impacts on householder comfort (monitored households)

The change in indoor temperature in winter months was statistically significant for both the combined retrofit/behaviour change group (+1.61 °C) and the retrofit only group (+1.9 °C), when compared against the control group.

Figure 56 andTable 15 show the changes in household comfort as measured by average daily temperature in living rooms during the winter months. The change in temperature was statistically significant for both the combined retrofit/behaviour change group (+1.61 °C) and the retrofit only group (+1.9 °C), when compared against the control group.

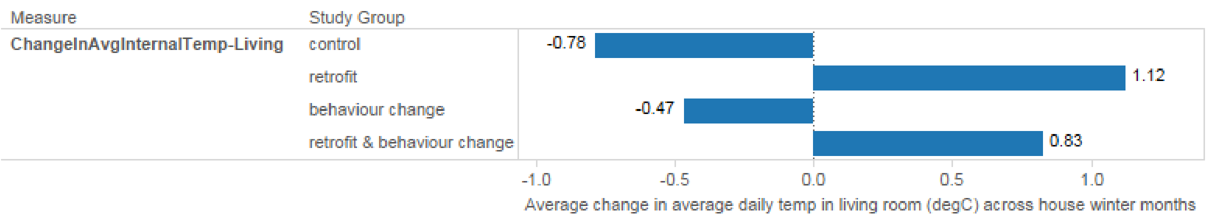

Figure 56: Mean change in average daily temperature in living room for houses in each study group during winter months (using monitored data, and sum of sub circuits for electricity)

Table 15: Intervention group change in average daily temperature in living room during winter months relative to control group

Intervention group	Change in average daily temperature in living room during winter months relative to control group (°C)
Retrofit	+1.9*
Behaviour change	+0.31
Retrofit & behaviour change	+1.61*

Table 16: Household average daily temperature in living room during winter months pre-intervention and post-intervention

Intervention Group	AverageTemp-Living for winter months (°C)	
	Pre-intervention	**Post-intervention**
control	17.47	16.68
retrofit	17.43	18.55
behaviour change	18.32	17.85
retrofit & behaviour change	17.54	18.37

By comparing the changes in temperature against the average daily temperature in the living room during winter months pre-intervention (Table 16) we can see that the retrofit only intervention led to a 10.9% increase in average daily temperature, and the retrofit and behaviour change intervention led to an increase of 9.2%.

3.12.5 Impact of LED lighting intervention (monitored households)

The electricity monitoring equipment in the houses measured consumption at the circuit level. This allowed examination separately the part of the electricity consumption that was used for lighting and enabled investigation into the impact of LED lighting retrofit interventions. The following analysis uses all monitored houses from the control and behaviour change groups, but only those monitored houses in the retrofit and combined retrofit/behaviour change groups that received LED lighting retrofit interventions.

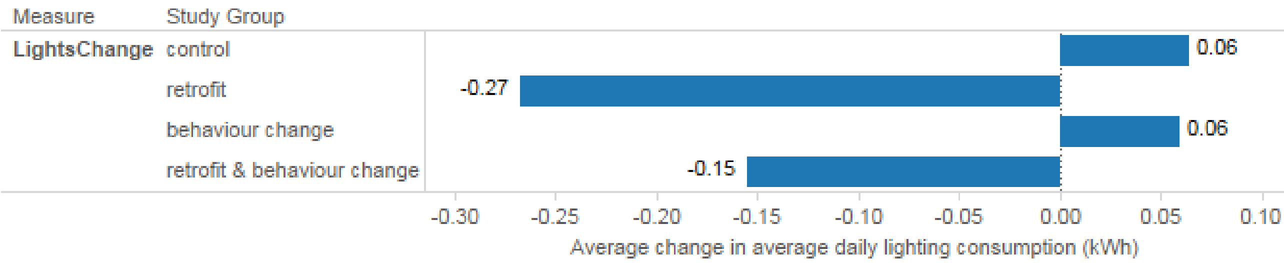

Figure 57: Mean change in average daily consumption of electricity for lighting for houses in each study group (using sum of monitored light circuits)

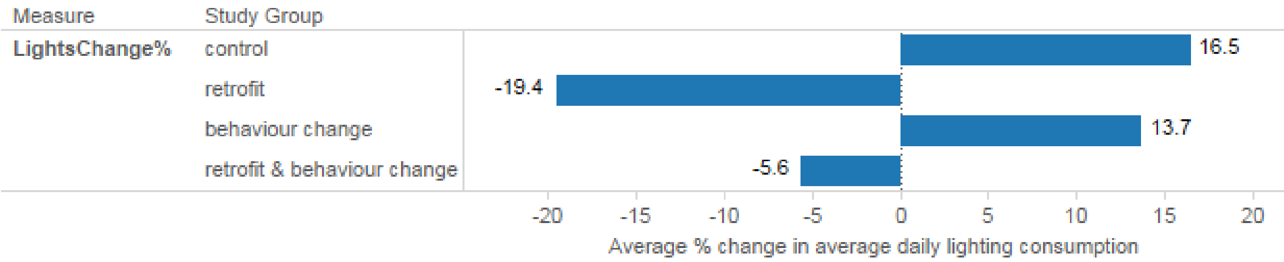

Figure 58: Mean percentage change in average daily consumption of electricity for lighting for houses in each study group (using sum of monitored light circuits)

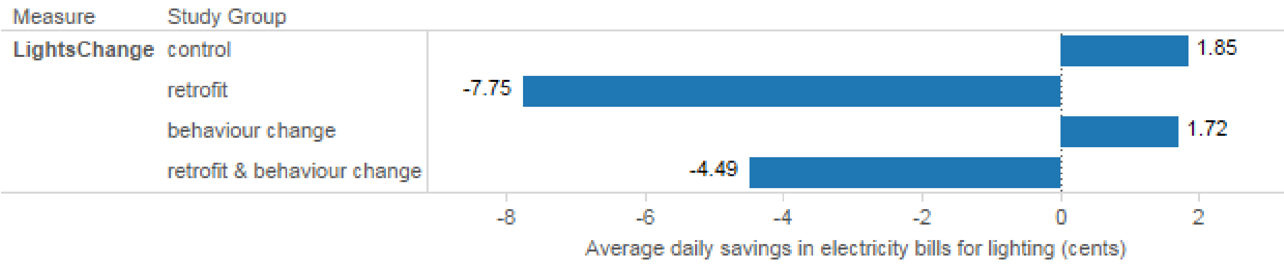

Figure 59: Mean change in average daily electricity bills for electricity consumed for lighting for houses in each study group

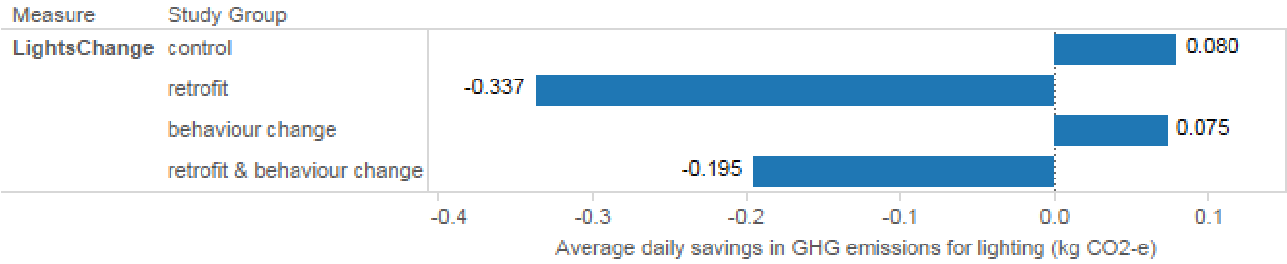

Figure 60: Mean change in average daily greenhouse gas emissions for electricity consumed for lighting for houses in each study group

Table 17: Intervention group changes in average daily electricity consumption, daily bills, and GHG emissions associated with lighting, relative to the control group

Intervention group	For lighting component of electricity consumption, relative to control group			
	Change in average daily electricity consumption (kWh)	Change in average daily electricity consumption (%)	Change in average daily electricity bills (cents)	Change in average daily GHG emissions (kg CO_2-e)
Retrofit	-0.33*	-35.9*	-9.5*	-0.42*
Behaviour change	0	-2.7	-0.1	-0.01
Retrofit & behaviour change	-0.21*	-22.1*	-6.3*	-0.28*

Households which underwent retrofit only interventions and which received LED lighting interventions made a mean saving in their average daily electricity consumption for lighting of 0.33 kWh, a mean percentage saving in their daily electricity consumption for lighting of 35.9%, a mean saving in their average daily electricity bills for lighting of 9.5 cents ($34.60/yr), and a mean saving in their average daily GHG emissions for lighting of 0.42 kg CO_2-e.

3.12.6 Impact on energy consumption (distributor data)

Relative to the control group retrofit houses had a mean change in their daily total energy consumption of -3.78* kWh, behaviour change houses had a mean change of -2.69 kWh, and retrofit & behaviour change houses had a mean change of -4.80* kWh. Looking at electricity only, relative to the control group, retrofit houses had a mean change of -1.05 kWh, behaviour change houses had a mean change of -0.77 kWh, and retrofit & behaviour change houses had a mean change of -0.15 kWh. Looking at gas only, relative to the control group, retrofit houses had a mean change of -2.54 kWh, behaviour change houses had a mean change of -3.25 kWh, and retrofit & behaviour change houses had a mean change of -7.01* kWh.

When tested for statistical significance (at the 0.95 level) using t-tests, the retrofit and behavioiur change group showed a change in total energy consumption which was statistically significant, and also in gas consumption. The retrofit group showed a change in total energy consumption which was statistically significant, but the change in gas consumption was not. None of the intervention groups showed a statistically significant change in electricity consumption by itself.

By comparing the changes in average daily energy consumption against the levels of consumption pre-intervention (Table 19) we can see that the retrofit and behaviour change intervention led to a saving of 11.4% in energy consumption, and a saving of 18.5% in gas consumption over the period of the analysis. The retrofit only intervention led to a saving of 7.1% in energy consumption.

Table 18: Intervention group change in average daily energy consumption relative to control group – using distributor data

Intervention group	Change in average daily energy consumption relative to control group [with 95%CI if difference is statistically significant] (kWh)		
	Total energy	**Electricity**	**Gas**
Retrofit	-3.78* [-7.24, -0.32]	-1.05	-2.54
Behaviour change	-2.69	-0.77	-3.25
Retrofit & behaviour change	-4.80* [-8.07, -1.53]	-0.15	-7.01* [-10.91, -3.11]

Table 19: Household average daily energy consumption pre-intervention and post-intervention (kWh) – using distributor data

Intervention Group	Energy		Electricity		Gas	
	Pre-intervention	**post-intervention**	**pre-intervention**	**post-intervention**	**pre-intervention**	**post-intervention**
control	50.38	54.08	12.61	11.48	44.37	53.05
retrofit	53.51	59.37	11.95	9.76	42.48	51.81
behaviour change	50.49	56.12	12.32	10.41	44.25	56.00
retrofit & behaviour change	42.02	42.90	10.48	9.20	37.81	42.66

3.12.7 Impact on energy bills (distributor data)

Relative to the control group, retrofit houses had a mean change in their daily total energy bills of -86.6 cents, behaviour change houses had a mean change of -36.7 cents, and retrofit & behaviour change houses had a mean change of -31.1 cents. Looking at electricity only, relative to the control group, retrofit houses had a mean change of -30.6 cents, behaviour change houses had a mean change of -22.3 cents, and retrofit & behaviour change houses had a mean change of -4.4 cents. Looking at gas only, relative to the control group, retrofit houses had a mean change of -16.5 cents, behaviour change houses had a mean change of -21.1 cents, and retrofit & behaviour change houses had a mean change of -45.4 cents.

When tested for statistical significance (at the 0.95 level) using t-tests, the retrofit only group showed a change in total energy bills which was statistically significant. The retrofit and behaviour change group showed a change in gas bills which was statistically significant.

Retrofit intervention led to a saving of 14.1% in costs for energy consumption. The retrofit and behaviour change intervention led to a saving of 18.6% in costs for gas consumption.

Table 20: Intervention group change in average daily energy bills relative to control group – using distributor data

Intervention group	Change in average daily energy bills relative to control group [with 95%CI if difference is statistically significant] ($)		
	Total energy	Electricity	Gas
Retrofit	-0.866* [-1.545,-0.187]	-0.306	-0.165
Behaviour change	-0.367	-0.223	-0.211
Retrofit & behaviour change	-0.311	-0.044	-0.454* [-0.706,-0.201]

Table 21: Household average daily energy bills pre-intervention and post-intervention ($) – using distributor data

Intervention Group	Energy		Electricity		Gas	
	Pre-intervention	post-intervention	pre-intervention	post-intervention	pre-intervention	post-intervention
control	6.068	6.047	3.657	3.329	2.873	3.435
retrofit	6.143	5.861	3.465	2.831	2.750	3.355
behaviour change	6.185	6.160	3.572	3.020	2.865	3.626
retrofit & behaviour change	5.089	4.904	3.040	2.668	2.448	2.762

Households which underwent a combination of retrofit and behaviour change interventions made a mean saving in their daily gas bill of $0.45 ($164/yr), or 18.6%.

Households which underwent retrofit only interventions made a mean saving in their daily total energy bill of $0.87 ($318/yr), or 14.1%.

3.12.8 Impact on greenhouse gas emissions (distributor data)

The change in in average daily greenhouse gas emissions due to gas consumption was statistically significant for the combined retrofit/behaviour change group, with a mean daily savings of 1.39 kg CO_2-e, when compared against the control group. The change in average daily greenhouse gas emissions due to total energy consumption was statistically significant for the retrofit only group, with a mean daily saving of 3.84 kg CO_2-e, when compared against the control group. No other results for changes in greenhouse gas emissions were statistically significant.

Table 22: Intervention group change in average daily GHG emissions relative to control group – using distributor data

Intervention group	Change in average daily GHG emissions relative to control group (kgCO2-e)		
	For total energy	For electricity	For gas
Retrofit	-3.84* [-6.73,-0.95]	-1.33	-0.51
Behaviour change	-1.60	-0.97	-0.65
Retrofit & behaviour change	-1.11	-0.19	-1.39* [-2.17,-0.62]

By comparing the changes in average daily GHG emissions against the GHG emissions associated with gas consumption pre-intervention (Table 23) we can see that the retrofit and behaviour change intervention led to a saving of 18.5% in GHG emissions for gas consumption, and the retrofit only intervention led to a saving of 16.5% in GHG emissions for total energy consumption.

Table 23: Household average daily GHG emissions for energy consumption pre-intervention and post-intervention (kg CO_2-e) – using distributor data

Intervention Group	EnergyDistKgCO2		ElecDistKgCO2		GasDistKgCO2	
	Pre-intervention	post-intervention	pre-intervention	post-intervention	pre-intervention	post-intervention
control	23.24	22.75	15.89	14.46	8.83	10.56
retrofit	23.27	21.32	15.06	12.30	8.45	10.31
behaviour change	23.79	23.07	15.52	13.12	8.80	11.14
retrofit & behaviour change	19.52	18.55	13.21	11.59	7.52	8.49

Households which underwent a combination of retrofit and behaviour change interventions made a mean saving in their greenhouse gas emissions due to gas consumption of 1.4 kg CO2-e, or 18.5%.

Households which underwent retrofit only interventions made a mean saving in their greenhouse gas emissions due to total energy consumption of 3.84 kg CO_2-e, or 16.5%.

3.12.9 Impact on householder comfort (for all houses with temperature data)

The change in average daily temperature in living rooms during the winter months was statistically significant for the retrofit only group (+0.96 °C), when compared against the control group.

There was insufficient summer data to be able to determine whether the interventions had an impact on indoor temperatures over the summer months.

Table 24: Intervention group change in average daily temperature in living room during winter months relative to control group – for all houses with temperature data

Intervention group	Change in average daily temperature in living room during winter months relative to control group (°C)
Retrofit	+0.96* [0.23,1.68]
Behaviour change	-0.02
Retrofit & behaviour change	+0.66

The retrofit only intervention led to a 5.1% increase in average daily temperature.

Table 25: Household average daily temperature in living room during winter months pre-intervention and post-intervention (for all houses with temperature data)

Intervention Group	AverageTemp-Living for winter months (°C)	
	Pre-intervention	Post-intervention
control	18.27	17.87
retrofit	18.69	19.24
behaviour change	19.26	18.84
retrofit & behaviour change	18.71	18.97

Feedback from householders after receiving insulation included:

"I had my doors sealed and insulation placed in the roof. Now it stays warmer when days are cooler and it warms up quicker and holds the heat."

Are you comfortable with the retrofit proposals that we offered to you?

"Oh yes very comfortable the minute that the draught excluders were put on I noticed oh there is something different here and you wouldn't think that a small thing like a draught excluder around a door or window could make such a difference. I felt it immediately and similarly with the new insulation it was just like a warm blanket had descended over the house, I was thrilled."

"It is not a young house … is pretty draughty ……. I did not realise it - I did not have enough insulation in the house and I now I don't have to get the heater on till later in the evening about 9pm and I am still comfortable and I used to put it on a 5.30pm. It felt like Christmas!"

3.12.10 Impact of IHD interventions on energy use

The allocation of households to IHDs was not a randomised procedure, so statistical analysis is not possible. The following analysis gives an account of the energy use of the different groups of households, but makes no statistically relevant claims.

3.12.10.1 Energy use results from the monitored data

Of the 28 households in the behaviour change group, 13 had the IHD Standard and 15 had the IHD Deluxe. Of the 32 households in the retrofit and behaviour change group, 11 had the IHD Standard, 15 had the IHD Deluxe, and 6 had no IHD.

Within the retrofit and behaviour change group, households which had an IHD installed (whether Standard or Deluxe) saved less energy than the households that did not have an IHD installed (Figure 61). Households with the Standard IHD installed saved more gas and more total energy than did the households with the Deluxe IHD installed, but used more electricity.

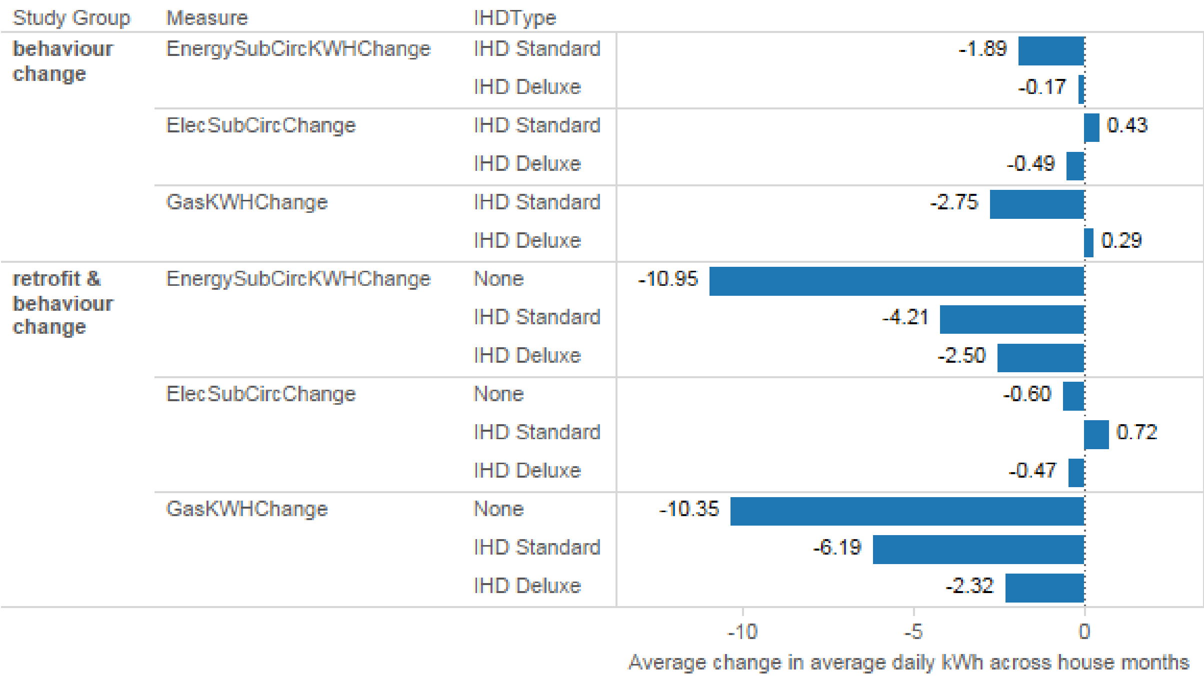

Figure 61: Change in average daily energy consumption for households with different IHD interventions (monitored data)

Within the retrofit group, households with the Standard IHD installed saved more gas and more total energy than did the households with the Deluxe IHD installed, but used more electricity.

3.12.10.2 Energy use results from the distributor data

Within the retrofit and behaviour change group, households which had an IHD installed (whether Standard or Deluxe) saved more on their gas, but less on their electricity and overall energy than the households that did not have an IHD installed (Figure 62).

Within the behaviour change group, households which had an IHD installed (whether Standard or Deluxe) saved more on their gas and overall energy, but less on their electricity than the households that did not have an IHD installed (Figure 62).

Within the retrofit and behaviour change group, households which had a Standard IHD installed made greater savings in their gas and overall energy use, but less savings in their electricity use than the households that had a Deluxe IHD (Figure 63). Households with the Deluxe IHD installed saved less electricity and gas, but more overall energy than did the households with no IHD installed.

Within the behaviour change group, households with the Standard IHD installed saved more electricity, gas and total energy than did the households with the Deluxe IHD installed (Figure 63).

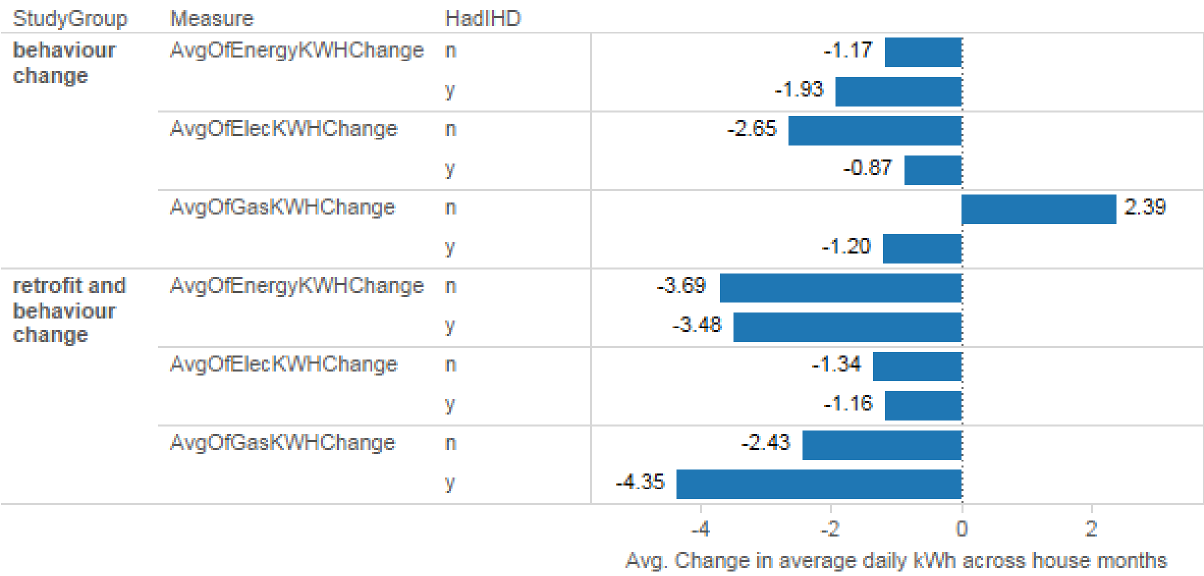

Figure 62: Change in average daily energy consumption for households with and without IHD interventions (distributor data)

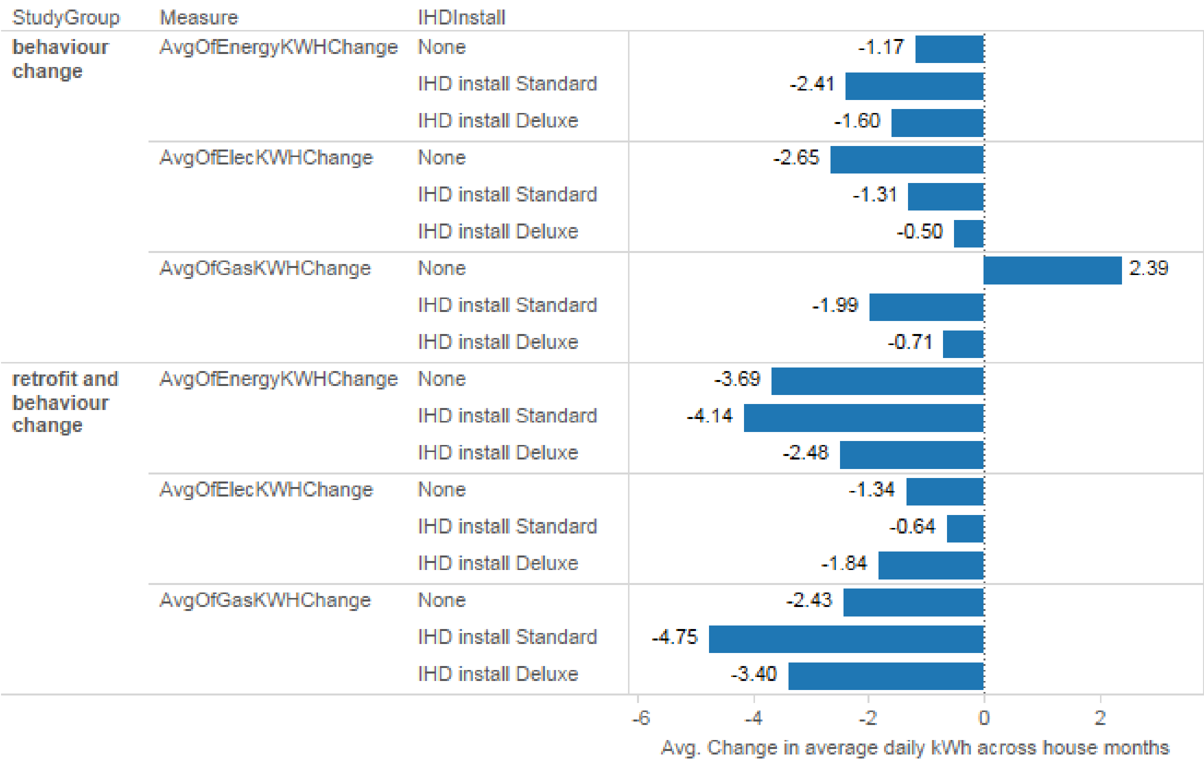

Figure 63: Change in average daily energy consumption for households with different IHD interventions (distributor data)

3.12.11 Householder views on retrofits

Over 90 percent of householders in the retrofit groups believed that the home improvements completed for them met their expectations (Table 26). When asked to rate the impact on the comfort of their home, the highest rated improvements were shade, heaters and coolers, insulation and draught sealing (Table 27).

Table 26: Householders' responses to the question, 'Did these home improvements meet your expectation?'

	Yes (%)	Yes (No.)	No (%)	No (No.)	Unsure (%)	Unsure (No.)
A. Retrofit group	95.71	67	0.00		0.04	3
C. Retrofit/Behavioural change group	94.03	63	0.01	1	0.04	3

Table 27: Householders' responses to the question, 'More specifically, rate the impact of the following home improvements on the comfort of your home'

Improvements	Num.	Useless	Not Useful	No change	Useful	Very Useful	% Useful or Very Useful
Insulation	126	0	0	18	38	70	85.7
Draught Sealing	103	2	3	15	38	45	80.6
Shade	8	0	0	0	3	5	100.0
Lighting	62	1	1	13	24	23	75.8
Heaters and Coolers	13	0	0	0	3	10	100.0
Appliances (Incl. TV)	7	0	0	2	2	3	71.4
Hot water service replacement	7	0	0	2	3	2	71.4
Other - please describe	31	0	0	13	7	11	58.1

Householders that received home improvement retrofit works have indicated that an increase in comfort levels have been achieved due to the works compared to the homes that did not receive retrofit works (effect size 0.2-0.35).

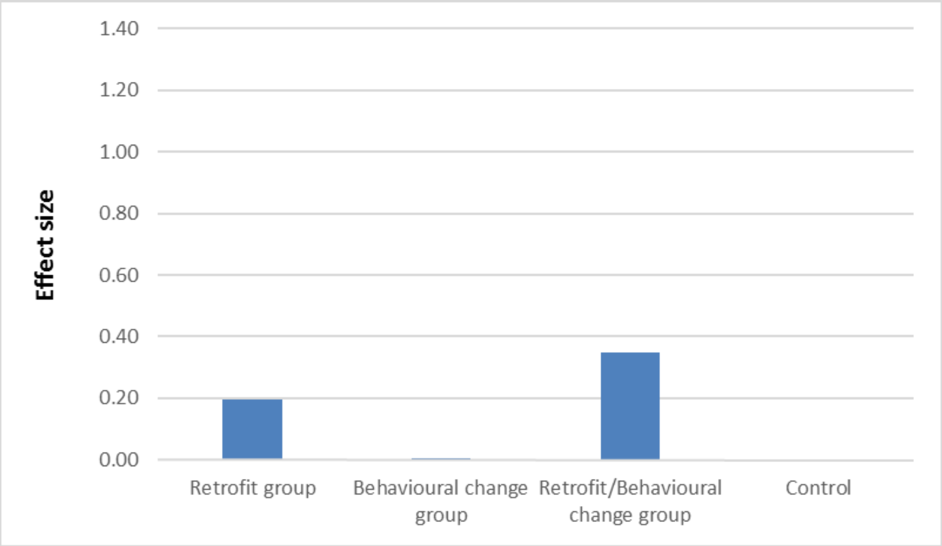

Figure 64: Effect size of Householders' responses to the question, 'How comfortable is your home? (heating/cooling/lighting etc.)' on the pre and post surveys using Control group as the base

3.12.12 Impact on NatHERS Star Rating

Sixty of the 120 monitored houses underwent a thermal efficiency star rating assessment pre-intervention. Their star rating varied from 0 stars to 5.5 stars with a mean of 2.7 stars (Figure 65).

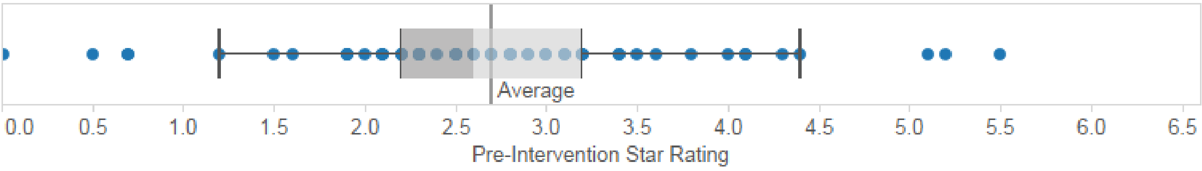

Figure 65: Star rating of 60 houses pre-intervention

Of these 60 houses, the 29 houses which had retrofit interventions also underwent a post-intervention thermal efficiency star rating assessment. Pre-intervention their star ratings varied from 0.5 stars to 5.5 stars with a mean of 2.7 stars; after the retrofit interventions their star ratings varied from 0.7 stars to 6.2 stars with a mean of 3.4 stars (Figure 66).

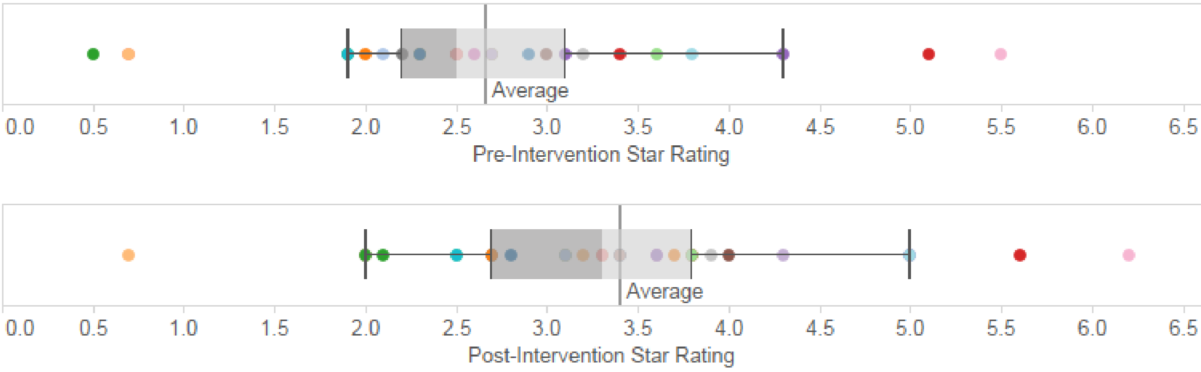

Figure 66: Star rating of 29 houses which had retrofit interventions pre-intervention and then post-intervention

Table 28: Star ratings before and after retrofit interventions on 59 randomly selected homes, change in star ratings and retrofit costs

Home identifier	Pre-Intervention Star Rating	Retrofit type: Draught sealing (various)	Retrofit type: Ceiling insulation	Post-Intervention Star Rating	Increase in Star Rating following retrofit	Cost of retrofit interventions ($)
1	2.8					2100
2	2.3	yes	yes	2.8	0.5	1864
3	1.9					
4	2.9					
5	3.2					
6	2.1	yes	yes	3.1	1	1820
7	2	yes	yes	2.7	0.7	2469
8	1.2					
9	0.7	yes		0.7	0	2852
10	0.5	yes	yes	2	1.5	2305
11	3.6					
12	3.4		yes	3.8	0.4	1830
13	2.5		yes	3.3	0.8	2545
14	3.5					
15	4.1					
16	2.8					
17	2.2					
18	3.1	yes	yes	3.6	0.5	1821
19	2.7	yes	yes	4.3	1.6	2695
20	3	yes	yes	4	1	1998
21	2.2					
22	2.5	yes	yes	3.4	0.9	2780
23	2.6	yes	yes	3.6	1	1655

24	2.8					
25	4					
26	5.5		yes	6.2	0.7	1488
27	2.2	yes	yes	2.7	0.5	2318
28	3.2	yes	yes	3.9	0.7	2794
29	2.4					
30	1.6					
31	4.1					
32	2.7	yes	yes	3.1	0.4	2187
33	2.3	yes	yes	3.3	1	2556
34	2.3					
35	1.9	yes	yes	2.5	0.6	1501
36	3.8	yes	yes	5	1.2	2934
37	2.9	yes	yes	3.4	0.5	1317
38	2.7	yes	yes	3.3	0.6	2846
39	2.3					
40	2.1					
41	3.4					
42	2.8					
43	2.6					
44	2.3		yes	3.7	1.4	1915
45	4.4					
46	3					
47	3.2					
48	3.1					
49	2.5					
50	2.5	yes	yes	3.2	0.7	2289
51	1.9		yes	2.1	0.2	1808
52	1.5					
53	5.2					
54	2.3	yes	yes	2.5	0.2	3190
55	2.1					
56	2.3					
57	5.1	yes	yes	5.6	0.5	1301
58	0.7		yes	2	1.3	1339
59	4.3	yes	yes	5	0.7	917
					Average retrofit cost	$2,129

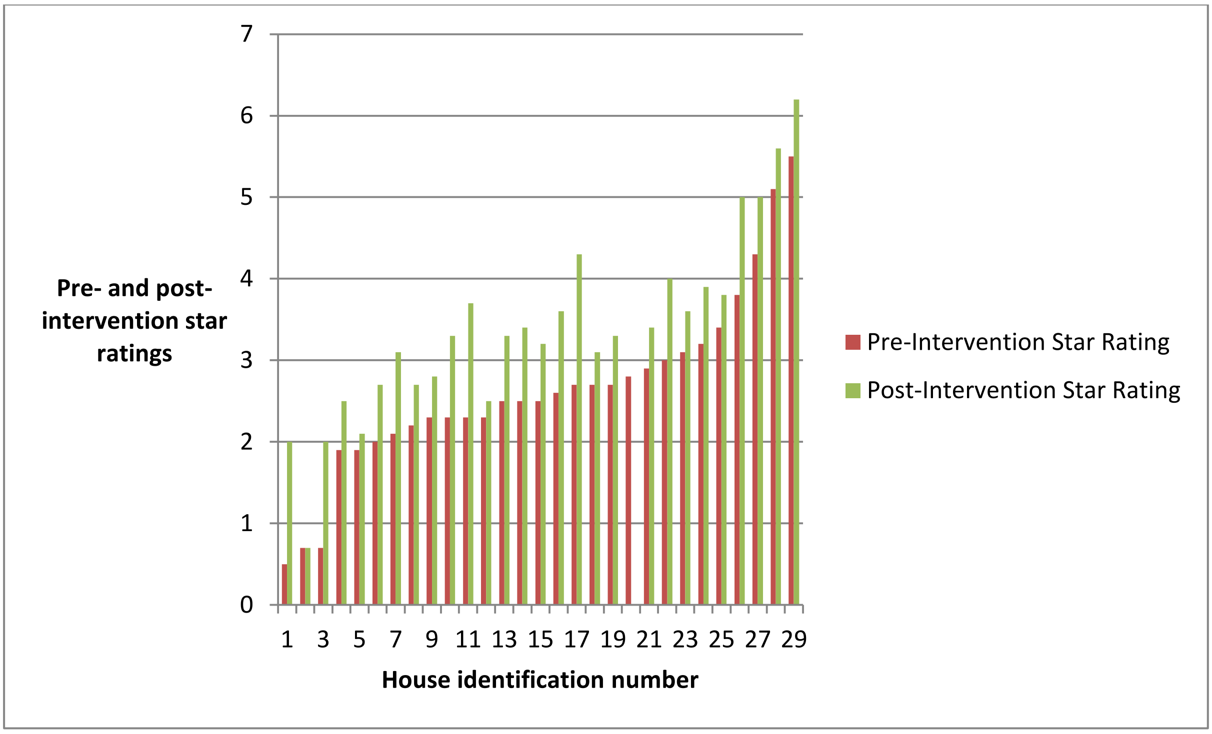

Figure 67: Star ratings for 29 test homes before and after building envelope retrofit works

3.12.13 Impact of Behaviour Change intervention

3.12.13.1 Impact of Energy Action Plan

3.12.13.1.1 Number of energy efficiency actions by householders

Most householders adopted new energy efficiency actions as a result of the EAP. This was demonstrated in the results to questions answered by both the ELOs and householders below.

Table 29: ELO responses to the questions, 'How many householders adopted new behaviours as a result of participating in this program?' and 'How many householders reinforced existing behaviours as a result of participating in this program?'

ELO response to questions regarding householder behaviours	None	A few	Some	Most	All	Average (/5)
Adopted new behaviours	0	1	3	2	0	3.2
Reinforced existing behaviours	0	0	0	5	1	4.2

Most householders (>80 percent) indicated they adopted at least one new action and over half reported they adopted two or more actions

Table 30: Householders', who participated in the EAP, responses to the question, 'How many new energy saving actions did you adopt?'

Householders response to "How many new energy saving practices did you adopt?"	Number (n=129)	Percentage
We didn't adopt any new practices	25	19.4
We adopted one new practice	35	27.1
We adopted two new practices	39	30.2
We adopted three new practices	14	10.9
We adopted four or more new practices	16	12.4
One or more new practices	104	80.6

Table 30: Householders', who participated in the EAP, responses to the question, 'How many new energy saving actions did you adopt?'

Householders response to "How many new energy saving practices did you adopt?"	Number (n=129)	Percentage
We didn't adopt any new practices	25	19.4
We adopted one new practice	35	27.1
We adopted two new practices	39	30.2
We adopted three new practices	14	10.9
We adopted four or more new practices	16	12.4
One or more new practices	104	80.6

Growth in the number of energy efficiency actions by householders in the behaviour change study groups was achieved, but not by householders in the other 2 study groups. The effect size was determined to be medium (effect size greater or equal to 0.4).

The number of the actions undertaken by householders to save energy was tracked during the project and the average number of actions has grown from 16.2 to 19.2 in this time. That is, householders, on average, had adopted three new actions. Importantly, there was a 10 percent increase in the number of householders who reported they incorporated 20 actions or more in their daily lives and a 14 percent decline in those reporting less than 10 actions. (Table 31, Figure 68).

Table 31: The average number of actions taken by householders who participated in the EAP prior and post interventions, and percentages by category (n=129)

		Pre-survey		Post-survey
Average number of actions		16.2		19.2
Correlation		0.7770		
Category	**Range of actions**	**Pre-survey (%)**	**Post-survey (%)**	**% Change**
Low	0-10	24.0	10.1	-14.0
Medium	11-20	49.6	53.5	3.9
High	21-30	26.4	36.4	10.1

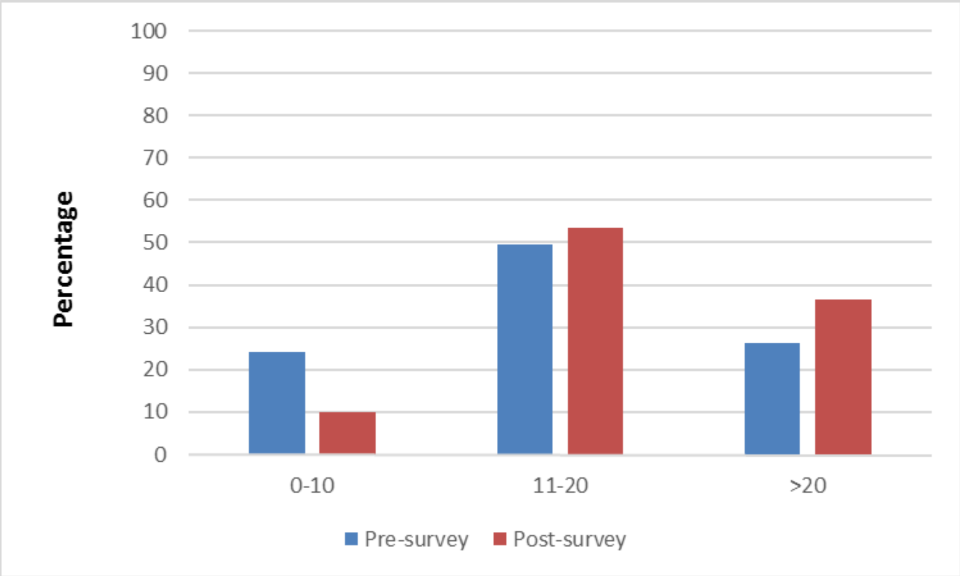

Figure 68: The percentage of householders in the three 'action' level categories (low number of actions, medium & high), pre-survey and post-survey (n=129)

The majority of new actions that the householders adopted were indoor temperature management (28%), buying more efficient appliances (17%) and water use (16%).

Table 32: Householders' responses to the question, 'What were they?'

	A. Retrofit group	B. Behavioural change group	C. Retrofit/ Behavioural change group	D. Control	%
Indoor temperature management (use of thermometer, heater type [fixed/portable], time of heater/cooler use, wearing suitable clothes, windows/doors open/closed, shade, use of blankets etc)	14	27	32	4	28.3
Draught sealing (seal doors, wall vents, holes in walls, fixed louver windows etc)	7	2	7	0	5.9
Water (only boil what you will use, clothes wash full load/in cold, short showers, cold rinse dishes)	4	22	15	2	15.8
Fridges (1 only, no hot food, defrosting, seal)	0	14	8	0	8.1
Lighting (when on/off, zone/pedestal lights)	5	12	15	3	12.9
Appliances (buying more efficient, switches off, standby)	5	22	16	2	16.5
Improving energy bills and retailers	0	3	6	0	3.3
Clothes drying on wash line	0	0	0	1	0.4
Other - Please specify	4	11	17	4	13.2

3.12.13.1.2 Householder feedback about the EAP

Householders indicated a high degree of satisfaction with the Energy Action Program (EAP). The majority of householders (79%) gave high ratings (4 or 5 out of 5). Of the 129 respondents, only a very few gave low ratings (less than 3) (Table 33).

Table 33: Householders' responses to the question, 'How would you rate the experiences you had with the energy action program?'

	Rating						
Householders' responses to 'How would you rate the experiences with the EAP?'	**1**	**2**	**3**	**4**	**5**	**mean**	**(%) High rating 4 or 5**
Householders who participated in the EAP (n=129)	3	0	24	45	57	4.19	79.1

Most householders (74.4 percent) indicated an improved understanding of saving energy compared to a minority of the control group (17.8 percent) (Table 34).

Table 34: Householders' responses to the question, 'On a scale from 1-5 how would you rate your improved understanding of saving energy?', EAP participants and control

	Rating						
	1	**2**	**3**	**4**	**5**	**mean**	**(%) Improved (3, 4 or 5)**
Householders who participated in the EAP (n=129)	22	11	40	23	33	3.26	74.4
Control (n = 73)	48	12	10	2	1	1.59	17.8

3.12.13.2 Impacts of In-Home Displays

3.12.13.2.1 Use of deluxe IHDs

For the 30 "deluxe' In-Home Displays, Table 35 and Figure 69 indicate the average use of each page of the energy use software by each householder during the 7 months of March – October 2015.

Table 35: Average number of times each page of the deluxe IHD was visited by householders in a 7 month period

Page visited on IHD	Home	Energy Usage	Tips Page	More Information
Average number of times each page was visited by householder	133	17	5	6

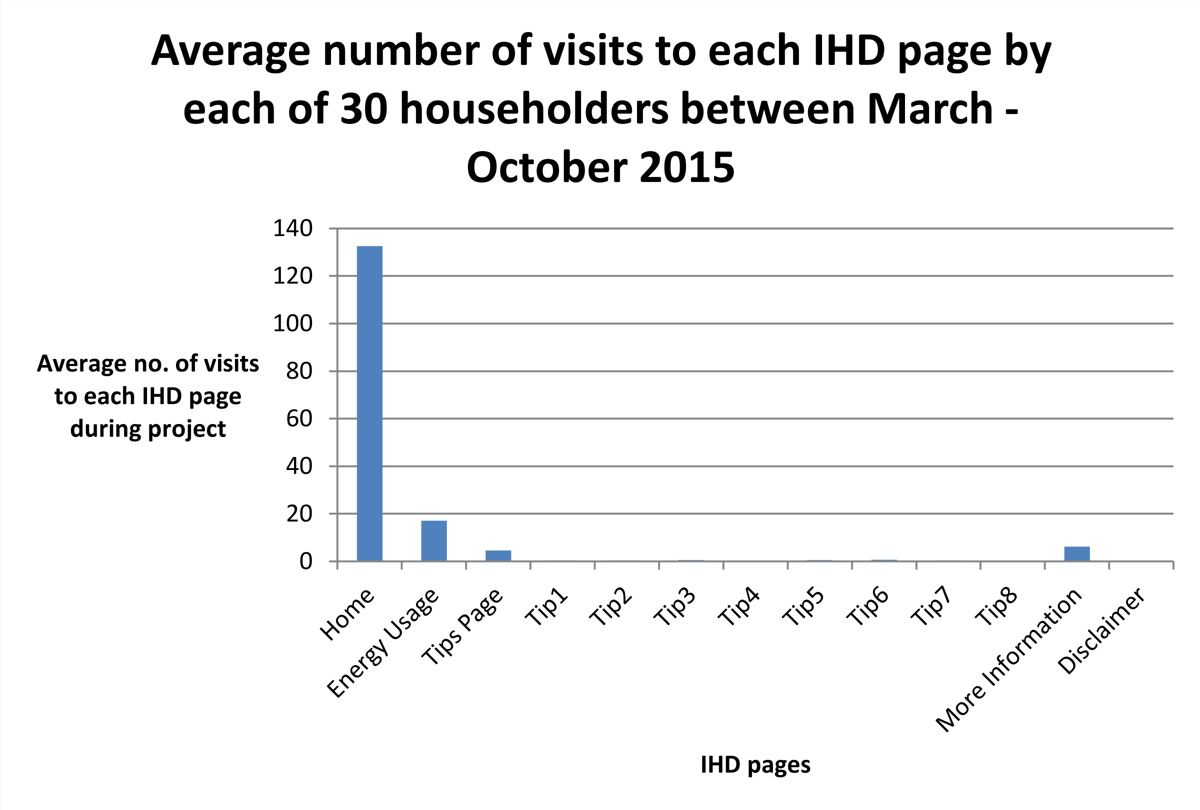

Figure 69: average number of times each page of the deluxe IHD was visited in 7 months

It is important to note that the IHD software defaulted to the home page when it wasn't used for 30 minutes, which made the number of visits to the home page artificially high.

The 'Energy Usage' page was visited approximately twice per month per user over the 7 months.

3.12.13.2.2 Householder feedback about IHDs

The results from the householder IHD survey suggests that the IHDs appealed to only a minority of participating householders. In most cases, two people in the household used the device (Table 36).

Table 36: The number of people in the household who used the IHD

Number of people	Deluxe	Watt's Clever
1	2	4
2	18	15
3	3	1
4	0	0
5	0	1

Twice as many householders who used the deluxe IHD indicated they were regularly or sometimes using it when compared to the Watt's Clever device (NB: the difference was not statistically significant) (Table 37).

Table 37: Householders' response to the questions, 'How often have you been using it? Are you still using it?'

	Deluxe (No.)	Watt's Clever (No.)
Regularly	6	4
Sometimes	4	1
A few times but not any more	8	11
Never	1	4
Other (see below)	4	1

10 of the 23 householders (44 percent) who were given the deluxe device indicated that they were regular or sometime users of the device, compared to five who had the Watt's Clever device (24 percent).

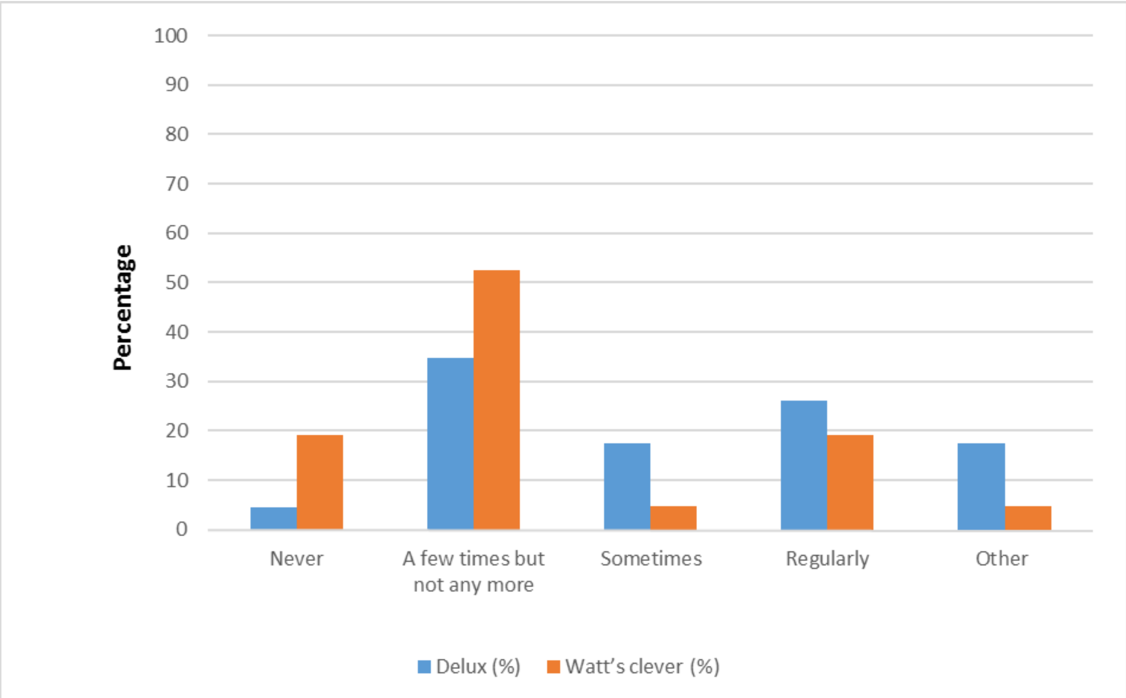

Figure 70: Householders' response to the questions, 'How often have you been using it? Are you still using it?', as percentages

These fifteen householders did so predominantly to observe their overall energy consumption and to find out how much power an appliance uses. Seven householders with the deluxe IHD (30 percent) and three with the Watt's Clever IHD (14 percent) believed it had influenced how they used their appliances and lighting around their house.

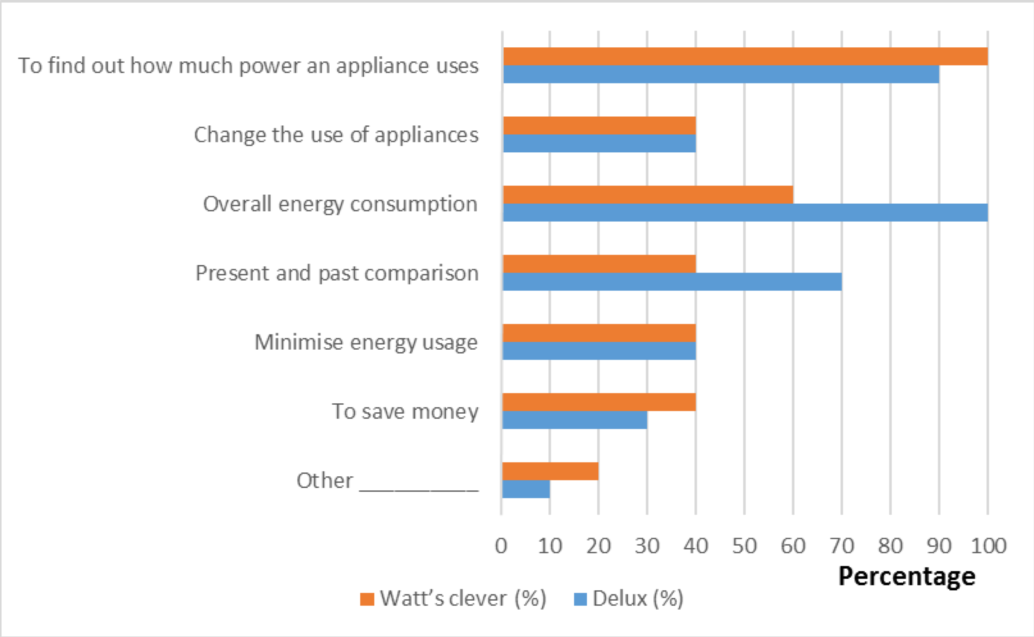

Figure 71: Householders' response to the questions, 'If regularly or sometimes, in what ways did you use it?', as percentages

Table 38: Householders' response to the question's, 'If regularly or sometimes, has it influenced how you use your appliances and lighting around the house?'

	Deluxe (No.)	Deluxe (%)	Watt's Clever (No.)	Watt's Clever (%)
Yes	7	30.4	3	14.3
No	3	13.0	2	9.5
Didn't use the device regularly or sometimes	13	56.5	16	76.2

For those that answered 'yes' to the question 'If regularly or sometimes, has it influenced how you use your appliances and lighting around the house?' the influences mentioned included 'more observant', 'conscious of power use' (bought a smaller kettle and only fills it with the required amount of water),' conscious of heating' (reduced heating at night), 'I was able to see how much my appliances were using when on and on standby' (air conditioner was using 100 watts on standby), 'made us more aware of timing and costs'.

When asked "how easy was it to use" the householders with the deluxe IHD were split between those who see the devices being difficult to use and those who see the device as easy to use. The data was bimodal, with 35 percent indicating it difficult or very difficult to use at one end of the scale and 48 percent finding it easy or very easy to use at the other end. The data for the Watt's Clever device, however, shows no such division with most householders (76%) reporting it as ok or easy to use.

Table 39: Householders' response to the question, 'How easy was it to use?'

	Deluxe (No.)	Deluxe (%)	Watt's Clever (No.)	Watt's Clever (%)
Very difficult	3	13.0	1	4.8
Difficult	5	21.7	3	14.3
OK	4	17.4	9	42.9
Easy	9	39.1	7	33.3
Very easy	2	8.7	1	4.8

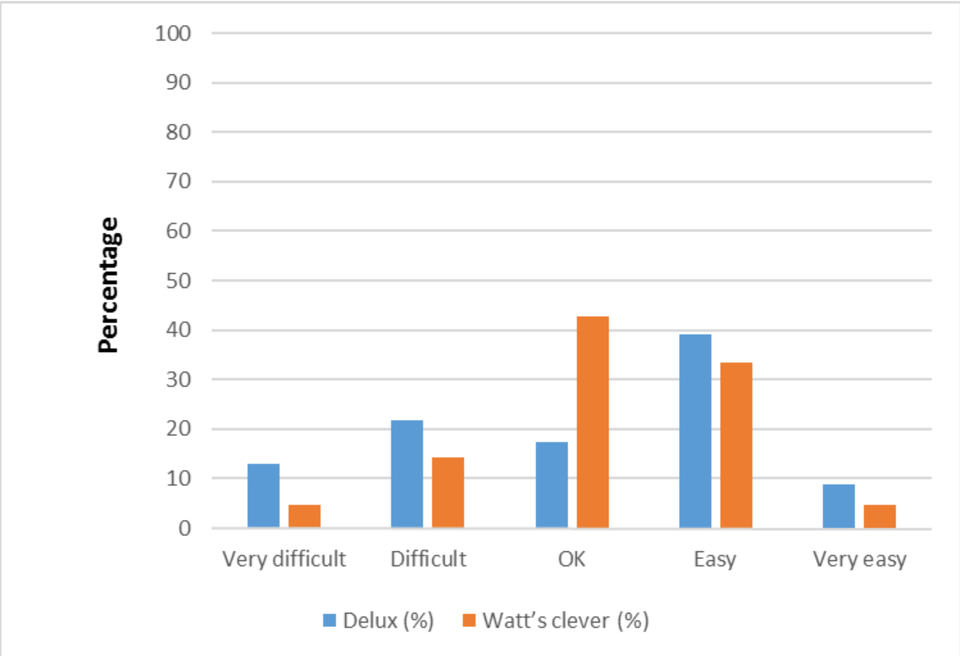

Figure 72: Householders' response to the question, 'How easy was it to use?', as percentages

Table 40: Householders' response to the questions, 'Why was it easy to use?'

	Deluxe (No.)	Deluxe (%)	Watt's Clever (No.)	Watt's Clever (%)
Couldn't work it out	2	8.7	2	9.5
Not good with technology	7	30.4	2	9.5
Too complicated	0	0.0	1	4.8
Difficult to read	2	8.7	6	28.6
Not interested	3	13.0	3	14.3
Tablet connection issues	11	47.8	3	14.3
Couldn't understand the data presented	1	4.3	3	14.3
Showed the information I wanted	6	26.1	5	23.8
Good presentation of data	10	43.5	3	14.3
Other (see below)	8	34.8	8	38.1

deluxe - other	Watt's Clever - other
• easy to navigate • health issues so difficult to concentrate for any length of time • Poor eyesight and difficulty with hands made it hard to use • it was easy to use • good display of the time in the location I had it. • good to learn that aircon was using power on standby	• showed when electricity use spiked • too ill to worry about it. Always shows high usage as oxygen machine on. • didn't give useful information. E.g. where energy used

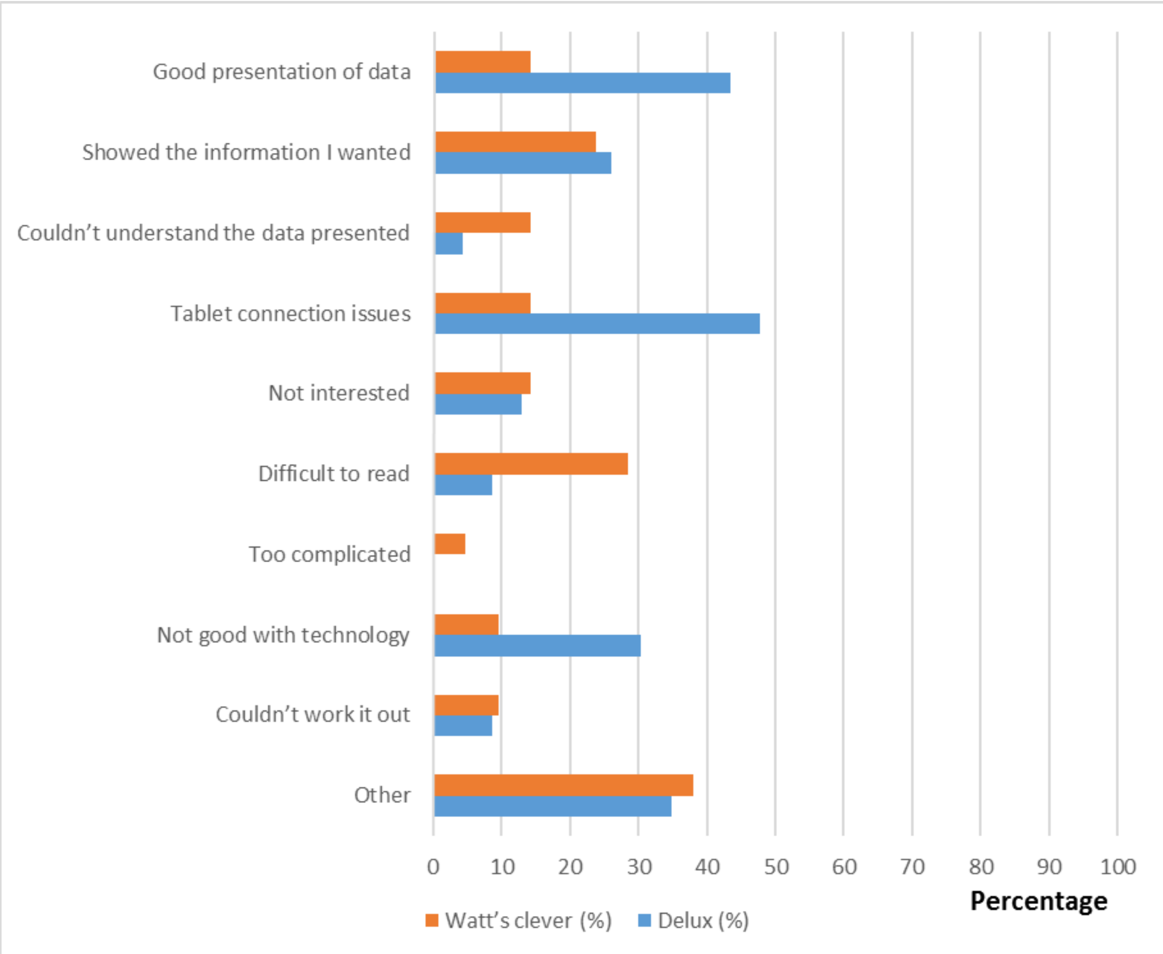

Figure 73: Householders' response to the questions, 'Why was it easy to use?', as percentages

The split among the deluxe IHD users suggests computer skills may be playing an important role in deciding how well it is used. On the other hand, a large number of Watt's Clever uses found it ok or easy to use but it was not appealing enough for most to use it on an occasional or regular basis. Some caution should be taken when considering these findings as the number of householders participating was small.

3.13 Intervention cost effectiveness

3.13.1 Monitored data

Using the mean intervention impacts (which were statistically significant) together with the cost of the interventions, the cost effectiveness of the interventions was calculated (Table 41). For example, it costs a household undergoing a combination of retrofit and behaviour change interventions $2.26 to save 1 kWh of total energy (electricity and gas) per year; it costs a household undergoing retrofit interventions only $1,431 to make their house 1°C warmer in winter, compared to retrofit and behaviour change combination interventions which cost $2237 per °C.

Table 41: Cost effectiveness of interventions which had a statistically significant impact – using monitored data

Intervention	Impact measure	Cost effectiveness
Retrofit and behaviour change	Total energy consumption (measured as sum of monitored sub circuits and gas)	$2.26 per kWh saved per year
Retrofit and behaviour change	Gas consumption	$2.06 per kWh saved per year
Retrofit and behaviour change	Total energy consumption (measured as sum of monitored mains circuits and gas)	$2.12 per kWh saved per year
Retrofit and behaviour change	Gas bills	$31.83 per $ saved in annual gas bill
Retrofit and behaviour change	GHG emissions from gas consumption	$10.39 per kgCO2-e saved over a year
Retrofit and behaviour change	Temperature in living room in winter	$2237 per °C warmer in winter
Retrofit	Temperature in living room in winter	$1431 per °C warmer in winter
Retrofit (including LED lighting)	Electricity consumed for lighting	$2.56 per kWh saved per year
Retrofit and behaviour change (including LED lighting)	Electricity consumed for lighting	$2.77 per kWh saved per year
Retrofit (including LED lighting)	Electricity bills - for lighting	$8.89 per $ saved in annual electricity bill
Retrofit and behaviour change (including LED lighting)	Electricity bills - for lighting	$9.23 per $ saved in annual electricity bill
Retrofit (including LED lighting)	GHG emissions - for lighting	$2.01 per kgCO2-e saved over a year
Retrofit and behaviour change (including LED lighting)	GHG emissions - for lighting	$2.08 per kgCO2-e saved over a year

3.13.2 Distributor data

Using the mean intervention impacts (which were statistically significant) together with the cost of the interventions, the cost effectiveness of the interventions was calculated (Table 42). For example, it costs a household undergoing a combination of retrofit and behaviour change interventions $1.65 to save 1 kWh of total energy (electricity and gas) per year; It costs a household undergoing retrofit interventions only $2,451 to make their house 1°C warmer in winter.

Table 42: Cost effectiveness of interventions which had statistically significant impact – using distributor data

Intervention	Impact measure	Cost effectiveness
Retrofit and behaviour change	Total energy consumption (using distributor data)	$1.65 per kWh saved per year
Retrofit and behaviour change	Gas consumption (using distributor data)	$1.13 per kWh saved per year
Retrofit	Total energy consumption (using distributor data)	$1.70 per kWh saved per year
Retrofit and behaviour change	Gas bills	$17.42 per $ saved in annual gas bill
Retrofit	Energy bills	$7.43 per $ saved in annual gas bill
Retrofit and behaviour change	GHG emissions from gas consumption	$5.67 per kgCO2-e saved over a year
Retrofit	GHG emissions from total energy consumption	$1.68 per kgCO2-e saved over a year
Retrofit	Temperature in living room in winter	$2451 per °C warmer in winter

3.14 Intervention cost- benefit analysis

3.14.1 Monitored data

Using the mean financial benefits (which were statistically significant) for 10 years together with the mean cost of the interventions, the cost –benefit ratios of the interventions were calculated.

Table 43: Cost - benefit ratios of interventions which had a statistically significant benefit – using monitored data based on 10 years of benefits

Intervention	Impact measure	Cost –benefit ratio
Retrofit	Lower electricity costs for lighting	6.77
Retrofit and behaviour change	Lower cost gas bills	2.54

3.14.2 Distributor data

Using the mean financial benefits (which were statistically significant) for 10 years together with the mean cost of the interventions, the cost –benefit ratios of the interventions were calculated.

Table 44: Cost - benefit ratios of interventions which had a statistically significant benefit - using distributor data based on 10 years of benefits

Intervention	Impact measure	Cost –benefit ratio
Retrofit	Lower cost total energy bills	0.74
Retrofit and behaviour change	Lower cost gas bills	1.75

3.15 Data uploaded to LIEEP portal

A lot of the data collected by this project will be used in analysis by the DIIS (along with data from 19 other LIEEP grant recipient projects). For this purpose, data was mapped into LIEEP schema format and uploaded to the LIEEP portal (Table 45). Energy and temperature data, which did not have a format specified for it, has also been uploaded to the LIEEP portal (Table 46).

Table 45: Data uploaded to LIEEP portal in LIEEP schema format

LIEEP Schema table name	Description	SECCCA file uploaded	Number of records
AAS_EE_SURVEY	Attitudes To Energy Efficiency Survey	AAS_EE_SURVEY.csv	313
DWELLING	Dwelling Details	DWELLING.csv	320
ENERGY_AUDIT	Energy Audit	ENERGY_AUDIT.csv	319
FUNDING_AGREEMENT_SURVEY	Funding Agreement Survey	FUNDING_AGREEMENT_SURVEY.csv FUNDING_AGREEMENT_SURVEY_post intervention.csv	319 276
GRANT_RECIPIENT_STAFF	Grant Recipient Staff	GRANT_RECIPIENT_STAFF.csv	17
GRANT_RECIPIENT	Grant Recipient Details	GRANT_RECIPIENT.csv	1
IHD	In-home Display	IHD.csv	60
INFORMATION	Information Session	INFORMATION.csv	361
INSULATION	Insulation Details	INSULATION.csv	1595
LIGHTING	Lighting	LIGHTING.csv	320
PARTICIPANT	Participant Details	PARTICIPANT.csv	320
PV_DETAILS	Photovoltaic Details	PV_DETAILS.csv	46
PROGRAM_BARRIER	Program Barrier	PROGRAM_BARRIER.csv	7
PROGRAM	Program Details	PROGRAM.csv	1
RETROFIT	Retrofit record	RETROFIT.csv	623
SPACE_COOLING	Space cooling	SPACE_COOLING.csv	320
SPACE_HEATING	Space heating	SPACE_HEATING.csv	320
TREATMENT	Treatment condition	TREATMENT.csv	4
WATER_HEATING	Water heating	WATER_HEATING.csv	320

Table 46: Data uploaded to LIEEP portal - not in LIEEP schema format

File name	Description	Number of records
DwellingDistributorElecBilling.csv	Electricity data from distributor - billing (accumulated) format	1,228
DwellingDistributorElecSmartMeter.csv	Electricity data from distributor - thirty minutely format	12,074,230
DwellingDistributorGasBilling.csv	Gas consumption data from distributor - billing (accumulated) format	3,365
DwellingInternalTemperatures.csv	Temperature sensor data – thirty minutely	3,664,415
DwellingMonitoredElecSolarGen30Min.csv	Electricity generation data from Ecofront monitors – thirty minutely	588,735
DwellingMonitoredElecSumMains30Min.csv	Electricity consumption data from Ecofront monitors – thirty minutely – sum of mains circuits	3,315,106
DwellingMonitoredElecSumSubCirc30Min.csv	Electricity consumption data from Ecofront monitors – thirty minutely – sum of sub-circuits circuits	3,316,132
DwellingMonitoredGas30Min.csv	Gas consumption data from Ecofront monitors – thirty minutely	2,853,434

3.16 Additional studies

3.16.1 RMIT Health Study

The study identified and described individual and socially shared householder practices, quantified outcomes in indoor temperatures, energy use, energy costs and householder health, and explained how householder practices influenced these outcomes. Five main themes of householder practices were identified i.e. the intersecting practices of:

- keeping warm
- affording energy
- maintaining air quality

were bundled up in the practices of:

- living at home
- staying healthy.

Protective responses of householders to perceived problems, i.e. coping and adaptation practices, were explored. In addition, the effect of the participation in the research project on householders was examined.

The retrofit intervention trial consisted of 29 homes. While survey and energy monitoring data was available for most homes, due to equipment failure or unverifiable installation dates, the number of matched data sets for measured indoor temperatures was reduced. Although due to the small sample size the results of the statistical tests were rarely significant, the analyses referred to below indicated trends that provided the basis for explanations of outcomes that had been influenced by householder practices.

Living at home

Householders shaped their homes in response to perceived shortcomings in the thermal performance of the building envelope and of the heating systems within the limits of their financial and physical means. Moving into the home had been a common trigger for building improvements. Summer heat was considered a bigger problem than the winter cold, as householders felt they had more coping strategies available to keep warm in winter. The improvement in the perceived comfort from the baseline to the follow-up winter was more pronounced in the intervention than in the control group. Many householders attributed the gain in comfort to the retrofit measures, which had made the homes *cosier* and *warmer*, and was felt to have reduced draughts, accelerated the speed of heating up the house and facilitated the conservation of warmth. Where a new reverse cycle air conditioner was installed, more benefits were attributed to the new heating device than to the top-up insulation and draught proofing.

Interventions led to an increase in the householders' overall satisfaction with the home. This shift may have reflected the householders' overall satisfaction with the retrofits and their perception of better conforming to social norms of house quality.

Keeping warm

With regards to the practices of keeping warm, the research found a clear improvement in the intervention group: the classification 'heating without achieving warmth' had been eliminated and the practices shifted towards more carefree heating.

Daily mean living and bedroom temperatures in the intervention homes increased more than in the control homes. The differences were more pronounced during daytime and in the late evening in the living rooms and during the night and daytime in the bedrooms, however, these differences were not statistically significant. Of particular note, contextual changes, such as in household composition and physiological capabilities, seem to have induced stronger changes in warmth than the material improvements made to the building fabric.

In most households, heating was seen as a reaction to cold rather than as a preventative measure. Many householders persisted in heating only to *take out the chill* and let themselves be guided by subjective comfort levels, the fear of unaffordable energy bills and the perceived norm of intermittent heating. Voluntary under-heating, which was explained by thermal history, by regarding frugality as a virtue or by health beliefs, was found in three homes.

Under-heating of living and bedrooms remained a common problem in both groups. The scope of the retrofits was not sufficient to raise temperatures to adequate levels in most homes. Householders protected themselves from cold exposure through coping and adaptation measures, some presenting health risks in their own right. Nonetheless, benefits from the retrofits in the intervention homes were observed in the reduced prevalence of households reporting to have felt cold and in the reduced number of coping strategies being employed to keep warm.

Affording energy

Subjective fuel poverty was more pronounced in summer than winter, with twice as many householders reporting that they could not cool their homes adequately than reporting to not being able to heat their home adequately. The retrofit measures of the Energy Saver Study eased subjective fuel poverty due to financial constraints in winter

The study also found that changes in energy bill payments were able to ease the perceived burden of energy costs irrespective of the intervention. Although the majority of householders received governmental energy concessions, awareness of these concessions was poor and some householders were missing out on the medical cooling concession. By contrast, householders were acutely aware of the energy providers' pay on time discounts. Direct debt and pre-payment seemed to ease financial and emotional stress and a switch in energy providers afforded better discounts. However, several householders remained overcharged as they did not engage in the energy market. Nonetheless, some householders continued to cope with high bills by trading fresh food or social activities for warmth.

The analysis of the time-stamped gas and electricity data for both winter periods revealed statistically significant benefits in electricity consumption and, hence, costs, in the intervention group. Changes in gas costs, absolute changes in electricity costs, total energy costs or greenhouse gas emissions, however, were not statistically different between the two groups. The analysis also failed to find statistically significant benefits of the intervention on heating energy. Health and age-related increases in cold sensitivity resulted in longer heating periods and higher energy bills. In two cases, the death of spouses resulted in pronounced drops in heating. A quantitative juxtaposition of simulated and actual changes in heating energy in 10 homes suggested that to achieve benefits in energy conservation, retrofit interventions should have aimed at a designed reduction of the heating load of at least 22 percent. Due to the small sample size, this finding was not statistically significant and should be considered as an indication rather than as a guideline.

Maintaining good indoor air quality

Indoor air quality is moderated by involuntary air exchange and ventilation rates. Retrofits may have unintended consequences for indoor air quality by increasing the indoor moisture content. Although the air tightness of all homes at the baseline was considered poor, improving to a fair rating in the intervention homes, this study found a low prevalence of draught awareness and an apparent disregard of draughts. Keeping windows permanently open was practiced by about half of the participating householders, in order to accommodate the dog, due to health beliefs or due to having grown with ‘sleep-outs’. The practice of keeping the bedroom window slightly ajar inhibited the gain in daily mean temperature in the intervention homes.

The retrofit measures had been effective i.e. inhibited involuntary air exchange and thus heat loss, in the living rooms during the nights. No evidence for statistically significant effects during other times of the day was found, possibly due to more random moisture generation and householder ventilation practices. For the bedrooms, retrofit measures had had no effect on overall ventilation rates. Permanently vented bedrooms led to lower vapour pressure levels in both control and intervention groups.

Staying healthy

In most households, warmth was regarded as being important for comfort i.e. an aspect of psychological rather than physiological health. Warmth in the bedroom was seldom considered as a protective measure. Accessibility and safety concerns featured strongly in the description of health issues at home. The outcomes in health from the health symptoms and stress surveys did not show a clear improvement in health for the intervention group. The results of the Quality of Life survey (SF-36v20) scores showed more improvements in the intervention than in the control group, but the differences between the groups were not statistically significant.

Incidental health gains with immediate effect were the removal of polluting gas heaters and other safety measures as a result of the pre-study audits. Other incidental benefits that were directly attributed to the study were the receipt of the Medical Cooling Concession in one household and the empowerment of householders towards energy providers and tradespersons.

Summary

In summary, the study has provided social context to the retrofits of homes with poor thermal quality and subjective fuel poverty of 29 HACC recipients in Victoria and has explained the effects of the Energy Saver Study retrofits on indoor temperatures, affordability of energy, householder health and satisfaction. The knowledge of the householder experience extended the framework of the pathways from housing quality to health outcomes beyond the material qualities of the dwelling to contextual factors. Amongst others, these were the physiological capabilities of the householder, the modes of energy bill payment and the social construction of the adequacy of indoor temperatures. In addition, the study has identified coping and adaptation practices that may be able to build resilience. The detailed exploration of the influences of householder practices on the mediating factors of indoor temperature and affordability of fuel as well as the identification of moderating coping and adaptation practices has helped to better understand the effects of residential energy efficiency interventions on health. However, more research is needed on other contextual and confounding factors that may increase vulnerability or enhance resilience.

3.16.2 Swinburne research: Who influences the householders most?

Data analysis suggests that social influence is key. The number and category of people that householders refer to is detailed below.

The relationships of most importance to the householders (when they are seeking advice on energy in the home) are partners. Children are the next most important influence, followed by ELOs (from this LIEEP project) and then friends.

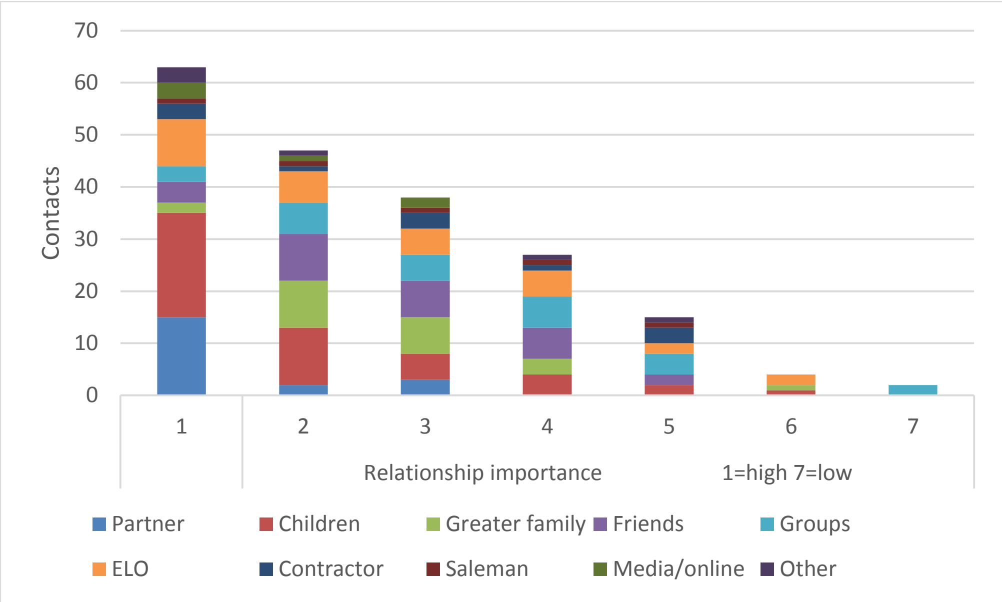

Figure 74: Relationships of most importance to the householder when seeking advice on energy in the home

In terms of who householders actually consult for advice on energy in the home, children are consulted most, followed by members of groups (that householders are themselves members of), then ELOs. Greater family are the next consulted, followed by partners and then friends.

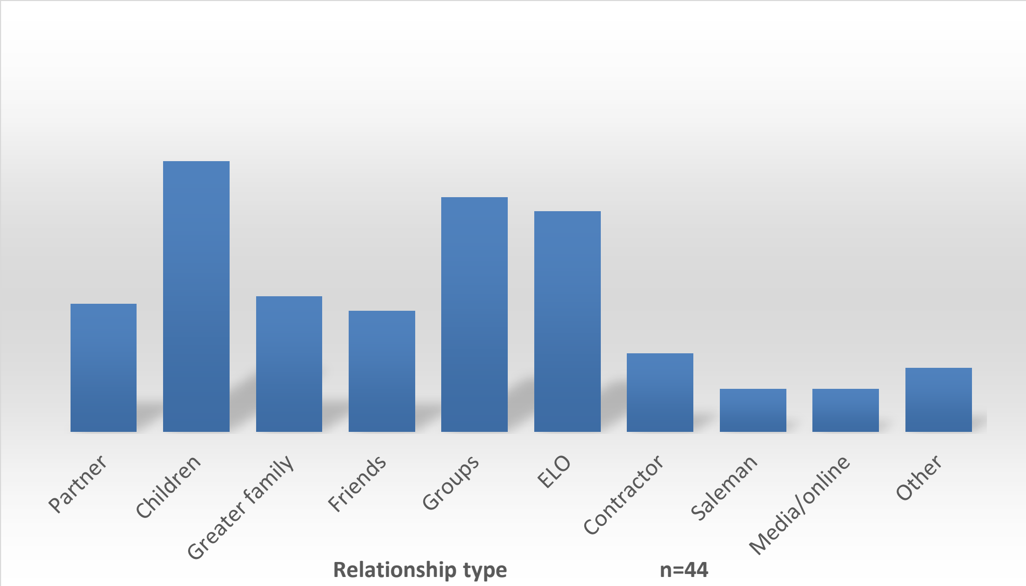

Figure 75: Who householders consult for advice on energy in the home

The overall story of Most Significant Change was selected by householders for reasons of high applicability, low challenge and recommendation. The energy action in the chosen story was to manage the use of standby power.

Additional findings of interest include:

- Competing practices and the impact of hygiene, entertainment, caring, comfort and financial management practices on positive outcomes
- The negotiation between couples and families and the challenge of managing differing physiological states under one roof
- The role of one-off actions versus repeated actions in the transition to habit.
- The significance of ventilation and health to this profile of householders
- The impact of housing suitability and life-stage transitioning on change
- The impact of new learning on effective and sustained change
- Getting household energy based actions into everyday conversations
- The role of community leadership in motivating social influence

This research will be completed by January 2017.