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Exploring the Effectiveness of an Energy Efficiency Behaviour Change Project on Well-Being Outcomes for Indigenous Households in Australia

Áron Perényi [1,*], Rowan E. Bedggood [1], Denny Meyer [2], Phillip Bedggood [3], Karen Farquharson [4], Clare Johansson [5] and Gina Milgate [6]

1 Swinburne Business School, Faculty of Business and Law, Swinburne University of Technology & Group of Energy Efficiency Researchers Australia (GEER), Hawthorn 3122, Victoria, Australia; rbedggood@swin.edu.au
2 School of Health Sciences, Faculty of Health, Arts & Design, Swinburne University of Technology, Hawthorn 3122, Victoria, Australia; dmeyer@swin.edu.au
3 Department of Optometry and Vision Sciences, The University of Melbourne, Parkville 3010, Victoria, Australia; pabedg@unimelb.edu.au
4 School of Social and Political Sciences, Faculty of Arts, The University of Melbourne, Parkville 3010, Victoria, Australia; karen.farquharson@unimelb.edu.au
5 Swinburne Business School, Faculty of Business and Law, Swinburne University of Technology, Hawthorn 3122, Victoria, Australia; cjohansson@swin.edu.au
6 Australian Council for Educational Research, Camberwell 3124, Victoria, Australia; gina.milgate@acer.edu.au
* Correspondence: aperenyi@swin.edu.au; Tel.: +61-3-9214-8078

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Abstract: The Koorie Energy Efficiency Project (KEEP) was a Victoria-based, Australian social marketing initiative designed to provide support to Indigenous households so they could better manage their energy bills by reducing or controlling their energy use. The program was delivered by trained, Indigenous project employees who visited Indigenous households in metropolitan and regional parts of the state. During the home visit, they provided an energy efficiency audit, as well as specific energy efficiency tips and advocacy support. Minor draft-proofing products were also supplied to each household. As part of this project, dwelling and householder information was gathered during each home visit, as well as measures of energy efficiency knowledge, behaviours, and well-being of the main householder before and after a home visit. The results indicate that home visits to support the energy efficiency of indigenous households are effective in terms of encouraging new energy efficiency knowledge, behaviours, and broader elements of well-being. Furthermore, the home visit was found to be effective across all home types, but was significantly more effective in reducing energy related stress and discomfort in traditional houses and traditional apartments. These households were also often small and densely occupied. This suggests that when social marketing programs use methods that are culturally suitable and respectful, such as those used in KEEP, they become a powerful tool to help drive social change in Indigenous communities. The authors conclude that such programs in future will be hindered in their effectiveness unless property owners, such as those of social housing, do not urgently address the maintenance of their properties and ensure they provide fit living conditions for the tenants.

Keywords: household energy efficiency; Indigenous households; behaviour change; well-being; social marketing

1. Introduction

The energy efficiency of buildings is a substantial component of energy consumption [1]. As such, residential energy efficiency has become a key contributor towards achieving global energy sustainability [2]. This has inspired numerous projects aimed at changing the behaviour of residential energy users to improve household energy efficiency [3–5]. Similarly, endeavors to adjust housing stock for new (e.g., improved energy requirements in building codes) and existing (e.g., insulation, window coverings, appliances) homes continue to attract substantial government attention [6,7]. However, one group that has been under-supported and under-explored in this arena is Indigenous people.

Representing only 3.3% of the population [8], many indigenous Australians face hardships and disadvantage in proportions much higher than other Australians. The Prime Minister's annual 'Closing the Gap' report reveals ongoing discrepancies in health, mortality, education, and employment between Indigenous and non-Indigenous Australians, revealing that efforts to reduce this gap are making little to no progress [9]. When it comes to their experience in the energy sector, this disadvantage continues. For example, in a study conducted by the Consumer Utilities Advocacy Centre [10], it was found that indigenous households in the Australian state of Victoria face substantial energy-related disadvantages [10] and experience a higher rate of electricity disconnections [11] when compared with non-Indigenous Australians. Other reports reveal that this type of disadvantage is also experienced in other parts of Australia, where household access to electricity remains problematic while mental health worsens [12]. As stated by Bedggood, et al. [13], "(t)he gulf between the living standards of Aboriginal Peoples and the rest of Australia is uncomfortably wide and growing larger" (p. 279). This situation warrants expedited action.

Programs delivering energy efficiency support are crucial for addressing the needs of people experiencing vulnerability. However, as Paone and Bacher [14] identify, "(a)chieving and maintaining energy-efficient behavior without decreasing the comfort of building occupants still represents a challenge" (p. 1). It is thus important to realise that besides reducing energy use and bills, numerous other benefits should be pursued, and captured, as a result of energy efficiency behaviour change efforts. There is some evidence supporting this notion. For example, Bedggood et al. [15] identified 11 key co-benefits ('co' meaning in addition to reduced energy use or bills) to improvements in home energy efficiency for low-income households in Australia, such as reduced stress, improved comfort, and greater self-efficacy and control. These findings support the growing evidence revealing the link between home energy efficiency improvements and subsequent improved health and well-being [16,17].

It should be noted that when considering the health outcomes for Indigenous people, it is important to consider a holistic approach by embracing 'all of health' aspects [18,19]. Well-being must therefore include not just physical health as westerners typically define it, but include social, emotional, spiritual and cultural well-being aspects of the individual and their community [20]. As such, it is important that factors beyond the 'absence of disease' are included in well-being measures [21], recognising that cultural continuity and strength can form a protective barrier for Indigenous peoples [22]. This fuller concept of well-being needs to extend to projects evaluating the impact of energy efficiency initiatives on people in their homes, whilst also addressing any cultural needs.

The connection between well-being outcomes and energy reduction with Indigenous people has not yet been explored, but because energy use can impact well-being via increasing bill stress and thermal discomfort, priority should be given to those and other well-being aspects. Reduced bills can be the result of home retrofits or structural upgrades (improvements to the housing stock or appliances used) or of adjusting the behaviour of people in their homes and how they use energy. The latter can be considered as a 'social marketing' project, which aims to influence a change in people's behaviour for improved social outcomes [23–25]. In this way, people can be supported in their homes, and empowered to reduce their energy bills, by guiding how they might use heating, cooling and other appliances, as well as when they use them, more efficiently and effectively. Further, the type of dwelling itself, and the family type occupying that dwelling, could influence the effectiveness of such projects. For example, older homes built before any energy efficiency standards were introduced will consume

more energy, although how this varies between smaller to larger homes is unclear. Those living in rental properties, such as many Indigenous people/families, invariably occupy older, inefficient homes, which have less efficient appliances [26]. Thus, behaviour change programs are important, but must be considered in light of the limitations of the characteristics of the dwelling itself, and the limitations of what tenants can change in those homes. In addition, single occupant homes compared with larger families are likely to consume energy differently. Although, how this affects the outcomes of behaviour change programs or varies by co-benefit is unknown. While neither aspect has been well investigated in previous studies (see, for example, the review conducted by Paone and Bacher [14]), they have not been explored at all for Indigenous homes.

Within this context, our research fills the need for knowledge in multiple areas. Firstly, we use data collected from a program that was devised to address the energy-related disadvantage of Indigenous households in Victoria. It achieved this by providing home energy efficiency tips and advocacy support as part of a social marketing project. It trained several Indigenous people to deliver this support to Indigenous homes, who were well equipped to support householders with regard to both energy-related and cultural matters. The project was evaluated in terms of household utility usage, the adoption of energy efficiency behaviours, and improved co-benefits, designed so they were specifically suited to an Indigenous audience. Secondly, we clarify the effectiveness of the program on numerous aspects related to this behaviour change including householder knowledge, health, and well-being, by taking into consideration the personal characteristics of the residents as well as the attributes of the homes they occupy. Thirdly, focusing solely on Indigenous households within a single regional state provides an additional benefit of eliminating the effects of regional differences and respondent heterogeneity. In summary, this article explores the following research questions:

- In what ways can a community-based social marketing program positively impact the energy efficiency outcomes for Indigenous households in a culturally suitable way?
- To what extent do home characteristics and household types influence Indigenous household responses to energy efficiency support programs?

The answers to these questions can inform future programs and support efforts, especially those aiming to redress the conditions faced by many Indigenous households. By better understanding the current and improved experiences of Indigenous households, programs will be able to help bring about improved well-being for Indigenous people.

The next section describes the project, reviews the literature on behaviour change as a social marketing tool, and discusses the health and well-being impacts of household energy efficiency. We then discuss the behavior change strategy implemented to address the specific needs of Indigenous communities and their members. This is followed by the description of the research methods. The findings are then presented and the results are discussed.

2. Project Development and Conceptualisation

2.1. The Project

In an effort to support indigenous households across Victoria, the Koorie Energy Efficiency Project (KEEP) was developed with the aim of helping households reduce their energy usage and bills using social marketing techniques to influence behaviour change. KEEP was one of 20 projects funded as part of the Commonwealth government's Low Income Energy Efficiency Program (LIEEP). KEEP delivered home energy efficiency visits to 1500 households, and provided general energy efficiency tips and advocacy for a further 3000 households. The project was led by a large not-for-profit organisation, and supported by three Indigenous, not-for-profit corporations who, together, employed and trained six Indigenous people to deliver home energy efficiency audits and support across the state. The program was the first of its kind in Australia and allowed three different approaches to conducting home energy visits to be trialed for their effectiveness. This paper draws upon the data gathered in this project, where

the authors were co-contributors with the project partners in devising the home visit support, project conceptualisation, and key concepts that were to be measured to evaluate the project outcomes. In this way, a cross-cultural collaboration enabled the design and delivery of the project to be respectful and inclusive of Indigenous people, while also meeting the funding requirements of the Commonwealth.

2.2. Social Marketing for Behaviour Change

Behaviour change programs for socially improved outcomes lie within the domain of social marketing. This field represents efforts to change the behaviour of people or groups to achieve an improved social or environmental position by applying adapted marketing techniques that are commonly successful in the commercial domain [26]. Numerous examples provide empirical evidence demonstrating the effectiveness of social marketing initiatives, particularly in the health domain [27]. For example, social marketing has been used to improve breast cancer screening, obesity, drug and alcohol abuse, and smoking [27]. One framework commonly used is community based social marketing (CBSM), which identifies six steps to adopt to bring about behaviour change programs when it comes to environmental and sustainable outcomes [28]. In engaging people directly, the framework guides program developers on key steps to take when implementing programs. CBSM has been used in a variety of contexts such as agricultural worker health [29], early diagnosis of lung cancer [30], and environmental regulation policy design and implementation [31]. These applications have all identified and overcome barriers to engaging the target audience and effectively implemented change in their behaviours.

Cultural, as well as other factors [28,32], may inhibit the desired behaviour change, and thus the exploration of these factors is warranted to enhance the effectiveness of such program designs. Approaches need to include a selection of behaviours to be targeted. Strategies to change the selected behaviours then need to be designed, implemented, and evaluated [33].

Although CBSM programs have been found to be very effective in achieving behaviour change with people experiencing vulnerability [30–32], the conditions under which these instances of behaviour change take effect are usually not investigated or reported upon. Understanding the effects of these conditions is particularly important for contextualizing research in energy efficiency, and for effectively informing future efforts. In this paper, we aim to help address this shortfall.

2.3. Barriers to Improving Household Energy Efficiency

Energy conservation behaviours have been demonstrated to reduce household energy consumption [34], although, because of a range of barriers faced, many households struggle to adopt such behaviours. For some, they are already using as little energy as they can, such that any additional reductions could compromise their health and well-being. This has been shown to occur when householders go without heat or food in order to afford their ever-rising energy bill [35,36]. Indeed, research has shown that people are more likely to die in their homes due to cold than heat [37]. So, the reduction of unnecessary energy use (e.g., adjustments in thermostats, better window coverings, or draft proofing) or alternative management of energy use (e.g., avoiding using energy during peak demand times) can improve affordability and usability of energy for households, which may then mitigate health and well-being risks. However, in order to achieve these outcomes, the barriers experienced by people in implementing sustainable energy efficiency behaviours must be addressed [27,33]. For Indigenous people in particular, any efforts to influence changes in the home need to be considerate and respectful of cultural protocols or nuances.

A summary of barriers to energy efficiency behaviours is provided in Table 1. Some of these barriers are general, and others specific to energy efficiency as a domain. Some are possible to address by behaviour change programs; others are outcomes of aggregate, systemic, or material circumstances. For example, financial barriers may alter an individual's energy-related behaviours directly, but may have an indirect impact through investment or purchase decisions. Asset-related

barriers may be completely outside the individuals' control, especially in the case of tenants or social housing. Policy-related barriers are under government control.

Table 1. Energy efficiency barriers and individual incentive factors.

Main Barrier	Range of Barriers
Financial	Cost–benefit uncertainty Energy price Hidden costs Income Split incentives (between owner and tenant)
Personal/ Behavioural	Trust (towards stakeholders) Acceptability (effort, comfort) Aesthetics (appliances and installations) Appearance (building design) Social norms Value–action gap
Knowledge	Defaults (use of settings on appliances) Discounting the future (preference for early payoff) Lack of information (decisions made based on assumptions not fact)
Policy	Regulatory (limits to personal energy efficiency choices) Uncertainty (unexpected change of circumstances)
Asset	Access to capital (affordability of energy efficiency measures) Property value (not increased much by energy efficiency measures) Tenure (owner, tenant, etc.)

Adapted from the works of Metcalfe and Dolan [38] and Benabou and Tirole [39].

Knowledge and behaviours are barriers that can be addressed by providing direct, person-to-person support for households, such as those provided by KEEP. Improvements in health and well-being are specific outcomes that can be measured at the same time as knowledge and behaviours (e.g., by household survey). Measuring changes in both behaviour and knowledge is consistent with other research projects [40–42].

2.4. Project Conceptualization

Initially informed by the energy efficiency literature, the key concepts that were to be measured in KEEP were presented, discussed, and decided upon by all project partners. In this way, KEEP ensured it was continually guided by the wisdom of its Indigenous partners; namely, Ngwala Willumbong Ltd, Victorian Aboriginal Child Care Agency (VACCA), and Aborigines Advancement League (AAL); the experience of providing home energy support by the project lead, Kildonan UnitingCare; and the expertise of the research partner in designing and evaluating projects (Swinburne University of Technology). Three key areas that were considered relevant for Indigenous households were knowledge, behaviour, and well-being. The measurement development of each is detailed below and final measures were considered, adjusted, and approved by several Indigenous co-workers on KEEP.

2.4.1. Knowledge

For the purpose of measurement, two types of knowledge are identified in the literature: codified knowledge and tacit knowledge [43]. Codified knowledge is usually presented in the form of information and thus is relatively easy to understand and to share [44], while tacit knowledge is difficult to articulate as it is conceived through an individual's actions [43]. Insch et al. [43] propose that to measure tacit knowledge, a behavioural element should be included. Therefore, it is important to develop survey items that capture both codified knowledge (e.g., knowledge of energy-star ratings) and behaviours that

reflect that tacit knowledge (e.g., knowing how to use the heating thermostat effectively). Developing a codified knowledge-based scale for energy efficiency was conducted in Canada by Michalos et al. [45], who developed a five-point Likert-type response scale. Similar efforts elsewhere produced a range of survey items with Likert-type response scales (see the works of DeWaters and Powers [41] and Nobiling et al. [42]). Drawing from these studies, and with the input of the Indigenous project partners, six survey items were selected to measure knowledge about energy efficiency in the home. Table A1 (in the Appendix A) contains knowledge-related questions used in the KEEP survey.

2.4.2. Behaviour

A range of previous studies identify numerous energy efficiency behaviours that can be measured in the home. For example, Stragier et al. [46] developed a scale for the measurement of energy efficiency behaviours based on a holistic conceptual framework. The scale was tested using a survey in two studies in Belgium. Similarly, Langevin et al. [47] conducted a study on low-income households in Philadelphia in the United States. Their qualitative findings indicated areas to pursue, such as the equipment used for heating, cooling, and lighting; and how often the householders cooked, watched TV, and so on. They also included knowledge-based energy aspects.

Taking a broader approach, the Living in Melbourne survey was developed and tested by Newton and Meyer [48]. Part of the survey asked questions that probed environmental sustainability-related values, attitudes, and intentions. The survey took into account two basic groups of variables: consumption variables (water, energy, appliances, carbon intensity of personal travel, and housing space) and explanatory variables (individual structural attributes and attitudes, as well as household, dwelling, and location contexts). Together, these studies informed the initial battery of possible survey items for measuring household behaviours around energy efficiency in KEEP. Table A1 contains five energy efficiency behaviour questions that were deemed appropriate by the Indigenous project partners and were thus included in the KEEP survey. As intention to act often informs an action [49], we also took the opportunity to include some general attitude questions.

2.4.3. Physical, Social, and Emotional Well-Being

From workshops conducted with the Indigenous project partners, in which they shared their reasons for becoming involved in the energy efficiency project, it became evident that the primary motivation was to provide genuine and practical help to Indigenous households that were struggling, particularly in relation to paying ever-rising energy bills. Anecdotal examples and evidence from previous research [10] were provided regarding the impact of energy use on the health and well-being of Indigenous households throughout Victoria. Concerning trends were noted, for example, people choosing to be cold in their home because they feared the cost of heating, or turning off lights at night to save money, which prevented children from reading or studying. These concerns are reflected elsewhere, with research evidence indicating significant reductions in food and entertainment (up to 50% and 80%, respectively) occurring in households struggling with their energy bills [50].

The concerns around thermal stress motivated KEEP to capture this element as well. In the Household Energy End-Use Project in New Zealand, 'comfort' was generally considered as a desirable benefit of energy efficiency [51]. Cold indoor temperatures are associated with damp and mould, which has been associated with a wide range of health risks [51]. Isaacs et al. [51] found that low income groups were over-represented in dwellings described as cold or below-average. This suggests that the most obvious indicator of well-being in the home is room temperature. These findings have been since corroborated by Williamson et al. [52], who suggest that thermal stress of householders is an important measure of health and well-being. Hence, it was important to include items on stress and thermal comfort for KEEP in developing the evaluation measure of social and emotional well-being.

Energy-related stress was thought to be further increased for Indigenous households, as they typically need to host a high number of guests, from time to time, as part of their culture, particularly around "sorry time" (extensive grieving process once a person dies) [53] or to provide a temporary

home for those on the move, some of whom may not have a home of their own. Furthermore, repairs and standard maintenance of many properties was thought to be sadly lacking; reflecting potential negligence on the part of landlords to sufficiently maintain their properties. This situation has been reported elsewhere [54], and a recent case in the Northern Territory had the courts rule in favour of an Indigenous tenant who had suffered in her home as a result of the landlord not maintaining it to a fit living standard [55]. Therefore, an improved sense of social and emotional well-being, which may also result from an improved level of physical well-being in the home, was considered an important aspect of household energy efficiency improvement. It thus became an integral component to measure in the survey (see Table A1) to fully capture the holistic outcomes of home visits, and was approved by the Indigenous project partners.

2.5. Delivering Home Energy Visits in Indigenous Households

Home visits were provided by Indigenous community development officers (CDOs) employed by the project partners of KEEP. The importance of trust is key to building relationships, which is particularly important when developing collaborative projects and reaching Indigenous people (see the works of [56,57]). There has been an increasing amount of participatory or action-based research conducted with Indigenous communities over the past 20 years [58], where the notion of 'having a yarn' is slowly gaining recognition [59] and is maximising community involvement where "(t)he knowledge, expertise, and resources of the involved community are often key to successful research" [60] (p. 774). CDOs were ideally placed to visit homes and build a rapport with householders before progressing the home energy audit, energy savings tips, and advocacy support they provided. In this way, KEEP ensured it was culturally respectful. Indigenous householders revealed how important it was that an Indigenous person was the one delivering home support to them [24].

Home visits also involved the CDOs administering a survey with participants, which involved the survey items developed just for KEEP (see Table A1) and the compulsory 'dwelling and occupant' items (LIEEP schema data), which were required by the funding body (see Tables A2 and A3 in the Appendix B). We note that some of these questions were not suitable for Indigenous homes, and so the project allowed the Indigenous CDOs to exercise their judgement and ask what they thought was suitable and respectful in each home they visited. This ensured that cultural protocols were followed and prioritized over general government survey needs. For example, it was not considered suitable to ask householders about their age or income in all cases, nor was it appropriate to go inside some homes to 'inspect' the number of lights or appliances the home used. Complete discernment was passed to the CDOs to uphold the cultural sensibilities of each home they visited.

3. Data Collection and Analysis

The home visits were rolled out to 1500 Victorian Aboriginal households, who received general energy efficiency tips and received support in understanding their energy bills and navigating improved arrangements with their energy retailers. Usable data were collected from 799 of these households in relation to the 'dwelling and occupant' survey, whilst 714 households provided self-reported measures of energy-related knowledge, behaviours, and well-being. These data provided a baseline measure. Subsequently, 193 of these households participated in a phone follow-up survey (see Table A1) between three and six months after the home visit. A comparison of pre- and post-home visit data by paired sample *t*-test allowed us to assess whether the home visit improved the energy-related circumstances of the household.

3.1. Scale Validity and Reliability

A randomly selected 242 of the survey responses, for householders who did not receive a phone follow-up, were used to test validity and reliability of the self-reported KEEP measures [61]. This figure was based on the recommendation by Hair et al. [62] that 10 observations per indicator is necessary for

factor analysis. The original survey consisted of 21 items; therefore, a minimum of 210 observations were needed.

These responses were subject to exploratory factor analysis (EFA) to determine survey validity, while Cronbach's alpha was used to test reliability [62]. Table 2 provides the validity and reliability characteristics of the scales. Values of 0.5 or higher are generally accepted as valid loadings [62]. Seven survey items with substantial cross-loading (of 0.4 or higher), or low factor loadings of below 0.5, were discarded. Key dimensions in which the effects of home visits were evaluated were energy-related behaviours, stress, comfort, and energy competency. Scale mean scores were calculated from these indicators to support further analysis. In the case of valid and reliable scales, unweighted mean scores are generally considered sufficient for further inferential data analysis [62]. The results indicate that the measures developed for each construct are valid and reliable.

Table 2. Measures of behaviours, stress, comfort, and competency.

Variance extracted: 67% Items	**Factors**			
	Behaviours	**Stress**	**Discomfort**	**Competency**
How often have you—Shut the door when leaving a room that is heated or cooled?	0.89			
How often have you—Turned off lights when leaving a room at night?	0.76			
How often have you—Deliberately turned off appliances to reduce your bill?	0.74			
How often have you—Adjusted the thermostat on heating or cooling to reduce your energy bill?	0.52			
Are you worried about being able to pay your energy bill?		0.86		
Are you worried about being disconnected?		0.66		
Do you feel stressed when having guests because of the increase in your energy bill?		0.48		
How often have you—Felt discomfort in your home due to temperature? (too hot/too cold/drafts)			0.72	
How often have you—Has this affected you at night time? (e.g., having to turn off lights, TV)			0.67	
How often have you—Felt uncomfortable being home due to energy use?			0.61	
How often have you—Felt your well-being at home affected by limiting your energy use?			0.53	
How often have you—Explained different parts of energy bills to others?				0.91
How often have you—Helped out friends or family with their energy use?				0.86
Do you find your energy bill confusing to understand?				−0.55
Cronbach's Alpha	0.81	0.74	0.74	0.71

3.2. *Effectiveness of Home Visits*

The differences between responses provided by household occupants during the home visit and phone follow-up interviews show significantly improved behaviours, reduced stress, reduced discomfort, and increased competency, as illustrated in Table 3.

Table 3. Paired sample *t*-test between first home visit and first phone follow-up responses.

N = 193	Paired Differences					t	df	Significance (2-tailed)
	Mean Difference	Standard Deviation	Standard Error Mean	95% C.I. of the Difference				
				Lower	Upper			
Δ Behaviour	1.48	0.84	0.06	1.60	1.37	24.61	192	0
Δ Stress	−0.61	1.13	0.081	−0.46	−0.78	−7.58	192	0
Δ Discomfort	−0.19	1.01	0.073	−0.05	−0.34	−2.66	192	0.01
Δ Competency	1.14	1.00	0.072	1.28	1.00	15.84	192	0

* Δ = scale mean score (phone follow-up) − scale mean score (home visit); C. I. = Confidence Interval; df = degree of freedom.

The use of the same questionnaire during the home visit and the follow-up phone interview allowed statistical comparison of the responses from before to after, and the data were recorded in such a way that responses were identified as belonging to the same respondent in the 'before' (start of the home visit) and 'after' (phone follow-up) dataset. The phone follow-up responses were all significantly better than the home visit responses ($p < 0.01$). These results demonstrate that the home visits had a positive impact for the participating households, at least in the short term (3–6 months later). However, these results do not reveal whether the home visits were equally effective for all households and home types. As this was a primary aim of this paper, further analysis was conducted.

3.3. Respondent Groupings by Objective Characteristics ('Home and Household Type')

The LIEEP schema data (Tables A2 and A3) contained two broad categories of indicators: home-related (e.g. room numbers, window types, appliance installations), and household type-related (e.g. numbers and types of occupants in the household and tenure type). In our analysis, second order household type indicators were derived from raw household and dwelling data, producing indicators of usage intensity. This allowed grouping and comparison of homes of different sizes.

A two-stage cluster analysis [62] was implemented to establish homogenous groups of households with respect to either household or home characteristics. The first stage utilized hierarchical clustering (using Ward's distance) to determine the optimal number of clusters, and the second stage provided an optimal allocation of observations across clusters. A household characteristics-based grouping was used to establish homogenous groups of households using household data, and a home characteristics-based grouping was derived using home data provided by the households.

3.3.1. Home Characteristics-Based Grouping

LIEEP survey data were collected from the homes in terms of their overall physical condition, structural characteristics, size, type, insulation, heating, cooling, and appliances within the household The indicators displayed in Table A2 were calculated from these characteristics, and were used in the classification process. Appliance specific indicators were eventually omitted because of the high degree of missing information. Cluster analysis was conducted on the dwelling data collected for 799 households. A solution identifying six home groups was defined for further evaluation. Wall and roof material made no difference in the grouping, nor did the number of storeys (house levels) or age of the dwelling. Six clusters were revealed as follows:

- 'Small modern homes' (SMH)—consisted of 107 homes with 4 total rooms on average, falling into the smallest size category. Homes typically had modern features such as an evaporative cooling system and gas heating.
- 'Small traditional apartments' (STA)—consisted of 128 small apartments, typically with 4 rooms, fan cooling, no insulation, no typical heating, and blinds covering their windows.

- 'Small traditional houses' (STH)—consisted of 271 small houses, typically resembling the traditional Western brick style of the 1950–1960s, with 5 rooms per dwelling. Homes typically had a dark roof, ceiling insulation, gas heating, and no particular cooling.
- 'Medium modern houses' (MMH)—consisted of 172 homes that were medium-sized houses, with 5 rooms on average. Homes typically had gas heating, evaporative cooling, double glazed or tinted windows, curtains, and ceiling insulation.
- 'Large traditional houses' (LTH)—consisted of 71 large houses with 7 rooms on average. The windows were typically single glazed and there was no typical heating or cooling.
- 'Large modern houses' (LMH)—consisted of 50 large houses with blinds, dark roofs, ceiling insulation, gas heating, air conditioning systems, and with 8 rooms on average.

3.3.2. Household Characteristics-Based Grouping

In order to provide a richer perspective, a classification of respondents was sought based on the characteristics of people living in the particular home. A total of 799 homes were grouped into three categories based on household characteristics and information about people living in those households (see Table A3). Three distinctly different groups of households were identified from cluster analysis. As the majority of participants were renters, tenure made no substantive difference between the groups.

- 'Densely occupied households' (DOH)—47 homes that housed an average of 6 people (4 children), with 2.1 people per bedroom and 5.7 people per bathroom.
- 'Standard family households' (SFH)—343 homes characterised by an average of 4 occupants (2 children), with 1.5 people per bedroom and 3.9 people per bathroom.
- 'Empty nest households' (ENH)—409 homes that housed an average of 2 occupants and no children, with 1 person per bedroom and 1.9 people per bathroom.

Figure 1 provides a summary of the classification results of homes and households. It shows the distribution of homes across the categories identified above. A pattern can be recognized between the distribution of household and home types, suggesting that these groupings are not independent.

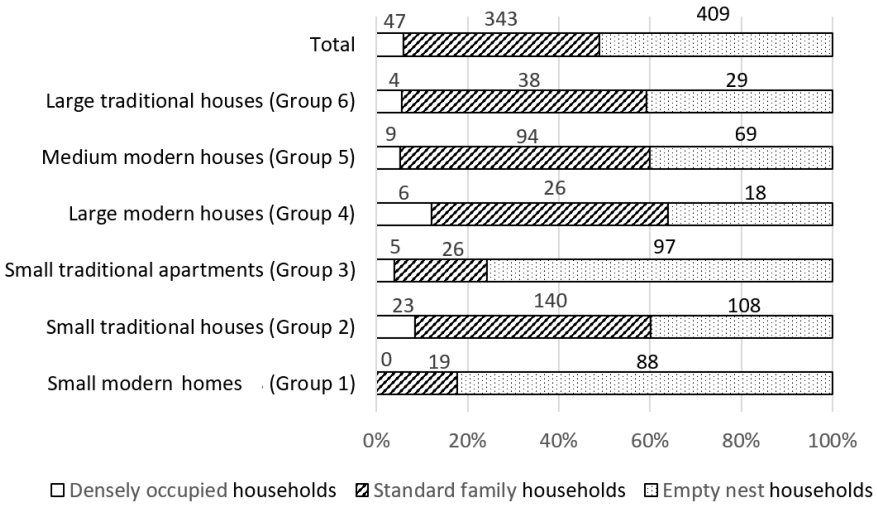

Figure 1. Home and household categories.

3.4. Analysis of the Differences in Effectiveness of Approaches

The moderation effect of home and household type on the effectiveness of approaches was evaluated using the two grouping schemas discussed above. Using a one-way analysis of variance (ANOVA) test [61], significant ($p < 0.05$) differences can be identified between home types, in terms of stress and discomfort. The lack of significant differences in terms of behaviour and competency

between the home groups suggests that while the home visit was effective, the household type made no difference in its effectiveness.

Table 4 further explores the influence of home group on survey responses. Improvements regarding stress levels were highest for small traditional houses (STH), followed by small traditional apartments (STA) and modern medium houses (MMH). This suggests that people living in larger, older housing may be experiencing more energy-related stress and thus need additional support.

Table 4. Significant stress and discomfort differences between home types. SMH—small modern homes; STH—small traditional houses; STA—small traditional apartments; LMH—large modern houses; MMH—modern medium houses; LTH—large traditional houses.

Effect (Δ = change)		N	Δ Mean	Standard Deviation	Standard Error	95% Confidence Interval		Δ Minimum	Δ Maximum
						Lower Bound	Upper Bound		
Δ Stress	SMH	38	−0.15	0.94	0.15	-0.46	0.16	−2	2
	STH	35	**−1.14**	1.02	0.17	−1.50	−0.79	−3.33	1
	STA	41	**−0.70**	1.30	0.20	−1.11	−0.29	−3.67	2.33
	LMH	14	−0.48	0.67	0.18	−0.86	−0.09	−1.67	0.34
	MMH	40	**−0.67**	0.96	0.15	−0.97	−0.36	−2.33	1.67
	LTH	11	0.03	1.56	0.47	−1.02	1.08	−1	4
	Total	179	−0.60	1.12	0.08	−0.76	−0.43	−3.67	4
Δ Discomfort	SMH	38	0.18	0.89	0.15	−0.12	0.47	−2.25	1.75
	STH	35	**−0.78**	1.19	0.20	−1.19	−0.37	−2.75	2.25
	STA	41	**−0.39**	0.95	0.15	−0.69	−0.09	−2	1.75
	LMH	14	0.02	0.86	0.23	−0.48	0.51	−1.25	2.25
	MMH	40	0.09	0.92	0.14	−0.21	0.38	−1.75	3
	LTH	11	0.07	0.66	0.20	−0.38	0.51	−1.25	0.75
	Total	179	−0.18	1.02	0.076	−0.33	−0.03	−2.75	3

Improved (reduced) discomfort levels were only reported in small traditional houses (STH) and small traditional apartments (STA), implying that home visits did not improve comfort in energy efficient or modern homes.

There were no significant differences between the observations falling into the three groups of households identified based on occupancy details. One-way ANOVA was employed to compare group means (details of the statistical tests are available from the authors upon request). With no significant differences of effects present, further analysis on the size of differences was not necessary.

4. Discussion, Conclusions, and Limitations

This paper explored the effectiveness of a community-based social marketing (CBSM) project (KEEP) that aimed to support Indigenous households to reduce their energy usage and bills by adopting more energy efficiency behaviours in the home. In addition, it investigated the extent to which these efforts helped to improve other energy-related co-benefits such as knowledge about energy efficiency and home life conditions such as stress, comfort, and well-being. This research aim was captured in the first research question: In what ways can a community-based social marketing program positively impact the energy efficiency outcomes for Indigenous households in a culturally suitable way?

Many social marketing programs explore the effect of their efforts on behaviour change (e.g., the works of [27,29–32]). We extended this general understanding by also determining why and when such behaviour changes might occur, and included a broader view of outcomes such as householder well-being. The findings reported here indicate that home energy visits, as used in KEEP, are an effective method for encouraging Indigenous households to adopt more energy efficiency behaviours. As knowledge of what to do is often a pre-cursor for action, the results that found significant improvements in knowledge suggest that such improvements led to the changes reported in behaviour. These results are consistent with other social marketing programs aimed at behaviour

change with Indigenous people [23,24]. Fundamentally, the delivery of a social marketing home support program by Indigenous people, for Indigenous communities, was successful and is thus a recommended method to adopt for future social marketing programs.

A further objective of this research was to explore the influence of other factors on behaviour change and co-benefit outcomes, such as the type of home and household on the effectiveness of these programs. This research aim was captured by the second research question: To what extent do home characteristics and household types influence Indigenous household responses to energy efficiency support programs?

The results indicate that KEEP was effective in helping indigenous households to experience improved comfort and less stress as they were better able to manage their home energy use and felt on top of their bills. This was particularly the case for those living in small and traditional type homes. These households are often densely occupied households or standard family households (see Figure 1). This means that efforts to support indigenous households with children or many occupants are likely to yield positive results and be truly effective in improving the quality of home life. Similarly, the energy efficiency characteristics of smaller and traditional (non-energy efficient) homes are also associated with elevated discomfort and distress of the householders. Here, KEEP was also able to have a positive impact on the householders and alleviate their situation by providing energy efficiency tips and support. Of importance is that the findings suggest that living in these types of homes is likely to cause undue stress to the householders and yet, with a shortage of housing, the tenant may be unable to move house or change their living conditions. This situation should encourage landlords, particularly those responsible for indigenous housing, to improve their maintenance of their properties and to review the energy efficiency of the home overall. Upgrades to insulation, fixed appliances, heating and cooling systems, window coverings, and draft proofing should be regularly considered as part of a continual property management plan. The gap between landlord property maintenance and the experiences of tenants of such properties warrants the implementation of 'minimum standards' regulations to existing dwellings and mandatory reporting on the property's energy efficiency rating. This call for changes in government regulation is echoed by others [26,63]. Building codes that apply to new constructions are thus inadequate to address the dire need of many Indigenous people living in poor quality, older housing.

This study also found that there was no significant difference for Indigenous households by household type in terms of their adoption of energy efficiency behaviours and competency, or reductions in stress and discomfort. This finding has several implications. Firstly, socio-demographic differences do not account for variations in how householders respond to social marketing energy efficiency initiatives. This means that such efforts in future should not be restricted to characteristics of householders themselves, implying that all Indigenous household types are likely to benefit from energy efficiency support efforts. This result is consistent with other studies, which found that household energy efficiency can be improved by home visits that target behaviour changes and knowledge [64–68], regardless of the type of household.

Secondly, the effectiveness of CBSM programs that provide home visits to improve household energy efficiency can also reap additional benefits for the householders (co-benefits). Our results demonstrate that such an approach can be effective in improving knowledge, health, and well-being outcomes as they relate to home energy use, particularly when households are facing asset-related barriers, and not just reducing energy bills. This means that behaviour change programs can be an effective and rapid means to alleviating issues at a household level, especially in cases in which substantial asset upgrading would otherwise be necessary. The findings address a current gap in knowledge as to whether home types and household types affect the adoption of new energy efficiency behaviours and experience of co-benefits, indicating that the former (home type) should be considered as a variable in future studies and programs. Nuanced changes in delivering support can be guided by this finding.

Thirdly, while this study focused on Indigenous households in Victoria, it is possible that as there was no valid discernment across various household types, variations for other cohorts may similarly not be accounted for by household type. This means that future CBSM approaches to improved residential energy efficiency may be equally useful to diverse groups of people, regardless of their specific living circumstances. Given the ongoing disadvantage experienced by Indigenous people in Australia, as well as other marginalized groups, more programs should be developed to alleviate the unhealthy living conditions that they experience. Energy efficiency measures can contribute to reducing utility bills, but can also improve other aspects of their quality of home life. Indeed, for some, achieving improved comfort may mean using the same amount of energy, just more productively.

The extent of the crisis for Indigenous people from living in poorly maintained properties that are not energy-efficient requires further investigation. The findings from the KEEP project regarding Victorian Indigenous households may well be reflected in Indigenous households elsewhere in Australia, which would call for a national response to improve their home living conditions by providing better housing and adequate support.

This research project is not without its limitations. Firstly, representativeness of the sample may be questioned because of the various biases and limitations in terms of accessing participants. Indigenous people and communities in Australia are often distrustful of research and government initiatives, and these views may discourage participation in such projects. This implies a limitation as to our ability to generalize the results beyond the scope of the sample. Indigenous communities and culture in Australia are also diverse and, therefore, generalization of the results on a broader range of Indigenous communities going beyond the scope of respondents in Victoria may be erroneous. Secondly, the research design followed a primarily quantitative, inductive logic. Our results may have exposed inferences between the home visits and the outcomes, and the temporal gap between 'before' and 'after' measures may serve as some degree of evidence regarding the causality relationship between home visits and results, but this analysis does not provide insights into how and why the actual home visits worked.

Further research is required to ascertain the reasons that the home visit approach worked better for some home types compared with others. In light of the results of such research, policy makers and community support organisations may consider specific incentives that target various types of homes and not use the same approach for everyone. Moreover, property owners need to be targeted to address the substantial upgrading necessary to their properties. Ironically, many Indigenous people and various low income groups live in government housing. This means that the people who are most vulnerable in society are being the least cared for by government bodies in terms of the housing provided to them. Unless this is addressed, such bodies may face future legal action where courts, such as the recent case in the Northern Territory of Australia [54], find them responsible and liable for their lack of maintenance actions.

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Appendix A

Table A1. A Survey items considered culturally appropriate for measuring energy-related knowledge; behaviour; and physical, social, and emotional well-being.

What do you think (or feel) about the following? 5-point scale from Not at all to Completely
Are you willing to reduce your energy use?
Do you find your energy bill confusing to understand?
Are you clear about what "energy rating" stars mean?
Are you unsure about specific ways to reduce your energy bill?
Do you think heating uses more energy than all other appliances?
Do you think reducing the thermostat by 1 degree makes any real difference?
Do you know how to run appliances in the most efficient way?
Are you relaxed about how much energy your household uses? (R)
Are you worried about being able to pay your energy bill?
Do you feel stressed when having guests because of the increase in your energy bill?
Are you worried about being disconnected?
How often have you . . . 5-point scale with response points Never, Almost Never, Sometimes, Often, Always
Turned off the TV at the wall?
Turned off lights when leaving a room at night?
Shut the door when leaving a room that is heated or cooled?
Adjusted the thermostat on heating or cooling to reduce your energy bill?
Deliberately turned off appliances to reduce your bill?
Has this affected you at night time? (e.g., having to turn off lights, TV)
Felt discomfort in your home due to temperature? (too hot/too cold/drafts)
Felt uncomfortable being home due to energy use?
Helped out friends or family with their energy use?
Felt your well-being at home affected by limiting your energy use?

Appendix B

LIEEP schema data

Table A2. Dimensions of Home Classification.

Classification Dimension	Schema-Data Variable(s)	Index Used
Dwelling age	DWELLING_AGE	Dichotomised (0–5, 5–9, etc.)
Wall material	WALL_CONSTRUCTION	Dichotomised (brick, concrete, wood, other)
Roof cover material	ROOFING	Dichotomised (tiles)
Roof colour	ROOF_COLOUR	Dichotomised (dark, intermediate, light)
Total number of rooms	BEDROOMS BATHROOMS LIVING_ROOMS	Total value of number of rooms
Number of storeys	STORIES	Dichotomised (one, two, more)
Window types	WINDOW_TYPES	Dichotomised (single glazed, double glazed and tinted)
Window covers	WINDOW_COVERINGS	Dichotomised (blinds, curtains)
Dwelling structure	STRUCTURE	Dichotomised (house, unit, other)
Insulation location	INSULATION_LOCATION	Dichotomised (wall, floor, roof, hot water system)
Heating type	HEATING_TYPE	Dichotomised (electric, gas, reverse-cycle appliance, other)
Cooling type	COOLING_TYPE	Dichotomised (fan, evaporative, reverse cycle, cooling only)
Appliance energy rating	ENERGY_RATING	Average score for all appliances reported on (number of energy rating stars)
Appliance condition	APPLIANCE_CONDITION	Average score for all appliances reported on (1: poor to 5: excellent)

Table A3. Dimensions of Household Classification.

Classification Dimension	Schema-Data Variable(s)	Index Used
Total number of occupants	NUM OCC AGE 0 9 NUM OCC AGE 10 19 NUM OCC AGE 20 29 NUM OCC AGE 30 39 NUM OCC AGE 40 49 NUM OCC AGE 50 59 NUM OCC AGE 60 69 NUM OCC AGE 70 79 NUM OCC AGE 80 89 NUM OCC AGE 90 99 NUM OCC AGE 100	Sum of occupant numbers across age ranges
Number of children (<20 years of age)	NUM OCC AGE 0 9 NUM OCC AGE 10 19	Sum of occupants in these two age categories
Bedroom use intensity	Total number of occupants/BEDROOMS	Average number of occupants per bedroom
Bathroom use intensity	Total number of occupants/BATHROOMS	Average number of occupants per bathroom
Tenure of occupancy	TENURE	Dichotomised (rented)

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