“With great power comes great responsibility”: Understanding the behavioural determinants of residential energy efficiency in Wellington.

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ABSTRACT

Recognition of the need for a transformation in our global energy systems to combat climate change has brought about an increased drive to curb energy consumption and increase energy efficiency. The residential sector is a prominent energy user and a key focus for this transition to a low carbon future. Psychology has played an increasingly important role in energy policy with an understanding that individuals act on motivators beyond economic explanations. This study provides a psychological evaluation of a residential energy efficiency intervention based in Wellington, New Zealand in order to develop a deeper understanding of how energy interventions engage participants in change and how they can be made more effective. The Wellington intervention uses a tailored information approach through a home energy audit to promote both efficiency and curtailment behaviours in local homes. By measuring before and after energy consumption changes in combination with salient psychological determinants, this quantitative study examines energy changes following the audit programme and the motivations involved in making these changes. The psychological determinants explored are the fundamental values held by programme participants as well as their level of concern for the environment. Analysis showed energy consumption changes following the audit to be variable and inconclusive as to the effectiveness of the overall programme. Values contributed a significant influence with self-transcendent values being a positive predictor of the number of efficiency behaviours implemented after the programme. This suggests that appealing to the altruistic concerns and collective interests salient within the self-transcendence value dimension when designing and implementing an intervention could aid uptake of energy conservation behaviour in future interventions.

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LIST OF ABBREVIATIONS

%ES	Percentage energy savings
EECA	Energy Efficiency and Conservation Authority
ESB	Environmentally significant behaviour
GEA	Global energy assessment
HDD	Heating degree days
IEA	International Energy Agency
HPwES	Home Performance with Energy Star
NAC	Normalised annual consumption
NEC	Normalised energy change
NEP	New Ecological Paradigm
OECD	Organisation for Economic Cooperation and Development
PDC	Per day consumption
PDEC	Per day energy change
PRISM	Princeton scorekeeping method
PVQ	Portrait values questionnaire
RCS	Residential Conservation Service
SPSS	Statistical package for the social sciences
VBN	Values, beliefs, norms
WCC	Wellington City Council
WHESP	Wellington Home Energy Saver Programme

1 INTRODUCTION

1.1 PREAMBLE

Energy production, consumption and appropriation has become inherently interwoven into the modern way of life. Almost every interaction within a modern lifestyle involves the consumption of energy; whether directly through the use of appliances and transport, or indirectly through food, clothing and packaging (Pierce, Schiano, & Paulos, 2010). Thus energy has been viewed as "the only universal currency: it must be transformed to get anything done" (Smil, 1994, p. 1). Indeed, human evolution has coevolved with and been reliant on energy discoveries and energy expansion, with the harnessing of coal and oil through the industrial revolution increasing society's ability to support larger populations, promote economic growth and improve human welfare (Fouquet & Pearson, 1998).

This harnessing of energy for human use has led to an increasing global energy consumption with primary energy use more than doubling in the last forty years (IEA, 2014). Whilst there is a fast growing and innovative renewable energy sector, fossil fuels such as coal and oil continue to provide the predominant energy source with 80% of the world's energy in 2012 being generated from fossil fuel sources (GEA, 2012b). Fossil fuels present not only a finite energy source but also contribute negative environmental impacts through pollution from production and combustion processes as well as damaging greenhouse gas emissions. The necessity for a transformation of the global energy system through rapid decarbonisation has been recognised internationally as key to building an environmentally sustainable future and reducing harmful carbon emissions (IEA, 2015; IPCC, 2014b). Indeed, changes to

the energy system have been identified as crucial to overcoming some of the most salient problems present in the world today such as food access and security, health and welfare improvements, environmental protection and conflict resolution (GEA, 2012b).

Curbing the growing consumption by making energy use more efficient has been highlighted as a central facilitator and enabler of this energy transition (GEA, 2012b; IEA, 2016b; IPCC, 2014a). Energy efficiency refers to the delivery of the "same service for less energy input" (IEA, n.d.). This means harnessing new technologies and equipment to provide the same services and lifestyle to users but utilising less energy in order to do so; for example, replacing an incandescent lightbulb with an energy efficient light bulb uses a smaller amount of energy whilst providing the same amount of light. The more efficient use of energy in this manner decreases demand on the system allowing for greater flexibility within the energy supply (GEA, 2012b).

1.2 ENERGY USE IN THE RESIDENTIAL SECTOR

Residential energy makes up 23% of the global energy picture (GEA, 2012b) and has been highlighted as a key sector to target for increased efficiency to mitigate climate change (GEA, 2012a; IPCC, 2014a) whilst also providing considerable social and health co-benefits through aiding poverty alleviation and generating warmer, healthier homes (Ryan & Campbell, 2012). Energy consumption in this sector refers to energy end-use; i.e. energy that is directly used by a household. The majority of this consumption is composed of energy used for space heating and cooling, appliances, water heating, cooking and lighting (IEA, 2016a). Energy consumption from household

transport, e.g. a family car, or embedded energy in household items such as food and packaging are not included in this definition of residential energy use.

Long term societal changes have contributed to the continuing rise in residential energy consumption such as a worldwide fall in family size and an increasing demand for and construction of larger houses (GEA, 2012a). Technological advances have further contributed with electronics and appliances becoming more economically accessible and culturally desired (GEA, 2012a). Thus, increased efficiency within this sector is a key strategy advocated for reducing energy consumption with investment growing and levels of efficiency already increasing mainly through improved regulation such as building codes and heating appliance standards (IEA, 2016b).

However, despite the improvements already being achieved, there remains substantial unrealised potential in this area (IEA, 2016a) with the promotion of residential energy efficiency to the end-user uncovering significant barriers to achieving maximum efficiency outcomes (Pollitt & Shaorshadze, 2011). This energy efficiency promotion has largely focused on efficiency gains through maximising household efficiency behaviours. An 'efficiency behaviour' consists of one-time or infrequent actions involving the adoption and purchase of new technology ranging from low-cost purchases such as draught excluders to expensive investments such as home insulation (Karlin et al., 2014). Whilst efficiency behaviours represent an important aspect of energy use, it has increasingly been acknowledged that changing household habits also has significant potential to contribute to reduced consumption (GEA, 2012a; Isaacs & Camilleri, 2010; Lopes, Antunes, & Martins, 2012; Ürge-Vorsatz & Herrero, 2012). This type of change in behaviour is referred to as a 'curtailment behaviour' and is defined as a frequent and repeatedly occurring habit or action that

often requires little financial investment to change, such as turning off an appliance when it is not in use (Karlin et al., 2014).

1.3 THE ENERGY EFFICIENCY GAP

The discrepancy between the uptake of energy conservation opportunities and the expected levels based on rational economic modelling has been termed the 'energy efficiency gap' and refers to the lack of adoption of energy efficiency (and curtailment) measures by consumers when in theory their adoption is financially beneficial (Gerarden, Newell, & Stavins, 2015). For instance, purchasing an energy efficient appliance saves money over the long-term through decreased energy use. However, uptake of such investments remains lower than expected.

Policy solutions to overcome the energy efficiency gap have historically revolved around economic theory. This perspective portrays individuals as rational actors within the energy system who will take action based on self-interest (Stern, 1986). The reasons presented to explain the energy efficiency gap centre on failures and barriers within the market which inhibit consumer investment (Howarth & Andersson, 1993). These market barriers and failures include: the uncertainty of energy prices, high initial costs of improvements, a lack of trust and understanding of new energy efficient products and difficulty in finding credible and relevant information about energy efficiency investments (Ansar & Sparks, 2009; Brown, 2001; Geller & Attali, 2005; Howarth & Andersson, 1993; Sutherland, 1991).

This economic perspective focuses on two main types of intervention; financial instruments (Ramos, Gago, Labandeira, & Linares, 2015) and information provision (Gyberg & Palm, 2009; Shwom & Lorenzen, 2012; Stern, 1992). Financial and

monetary interventions are provided in the form of subsidies or low interest loans for energy efficient investments and aim to overcome the limited access of households to capital and the high initial costs of large building changes such as insulation (Howarth & Andersson, 1993). Information provision has largely been supplied to energy consumers through broad and general mass media campaigns via leaflets, television adverts and internet campaigns which aim to overcome the uncertainty and lack of knowledge around energy efficient products as well as highlighting benefits to the consumer of investment in energy technology and undertaking curtailment behaviours (Henryson, Hakansson, & Pyrko, 2000; Lindén, Carlsson-Kanyama, & Eriksson, 2006).

Despite the continued prevalence of these strategies to overcome the energy efficiency gap, this economic perspective has been acknowledged to be limited in its ability to predict and influence both human behaviour and investment in energy conservation measures. Stern (1992) highlights that "policies based on careful technical and economic analysis have often been psychologically naïve or politically unrealistic" and "incentives designed to motivate economically rational decision makers often fail with ordinary citizens" (p. 1224). Therefore, the economic policy fixes to overcome the energy efficiency gap have not always brought about the expected magnitude of energy efficiency or conservation expected. Research has thus increasingly turned to psychology to strive for a deeper understanding of our relationship with energy and what motivates both conservation behaviour and the uptake of new technologies.

Behavioural economics integrates a psychological understanding of human behaviour with economic theory. This perspective asserts that many of the failures to achieve

optimal energy efficiency are due to the 'bounded rationality' involved in our decision making abilities; that is, our decisions are rational but hindered by the parameters that the decision making process is contained in and the intrinsic biases that we hold (Pollitt & Shaorshadze, 2011; Shwom & Lorenzen, 2012). In practice, this means that individuals often base energy choices on an incomplete understanding of the situation and use shortcuts or 'rules of thumb' to make decisions (Pierce et al., 2010). These rules of thumb can mean choosing a brand that is familiar, isolating product choice based only on one criteron or relying on the recall of incomplete prior knowledge rather than seeking or verifying information (Wilson & Dowlatabadi, 2007). Further bias in decision making comes from a preference for the status quo which gives an attachment to equipment and appliances already owned (Pollitt & Shaorshadze, 2011). The behavioural economics perspective maintains an economic solution focus with both monetary incentives and information provision featuring prominently in influencing individual action (Ramos et al., 2015).

1.4 THE PSYCHOLOGICAL PERSPECTIVE

The psychological perspective of residential energy consumption conveys a more complex and layered decision making process when it comes to energy choices. It is based on the growing body of behavioural research which shows that an economic perspective (even with the inclusion of behavioural economics) can present an overly simplistic picture of decision making (Steg & Nordlund, 2012). Thus, a psychological viewpoint tries to explain why people use resources such as energy in particular ways and what motivates people to engage in environmentally significant behaviours. Environmentally significant behaviour, or ESB can be defined as behaviour which "harms the environment as little as possible" (Steg & Vlek, 2009, p. 309) such as biking

to work instead of using a car, or recycling waste materials. Energy efficiency and curtailment behaviours are both regarded as environmentally significant behaviours as they contribute to a decreased environmental impact through reduced energy consumption.

From the psychological perspective, energy choices can be explained through an interplay of varying psychological determinants that further depend on externally driven constraints such as situational and contextual factors. These include socio-demographic variables such as household income, property size, and the number and age of household members. Motivators of energy consumption behaviour include an individual's intrinsic value system, their level of concern for the environment as well factors such as the social and cultural norms of behaviour which reflect the moral obligation an individual feels towards performing an action (Steg & Vlek, 2009) .

Values are viewed as the foundation of human behaviour, influencing subsequent attitudes, worldviews, opinions, and ultimately decision-making and action (Schwartz, 1992). Values are therefore a crucial aspect of behaviour to understand when attempting to bring about change. For example, an individual who holds altruistic values (i.e., valuing the collective interests of society) is more likely to engage in environmentally significant behaviour and have a higher level of concern for the environment than an individual who holds egoistic or self-interested values (De Groot & Steg, 2008).

To overcome the energy efficiency gap, a psychological understanding highlights the importance of not only understanding motivations such as values but also the cognitive barriers and enablers of energy conservation. Examining these barriers and

enablers has highlighted the key role of information in supporting energy conservation; however, unlike the generic information prevalent in the economic perspective, behaviour research has shown that information is much more effective if given in a personalised format (Abrahamse, Steg, Vlek, & Rothengatter, 2007). This could be in the form of frequent and relevant feedback of consumption on a home energy bill or by supplying specific and tailored energy advice through an in-home energy visit (often called a home energy audit) (Abrahamse, Steg, Vlek, & Rothengatter, 2005).

Psychology further highlights that interventions to promote energy efficiency and curtailment behaviours will be more effective when determinants of behaviour are included in both their design and evaluation (Abrahamse et al., 2005). Acknowledgement and understanding of these behavioural determinants will contribute to increasing the effectiveness of future interventions and will aid in moving beyond the common outcome focused economic evaluation to an in-depth analysis of why an intervention has succeeded, or indeed failed (Abrahamse et al., 2005; Lopes et al., 2012; Steg, 2008; Stern, 1992). However, few evaluations of energy conservation programmes have investigated these behavioural determinants. This research therefore, aims to form a better understanding of the contribution that behavioural determinants make to energy conservation behaviour.

1.5 New Zealand's relationship with energy

New Zealand reflects some of the ubiquitous changes in energy patterns with domestic residential energy consumption rising 14% between 1971 and 2005 along with a large growth in appliance use and a fall in the number of occupants per

household (Isaacs & Camilleri, 2010). However, New Zealand's energy supply shows a very different profile to other OECD countries with a much larger portion of its electricity production coming from renewable sources; 80.8% of electricity production in 2015 being from renewable energy (MBIE, 2016) compared to an OECD average of only 23.0% (IEA, 2016c).

Differences in energy end-use are also evident: New Zealand homes are significantly under heated by international standards and have colder indoor living room temperatures than recommended by the World Health Organisation (Howden-Chapman et al., 2009; Isaacs & Camilleri, 2010; Stoecklein et al., 2002). This is derived in part from historically poor construction and insulation (Howden-Chapman et al., 2009), with an estimated 600,000 homes in New Zealand currently having inadequate insulation (EECA, 2016). This is reinforced by traditional and ingrained behavioural patterns stemming from the colonial era which have created a masculine cultural identity that the cold needs to be endured (Cupples, Guyatt, & Pearce, 2007). This manifests in common practices such as heating only one room in the house (Centre for Social Research and Evaluation, 2010; Isaacs & Camilleri, 2010) and the action of putting on extra layers instead of turning on a heating source (Cupples et al., 2007).

These differences in the culture of energy use in New Zealand present some unique challenges in encouraging residential energy efficiency with large structural changes promoted to improve the building stock. In line with the economic perspective presented above, New Zealand has focused its residential energy conservation behaviour change efforts on providing economic incentives to encourage energy efficient investments and mass media campaigns and information provision to change energy behaviour (MED, 2011). These economic incentives have been provided

through the government led 'Warm Up New Zealand' campaigns which commenced in 2009 and offered subsidies to mostly low-income households for the retro-fitting of insulation and efficient heating systems (EECA, 2014). Increased energy efficiency has been an important part of this campaign and evaluation suggests evidence of energy savings following the programme (Grimes et al., 2012). However, it has mainly been a vehicle to assist with the primary aim of decreasing negative health outcomes from the impacts of fuel poverty within low income households (fuel or energy poverty has been defined as a spending of more than 10% of household income to ensure adequate home warmth is achieved; Boardman, 1991). The intervention has proved highly successful in terms of uptake with over 294,000 homes being retrofitted under the Warm Up New Zealand scheme by 2015 (EECA, 2016) though funding for this programme was cut in the most recent government budget (Green Party, 2016). Similar New Zealand interventions involving financial subsidies for large retro-fits have also shown positive results either through reduced energy use (Howden-Chapman et al., 2009) or reduced particulate emissions (O'Connell, Gaudin, & Kirk, 2010). However, the 'take-back' or 'rebound' effect has also been demonstrated whereby increased energy efficiency has resulted in an increased energy consumption i.e. some or all of the possible energy savings were used to create a warmer and more comfortable home environment (Grimes et al., 2012; Howden-Chapman et al., 2009).

The pool of New Zealand specific behavioural interventions to promote energy conservation is small. Scott, McCarthy, Ford, Stephenson and Gorrie (2016) show a positive role for both tailored information and community engagement to encourage changes in efficiency behaviours, household practices and people's aspirations for energy change in the New Zealand city of Dunedin. However, the majority of New

Zealand intervention studies have largely been created and analysed using an economic rather than psychological perspective, with little research and understanding of the underlying motivations of households to undertake energy efficiency and curtailment improvements. Reflecting the wider literature, a psychological approach is largely absent in intervention planning and evaluation. This study will contribute to the New Zealand residential energy consumption literature by broadening this psychological understanding and examining the behavioural determinants of energy conservation in a New Zealand context.

1.6 What is Wellington doing that is different?

New Zealand's capital Wellington is the country's third largest city. Accepted as one of the Rockefeller Foundation's '100 Resilient Cities' and with ambitious climate change targets, Wellington City positions itself as a leader in transitioning to a low carbon future (WCC, 2016). In 2011, the Wellington City Council (WCC) initiated the Wellington Home Energy Saver Project (WHESP) which, unlike the majority of New Zealand interventions, moved away from a pricing mechanism as a primary motivator and instead implemented a tailored information format which has successfully resulted in energy savings in other countries (Abrahamse et al., 2005) and has also shown itself to be a positive motivator to behaviour change in New Zealand (Scott et al., 2016). A voluntary and free home energy audit from an energy expert was offered to city residents which resulted in an individual list of household recommendations for energy efficiency improvements (WCC, 2014). In contrast to other New Zealand interventions, the audit included both efficiency and curtailment behaviours with recommendations ranging from large scale expensive changes such as ceiling

insulation to small scale, more easily adopted changes such as the use of draft excluders or the opening of windows to allow natural ventilation.

An analysis of the motivations and underlying determinants of behaviour based on psychological theory were absent from WHESP's initial evaluation (WCC, 2014). It was also unclear whether energy savings had been experienced by participating households with household energy consumption unmeasured. This presents a unique opportunity to gain a better understanding of a tailored information energy intervention in a New Zealand context using a measure of energy consumption change. This study therefore aims to contribute an evaluation of energy consumption and behaviour following the WHESP programme in conjunction with investigation into the psychological determinants of these behaviours.

1.7 RESEARCH QUESTIONS

This study will utilise a quantitative approach to evaluate the WHESP programme, using energy consumption data in conjunction with psychological variables to better understand the relationship between the motivators of energy conservation behaviour and the implementation and impacts of those behaviours.

Table 1-1: Research Questions

Research Questions
Research question 1: Did the Wellington Home Energy Saver Programme (WHESP) through its home audit intervention produce significant changes in energy use for the participating households?
Research question 2: What relationships exist between the psychological variables and energy saving actions undertaken as part of the WHESP programme?
Research question 3: What role do socio-demographic factors and psychological variables play in energy conservation outcomes?

1.8 THESIS PREVIEW

Table 1-2: Thesis chapter summaries

Chapter	Summary
1 Introduction	Chapter 1 has outlined the background of residential energy consumption. It explored the differing perspectives and methods of promoting energy conservation behaviour both globally and in New Zealand culminating in the overall aim and outline for this study.
2 The provision of information to change behaviour	Chapter 2 reviews the effectiveness of differing information based interventions. The local New Zealand context is examined with focus on a Wellington based tailored information programme. The first research question and hypothesis are framed.
3 Values, environmental concern and ESB	This chapter considers the framework for the study and examines the theory behind two determinants of behaviour: values and environmental concern. The review of existing literature highlights common themes and relationships in relation to environmentally significant behaviour and energy conservation. This creates two more research questions and their corresponding hypotheses.
4 Methodology	The research design is outlined in this chapter with key relevant literature highlighted and decisions within the research process made explicit. The two distinct phases of the study are presented in detail. First the method of energy consumption data collection and analysis is examined and secondly, the design of the survey and its implementation.
5 Results	The results chapter is presented in order of the hypotheses. Assumptions are tested and analysis conducted accordingly, with concluding remarks outlining the degree of acceptance of each hypothesis based on the findings.
6 Discussion	The discussion synthesises the evidence of previous literature with the findings of this study and examines the wider implications of the results. The limitations of the study are detailed along with suggestions for future research. The chapter concludes with recommendations for policy arising from the study.
7 Conclusion	This chapter provides a summary of the key conclusions from the study, bringing together themes from the discussion and implications for future energy conservation research.

2 THE PROVISION OF INFORMATION TO CHANGE BEHAVIOUR

2.1 INTRODUCTION

As outlined in Chapter 1, the predominant strategies utilised to promote energy efficiency and conservation behaviour in a residential setting have been financial incentives and information campaigns. This chapter will expand on the role of information in changing behaviour, examining the information strategies that have proved effective and ineffective. The role that information has played in New Zealand's approach to changing energy behaviour will be explored in greater detail with closer examination of the Wellington Home Energy Saver programme.

2.2 INFORMATION PROVISION

Mass media campaigns have been particularly attractive for their ability to engage a wide audience at a relatively low financial cost (Wakefield, Loken, & Hornik, 2010) and have been employed to encourage environmentally significant behaviours such as energy conservation and climate change mitigation (Bartiaux, 2008; Owens, 2000; Stern, 1992). However, whilst there has been evidence of some success, the effectiveness of information campaigns in encouraging behaviour change remains inconsistent across energy conservation studies (Abrahamse et al., 2005; Wakefield et al., 2010).

Abrahamse, Steg, Vlek and Rothengatter (2005) in their review of household energy conservation interventions concluded that whilst information resulted in increased knowledge, there was limited evidence of changes in behaviour or actual energy savings. Henryson et al. (2000) illustrate a short term decrease in energy demand

following a public information campaign in Stockholm; however, these positive results lasted for less than a week and did not bring about any long-term energy saving changes. Delmas, Fischlein and Asensio (2013) indicate that information can have a significant but varied effect on energy use with their analysis of 156 informational interventions highlighting energy savings of up to 18.5% for one programme but also an energy consumption increase of 55% at the other end of the spectrum. This illustrates that information can also achieve the opposite effect to that desired and suggests that other interventions may also be needed or that information needs to be presented in different ways to encourage change.

Wakefield et al. (2010) cite that the lack of effectiveness of information provision is because "homogenous messages might not be persuasive to heterogeneous audiences; and campaigns might address behaviours that audiences lack the resources to change" (pp. 1261). Gyberg and Palm (2009) highlight the passive nature of mass information provision whereby the transfer of knowledge between the informer and the individual exists solely as one of external persuasion and thus requires little effort or engagement on the part of the recipient. Gardner and Stern (2008) attribute the failure of information to encourage behaviour change to its non-specific nature, and note that information tends to be overwhelming and generally lacks any communication of how individual actions can be effective in reducing energy consumption. Kollmuss & Agyeman (2002) suggest that a greater level of environmental awareness does not automatically lead to an increase in the instance of environmental behaviour. Thus, it has been widely acknowledged that though information provision does engender a greater public awareness of the environmental issues involved in energy use and is beneficial to increasing knowledge

of issues, this heightened awareness does not necessarily correspond to energy saving behaviour (Abrahamse et al., 2005; GEA, 2012b; Stern, 1999). For example, a study of Belgian households by Bartiaux (2008) demonstrates that whilst there was a high level of participant understanding of energy use behaviours and environmental issues such as climate change, this knowledge was not sufficient to change an individual's daily energy habits and routines.

Despite the lack of behaviour change evident, information campaigns remain one of the most widely used strategies to promote residential energy conservation (Gynther, Mikkonen, & Smits, 2011; Kollmuss & Agyeman, 2002) with findings from behavioural research largely under-utilised in energy conservation programme design (Gynther et al., 2011). Gynther et al. (2011) emphasise that behavioural insights would promote more effective interventions than current strategies have achieved by providing a more complex understanding of the motivations of behaviour. This under-utilisation is further reflected in programme evaluation with few residential energy interventions examining psychological determinants of energy consumption or conservation ex-post (Abrahamse et al., 2005). These behavioural determinants are important in increasing the effectiveness of future interventions because they provide an in-depth analysis of why an intervention has succeeded or failed (Abrahamse et al., 2005; Lopes et al., 2012; Steg, 2008; Stern, 1992).

2.3 INFORMATION PROVISION: A TAILORED APPROACH

Whilst media campaigns have shown limited effectiveness, behavioural research does demonstrate an important role for information in the cognitive and behavioural process, with knowledge and awareness remaining a vital part of energy consumption

decision-making. Gardner and Stern (2008) describe the mostly positive motivations of individuals to act on energy related issues for the benefit of the environment but highlight that many feel they don't possess enough knowledge on which actions to take and the corresponding effectiveness of these actions to mitigate the problem. Henryson, Hakansson, and Pyrko (2000) outline a Swedish project in which lack of knowledge was one of the largest barriers to energy savings cited by respondents. Participants in the project felt that more information would be the most influential factor in undertaking future energy conservation measures.

To make information more effective, the psychological literature highlights that when information is presented in a specific and personalised or tailored format it becomes a more powerful tool in engaging households in energy saving behaviour (Abrahamse et al., 2005, 2007; Gardner & Stern, 2008; Steg, 2008; Stern, 1992). The tailoring of energy messages involves a more personal strategy of communication and means that only relevant information is received by an individual or household who can then more easily identify actions they are able to take to reduce energy consumption (Abrahamse et al., 2005). For example; providing targeted and detailed information to households, including details of environmental effects, was shown by Ek and Söderholm (2010) to have a significant positive impact on the willingness of respondents to undertake electricity saving actions compared to a group who only received a broad framing of the energy information. Abrahamse et al. (2007) found that using a web-based tool to provide a tailored list of household specific energy efficiency recommendations, in combination with securing a commitment to conserve energy, produced energy savings amongst participating households compared to a control group.

There remains some inconsistency in the effectiveness of tailored information interventions, with some interventions exhibiting little or no energy use change (Abrahamse et al., 2005). This shows the heterogeneity of context, culture and situation on householders and highlights the need for consideration of these aspects in program planning (Delmas et al., 2013; Steg, 2008). Given the disconnect between knowledge and behaviour, information should further be viewed as one tool to be utilised in combination with other intervention tools, with a wide range of barriers still evident that even tailored information remains unable to overcome (Abrahamse et al., 2007; Gardner & Stern, 2008; Stern, 1999). These include monetary barriers to investment in large home energy changes and the cultural and social embeddedness of energy routines (Owens & Driffill, 2008) making behaviour difficult to change. Information provision is a critical aspect of programme design but it will be more effective when used in combination with other interventions such as financial incentives or wider community engagement (Abrahamse et al., 2007; M. G. Scott et al., 2016; Stern, 1999).

2.3.1 Energy Audit Interventions

A home energy audit has proved an effective mechanism for delivering tailored information to households (Abrahamse et al., 2005; Ramos et al., 2015). This approach consists of a household visit by an energy expert who performs an assessment of the home's energy efficiency and offers personalised recommendations to the household on improvements that can be undertaken. The audit is generally free or low-cost and participation is voluntary. There are many variations and additions to this basic template, with some audits offering details of contractors and prices for the recommended improvements, some experts are able

to install minor upgrades at the time of the home assessment, some audits are coupled with detailed energy feedback or other information strategies and a number of programmes offer financial assistance through subsidies or low interest loans to aid in the uptake of the recommendations (Belzer, Mosey, Plympton, & Dagher, 2007; Henryson et al., 2000; Hirst, 1984; Tonn, Hawkins, Schweitzer, & Eisenberg, 2013). Many audits are based solely on technical advice aimed at improving energy efficiency behaviours through investment in equipment and upgrades (Bartiaux, 2008; Liaukus, 2014), whilst some also attempt to change energy habits by making recommendations based on curtailment behaviours (Revell, 2014).

Auditing first became a widely utilised tool in the United States following the oil crisis of the 1970s (Hirst, 1984; Stern, 1992) and has been further developed and expanded across the US over the last few decades (Liaukus, 2014; Palmer, Walls, Gordon, & Gerarden, 2013). Home energy audits are also currently a mandated strategy in the European Union via the EU Energy Efficiency Directive (European Parliament, 2012) which outlines a clear role for auditing in residential energy efficiency strategies. However, there has been a limited understanding exhibited of the impact of audit programmes in both energy savings experienced and cost effectiveness (Hirst, 1984; Palmer et al., 2013; Tonn et al., 2013). The following provides a short review of the audits that have been evaluated but the lack of program evaluation remains a significant barrier to fully understanding the application and effectiveness of this strategy given the often significant financial and resource heavy investment by the governments, utilities and organisations involved (Abrahamse et al., 2005; Ramos et al., 2015).

The United States Residential Conservation Service (RCS) auditing program of the early 1980's remains one of the largest applications of the auditing strategy involving 40 states and over 3 million households (Clinton, Geller, & Hirst, 1986). The implementation of this auditing program varied in its application across the country depending on the state involved and very few of the participating RCS states evaluated the impact of their program (Hirst, 1984). Of those programs that did analyse the energy savings involved, it was revealed that on average a small but significant reduction in energy use of 3-5% was evident (Hirst, 1984). However, due to the differences in implementation, some states experienced greater average energy savings of up to 15% and this was attributed to the availability of subsidised loans in conjunction with the home audit in these areas (Hirst, 1984).

A more recent and similarly extensive US program 'Home Performance with Energy Star' (HPwES) run by the United States Department of Energy was initiated in 1999 and remains current across the country today (see table 2-1 for a summary of the more recent audits and their impact). This program relies heavily on the 'Energy Star' product rating mechanism to promote energy efficient purchases through the home audit process (Tonn et al., 2013) . Again, very few of the states involved have evaluated their programs despite its wide and continuing promotion (Tonn et al., 2013). The audit program implemented in Austin, Texas as part of HPwES was evaluated and provides evidence of a large 25-35% energy saving amongst 7,000 participating households, though this is only related to electricity used for cooling and does not involve other energy behaviours (Belzer et al., 2007). In an evaluation of the New Jersey HPwES, only 17 homes were sampled and these were selected on the basis that they were projected to be in the top 25% of energy savings. This explains its

Table 2-1: Audits since 2000 (for anything prior see Abrahamse et al., 2005)

Audit Programme	Location	Sample size	Type of recommendation	Energy type analysed	Measurement	Outcome
Task 2000 Hennryson et al (2000)	Vattenfall, Stockholm Sweden	350	Curt	Resistive heating	Unclear	average energy saving **3.1%**
Home Performance with Energy Star Belzer et al (2007)	Austin, Texas USA	6,667	Ef	Electricity used for cooling	Billing records	average electricity saving **25-35%**
SEREC Bartiaux (2008)	Belgium	40	Ef	NA	Recommendations undertaken	**11%** of proposed measures implemented 1 year after audit
RE: NEW Revell (2014)	London UK	118	Ef & Curt	NA	Estimated carbon emissions from self-reported changes	**146 KgCO2** average abatament per household
EmPower Program Alberini & Towe (2015)	Maryland USA	17,000	Ef	Electricity use	Monthly electricity bills	average decrease in electricity use **5%**
Get Bill Smart Alexander et al (2016)	Great Hobart, Tasmania Australia	169	Ef & Curt	Electricity Use	Quarterly electricity bills	average decrease in electricity use **1.44 KWh**

Ef: Efficicency behaviours, Curt: Curtailment behaviours

extremely high achievement of 27 – 61% energy reduction and thus the result gives no indication of the effectiveness of the program as a whole (Liaukus, 2014). A smaller US program initiated in Maryland performed a more rigorous evaluation of its energy audit intervention 'Em Power' in 2011 by collecting four years of energy data for 378 participating households which resulted in average energy savings of approximately 5% (Alberini & Towe, 2015). Indeed, Delmas et al. (2013) establish that the highest quality studies often have the lowest energy savings and that some analyses may overestimate energy savings if factors such as demographics, weather conditions and the existence of a control group are not taken into account. They also establish however, that from the 156 studies analysed, individualised information through home energy audits produce the largest energy savings (13.5% on average) compared to other information strategies.

All of the US programs outlined above focused on energy efficiency investments ranging from small and low-cost purchases such as energy efficient bulbs to larger investments like heating and cooling systems with the implicit assumption in evaluation that the actual behaviour of the households had not changed during the duration of the study (Liaukus, 2014). Henryson et al. (2000) illustrate the employment of the audit strategy in a different way in Sweden, with a program focused solely on curtailment behaviours and changing habits. This program further integrated the home energy audit with differing levels of information including frequent and readily available energy use feedback and resulted in modest average energy savings of 3.1%, solely through the adoption of curtailment behaviours.

Curtailment behaviours are generally viewed by householders as the most effective means of achieving an energy reduction (Attari, DeKay, Davidson, & De Bruin, 2010),

whilst also being viewed less positively than efficiency behaviours due to their perception as a sacrifice to the quality and comfort of the household's everyday life (Poortinga, Steg, Vlek, & Wiersma, 2003; Stern, 1992; Wilson & Dowlatabadi, 2007). Abrahamse et al. (2005) highlight the complex interplay between technology and the way technology is used by the individual and conclude it is not so easy to present the two behaviours of efficiency and curtailment as distinct from each other. Therefore, whilst efficiency behaviours are judged by experts to generate a higher environmental impact (Attari et al., 2010), Gardner and Stern (2008) emphasise that curtailment and efficiency behaviours are not an "either-or" choice (p. 20) and promotion of both efficiency and curtailment behaviour are important to energy conservation outcomes.

The 'Get Bill Smart' home energy audit intervention conducted in Tasmania, Australia recommended both efficiency and curtailment behaviours prompting a 1.44 KWh per day reduction in electricity consumption of participants compared to a control group (Alexander et al., 2016); whilst the RE:NEW project in London reported a 3% decrease in carbon emissions following the delivery of free home energy visits (Revell, 2014). Unlike the previous studies reported above, the RE:NEW project evaluation also sought to find which types of behaviour had contributed to the positive impact of the programme. Energy savings were found to stem largely from the small efficiency behaviours implemented rather than from the large efficiency investments or the curtailment behaviours recommended. Matching these findings, Bartiaux (2008), in her analysis of a Belgian audit program, also established that the most prominent measures undertaken were generally the easiest and least costly such as the installation of a low flow shower head. However, this study focused on solely encouraging efficiency behaviours and only 11% of all recommended measures were

reported to have been implemented one year after the audit showing a varied response to the intervention.

There is evidence within the literature of heterogeneity in response to energy audits. McDougall, Claxton and Ritchie (1982) concluded that the ENERSAVE home energy audit program had "little or no effect on homeowners conservation activities" (p. 265) and McMakin, Malone and Lundgren (2002) found a 2% increase in energy consumption following their residential audit intervention in Arizona. Whilst Henryson et al.'s (2000) study had ultimately shown an average decrease in energy consumption, a widely varied response was evident with 20% of households increasing their energy use compared to before the intervention.

Therefore, a greater understanding of program impact and the factors and behavioural determinants involved in successful and unsuccessful strategies is critical to understanding household responses to energy audits and how to improve future applications of auditing interventions (Abrahamse et al., 2005; Lopes et al., 2012; Steg, 2008; Stern, 1992). This thesis will examine both the energy consumption changes following an audit intervention in conjunction with key psychological determinants of behaviour in order to better understand the motivators and reasons for both energy and behaviour changes.

2.4 THE NEW ZEALAND CONTEXT: INFORMATION PROVISION TO PROMOTE ENERGY CONSERVATION

Energy saving information campaigns in New Zealand are primarily administered by the Energy Efficiency and Conservation Authority (EECA) who are the principal agent in implementing the government's energy efficiency priorities (EECA, 2014).

Information has been presented in the form of mass media coverage and online information such as the 'Energywise' consumer information campaign which provides a wide range of online energy saving tips and information on energy labelling (EECA, 2014). However, it is difficult to evaluate the effectiveness of this information provision given that success has generally been judged through increased awareness rather than evidence of behaviour change or energy savings. For example, EECA cite an estimated 65% of individuals express an understanding of the Energywise brand but it is not ascertained if this led to a corresponding change in energy behaviour (EECA, 2014). An estimated 39% of consumers have taken action after viewing the Energy Spot videos which provide energy efficiency tips (EECA, 2014); however, no reference was given to how this figure was produced and what likely impact it would have on energy savings or which behaviours were adopted. It is well documented within the psychological literature that increased awareness does not necessarily lead to behaviour change (Stern, 1999) and thus, despite claims of success, it is unclear whether the consumer information provided by EECA has overcome the barriers involved and illustrates that a greater awareness of behavioural research in this area could prove beneficial. It also suggests that a more in-depth evaluation of outcomes is necessary to understand the efficiency gains achieved.

2.4.1 Wellington's Home Energy Saver Program (WHESP)

In 2011, the Wellington City Council initiated the Wellington Home Energy saver Project (WHESP) which used a tailored information strategy in the form of a home energy audit. The program had multiple and diverse aims to -

- "reduce energy consumption, energy costs and greenhouse gases in Wellington households

- remove barriers to taking action on energy/climate change in residents' own homes
- make energy efficiency a higher priority amongst Wellington households"

(WCC, 2014, p. 6)

The program is also integral to the council's "Low Carbon Capital" plan which outlines the city's policies and strategies to reduce greenhouse gas emissions (WCC, 2016). The home energy audit is free to households who voluntarily participate in the programme and a small financial incentive in the form of a subsidy of up to 50% of the cost of efficiency purchases is available at the time of the audit up to a $115 value (WCC, 2016); this covers items such as low-flow shower heads and energy efficient lighting. The tailored recommendations are provided to households in the form of a detailed report and range from large scale expensive changes such as ceiling insulation to small scale more easily adopted changes such as the use of draft excluders. The audit also includes promotion of curtailment behaviours such as drying clothes outside instead of using a drier.

Though the project is currently ongoing, a preliminary evaluation was completed in 2014 highlighting high customer satisfaction with the WHESP audit, with 96% of houses implementing at least one of the recommended changes, 73% responding that their home was a better place to live and more than 80% of the respondents agreeing that they had gained knowledge and confidence about how to reduce their household energy use (WCC, 2014). However, the report also highlighted the inability of households to know if they had indeed saved money or made energy savings due to price and seasonal fluctuations in energy bills. In line with previous research,

underlying determinants of behaviour based on psychological theory were absent from the evaluation as was an analysis of any energy savings.

This thesis provides a novel contribution to the field by delivering an evaluation of the physical energy savings involved in the WHESP, hereby providing a quantitative analysis of the effectiveness of a New Zealand intervention which specifically targets energy conservation through a tailored information format. Further, this research explores the psychological factors and determinants of energy behaviours within the programme which will be outlined in chapter 3. This will enable a more complex understanding of the programme's participants to be explored and, in conjunction with a measure of energy savings, will contribute a unique perspective to the international behaviour change literature.

2.5 Research Question 1

Based on the literature reviewed above, the following research question and hypothesis was developed for this study. Research questions relating to the psychological determinants of energy use will be presented at the end of Chapter 3 which describes the theoretical framework for the psychological variables.

Table 2-2: First research question and hypothesis

Research Questions and Hypotheses
Research question 1: Did the Wellington Home Energy Saver Programme (WHESP) through its home audit intervention produce significant changes in energy use for the participating households?
H_1: Households participating in the WHESP consumed less energy following the home energy audit than before the intervention took place.

3 VALUES, ENVIRONMENTAL CONCERN AND ENVIRONMENTALLY SIGNIFICANT BEHAVIOUR

3.1 INTRODUCTION

The psychological literature outlines several behavioural variables related to environmentally significant behaviour and more specifically that of energy conservation behaviour. Two of these psychological variables will be examined in depth in this chapter: values and environmental concern. Values have been represented as the foundation of behaviour from which all other behavioural influences stem and their importance and influence on energy conservation behaviour will be examined in the following chapter. The relationship between environmental concern and energy conservation behaviour will also be considered along with the role and impact of socio-demographic factors found to contribute to household energy consumption. This chapter will conclude with the final research questions and hypotheses to be examined in this study.

3.2 AN UNDERSTANDING OF HUMAN VALUES

A value in the most basic sense represents an apportioning of 'worth' to an item or object (Lowrance, 1986). Put simply, human values define what is important to us (Schwartz, 2012) and as such are the "criteria that people use to select and justify actions and to evaluate people (including the self) and events" (Schwartz, 1992, p. 1). They are intrinsic beliefs that guide actions and behaviours in all aspects of everyday life. Rokeach (1973) outlines that human values are a cognitive manifestation of basic human needs; however, they remain distinct from needs through their ability to also be shaped by both societal and psychological forces (Rokeach, 1973). This distinction

from ‘needs’ makes the possession of values one of the defining features which separate humans from non-human species (Rokeach, 1973). Values are stable and intrinsic to our existence but are also moulded over the long-term by situational, cultural, institutional, environmental and contextual factors such as relationships, religion and personal experiences.

Schwartz (1992) outlines 5 qualities that values possess:

> “*Values (1) are concepts or beliefs, (2) pertain to desirable end states or behaviours, (3) transcend specific situations, (4) guide selection or evaluation of behavior and event, and (5) are ordered by relative importance.*” (Schwartz, 1992, p. 4)

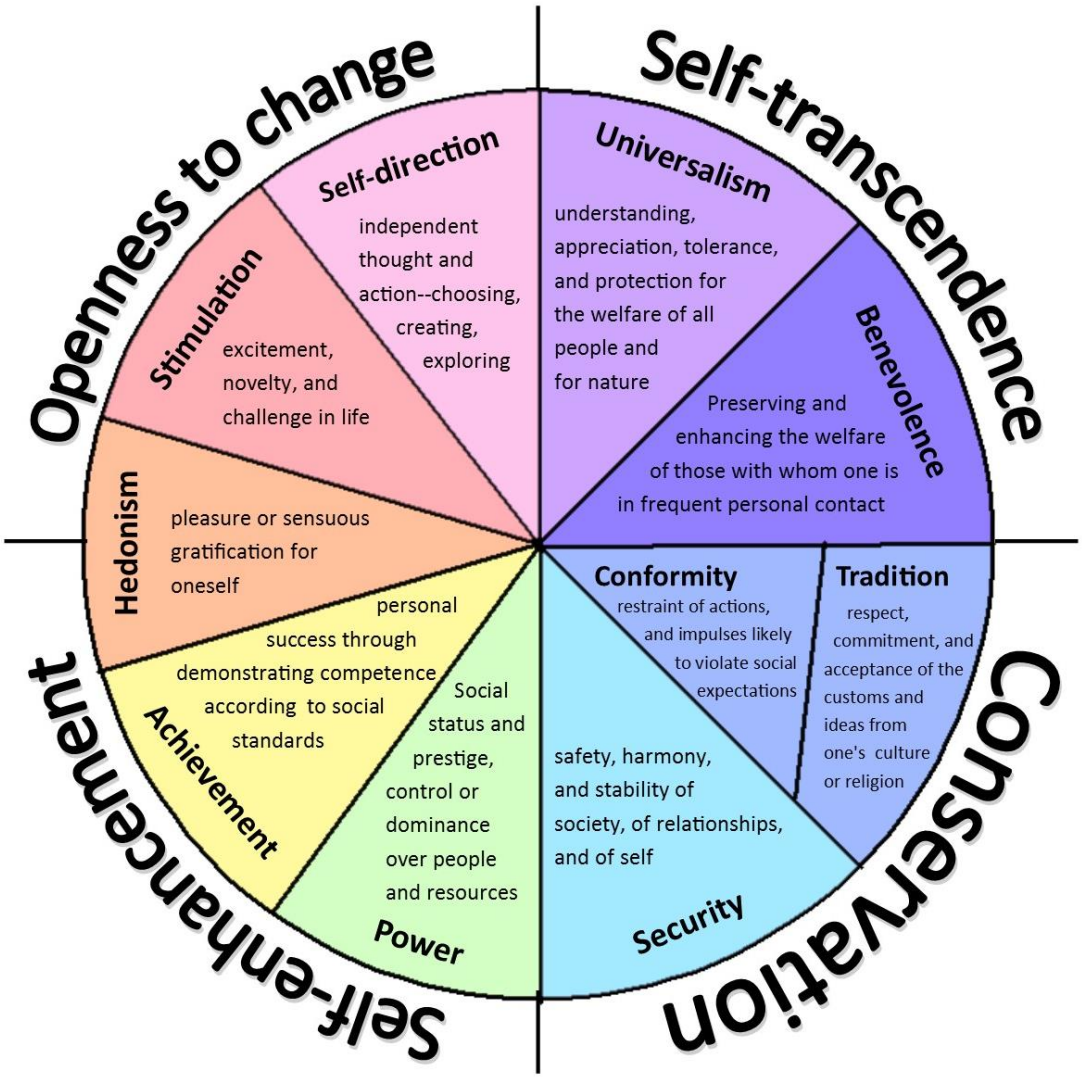
The last of these qualities, the ordering of values, suggests that values are part of a “hierarchically organized system” (Rokeach, 1973, p. 6). This means that an individual gives differing values a different level of importance, and each person’s values system represents a unique hierarchy based on their intrinsic beliefs. This value hierarchy is activated in different ways depending on which values are triggered in a given situation and the relative importance of these values within the value system as a whole (Rokeach, 1973; Schwartz, 1992). For example, keeping a home warm and dry is likely to trigger values related to personal comfort as well as those of valuing family health and wellbeing. If these values are important to an individual, then maintaining a warm dry home may outweigh other concerns such as the environmental impact of energy use which relates to altruistic values.

3.2.1 Towards a universal value classification

Schwartz provides empirical cross-cultural evidence which indicates that there are human value types which are universal (Schwartz, 1992, 1994; Schwartz et al., 2001). His work has uncovered 56 different values evident within cross-cultural populations including values such as ambition, sense of belonging and equality. These 56 values were found to form 10 distinct value types. These 10 value types group together individual values found to be related and complimentary; for example, the value type of 'self-direction' includes values such as freedom, creativity, independence and curiosity which collectively represent "independent thought and action" (Schwartz, 2012, p. 4; see Figure 3-1 for defining goals of each of the 10 value types).

Schwartz arranged these 10 values types into two dimensions based on their relationships to each other (see Figure 3-1). The placement of the value types within two-dimensional space represents the relationship the value types have with each other in a circular continuum. Value types placed next to each other are closely related. This means that when one of these values is ranked highly by an individual or is activated in a particular situation, the adjacent value types are also often ranked as being of importance or also activated to a certain degree. In contrast, those value types opposite each other in the figure show an inverse relationship. For example, the value of 'universalism' (which includes the values of equality, wisdom and unity with nature) tend to be in conflict with values represented by the opposing value type of 'power' (which includes values such as wealth, authority and social recognition; Schwartz, 1992).

Figure 3-1: Theoretical values framework. Adapted from Schwartz (2012)



These 10 value types have been further condensed into two dimensions. The first dimension is the self-enhancement vs self-transcendence value dimension, which includes value types of universalism and benevolence that describe the altruistic concerns and collective interests of 'self-transcendence' on one end of the spectrum versus 'self-enhancement' which comprises value types that illustrate individual, egocentric interests such as achievement and power at the opposing end. The second dimension refers to 'openness to change', including the value types of stimulation and

self-direction, versus 'conservation' which describes the values related to security, tradition and conformity.

3.2.2 What do values tell us about environmental behaviour?

These deeply held human values, ascertained as relatively stable and transcendent of situational factors, are seen as a central foundation of ourselves and our cognitive processes. All other aspects of human nature; attitudes, motivations, worldviews, intentions and ultimately human behaviour and action (or inaction) are correspondingly built on these values that we hold (Rokeach, 1973; Schwartz, 1992; Stern, 2000; Stern, Dietz, & Guagnano, 1995). Indeed, in the first national survey of values in the USA, Rokeach (1973) found that values were related to a diverse range of decisions and behaviours. Some of the environmentally significant behaviours (ESB) shown to be related to values include recycling, composting and walking or biking to work (Schultz et al., 2005; Thøgersen & Ölander, 2002).

Whilst differing individual values and value types have been shown to influence ESBs (Fraj & Martinez, 2006; Neuman, 1986) one common finding is that individuals who give importance to collective interests through self-transcendence values (also sometimes described as 'pro-social' or 'altruistic' values; Steg & Vlek, 2009) are "more willing to engage in diverse types of ESB" (De Groot & Steg, 2008, p. 333). In contrast, those who prioritise self-enhancement values reflecting individual interests (sometimes presented as 'pro-self' or 'egoistic' values) are less likely to engage in ESB (De Groot & Steg, 2008; Stern, 2000). This means that the more a person values the interests of others around them, the more likely they are to behave in a way that benefits the environment and the more a person values their own interests, the less likely they are to perform environmentally beneficial behaviours. This finding reflects

the opposition evident in Schwartz's value dimensions and "captures the conflict between values that emphasize concern for the welfare and interests of others (universalism, benevolence) and values that emphasize pursuit of one's own interests and relative success and dominance over others (power, achievement)" (Schwartz, 2012, p. 8).

A number of studies have examined the relationship between self-transcendence and self-enhancement values and ESB and the most relevant are summarised here. Thøgersen and Ölander (2002) in a Danish study, established a connection between the universal value type in the self-transcendence dimension and an increased frequency of engagement in environmentally friendly behaviours such as biking to work or purchasing energy saving light bulbs. Similarly, Nordlund and Garvill's (2002) Swedish study tested the relationship between values (in combination with a number of other factors) and various ESBs and found self-transcendence to be positively related to ESBs including recycling, energy conservation and transport behaviour. Stern et al.'s (1999) research found a positive relationship between the 'altruistic' values of a sample from the United States and support for environmental activism and the environmental movement. Karp (1996) confirmed a positive relationship between self-transcendence values and participation in environmentally beneficial activities such as reducing plastic use or voting for an environmentally supportive political candidate. In addition, a negative association was evident in this study between values in the self-enhancement dimensions and the frequency of ESBs. Schultz et al (2005) indicated that this negative relationship between 'egoistic' values and ESB might also be different in different cultures, with Germany, India and New Zealand

demonstrating a larger negative association between self-enhancement values and ESBs than the other countries involved in their cross-cultural study.

Values have also been shown to be a determinant of pre-cursors to behaviour such as attitudes, specific situational beliefs, intentions, concern for the environment and commitment to act in an environmentally friendly way (Neuman, 1986; Schwartz et al., 2001). Self-transcendence values are positively associated with favourable environmental attitudes and a greater feeling of responsibility and concern for the environment; whilst self-enhancement values present the opposite relationship, with individuals who place more value in personal interests being less likely to have environmentally positive attitudes or be concerned about environmental issues (De Groot & Steg, 2008; Schultz et al., 2005; Schultz & Zelezny, 1999).

3.3 ENVIRONMENTAL CONCERN

Despite the centrality of values to human behaviour, it is widely acknowledged that there are also many further variables which mediate the relationship between values and environmentally significant actions (Abrahamse & Steg, 2011; Neuman, 1986; Steg, Dreijerink, & Abrahamse, 2005; Stern, 2000; Stern, Dietz, & Kalof, 1993). These variables are said to 'mediate' this relationship through their position in between an individual's values and their behaviour forming a link which both connects and influences the relationship between them (Baron & Kenny, 1986). A number of these variables such as attitudes, beliefs and environmental concern have already been mentioned above but additionally include: contextual and situational factors that influence the ease with which a behaviour can be undertaken; cultural factors which influence the acceptability of the behaviour within social circles; and habits formed

and reinforced through recurring behaviour patterns (Steg & Nordlund, 2012). These additional and sometimes very influential factors mean that despite an individual's deeply held values of environmental responsibility, the corresponding pro-environmental behaviour is not always evidenced in their actions (Kennedy, Beckley, McFarlane, & Nadeau, 2009; Kollmuss & Agyeman, 2002; Nordlund & Garvill, 2002). Kennedy et al. (2009) found that 72.3% of the 1421 respondents in their Canadian study stated that they felt prevented from doing what they thought was best for the environment. Prominent reasons for this feeling of prevention were a lack of knowledge or time, money considerations and perception of a decision or action being beyond the respondent's control. Termed the 'value-action gap' (Kollmuss & Agyeman, 2002), this disparity between value priorities and the corresponding actions taken has been prominently discussed within environmental psychology and implies that, despite the centrality of a value system to the actions we engage in, there are significantly more factors involved in behaviour beyond that of values.

3.3.1 The role of environmental concern

One of these influential factors which is of specific interest to this research is the level of concern for the environment that an individual holds. Environmental concern has been described as one of the causal factors in a chain which links values at one end and behaviour at the other (Stern, 2000). Stern et al. (1995) portray environmental concern as a filtering component, or mediating factor, which intercedes between the social and structural influences apparent in decision making and an individual's emerging attitudes and behaviour.

With an increasing public and political awareness of the environmental problems associated with the modern 'developed' lifestyle and a shifting global focus to

sustainability during the 1970s, Dunlap & Van Liere (1978) argued that a new worldview originally called the "New Environmental Paradigm" and later the revised "New Ecological Paradigm" or NEP (Dunlap, Van Liere, Mertig, & Jones, 2000) was becoming more prominent in society. This emerging NEP perspective challenged that of the "Dominant Social Paradigm" which exhorted attitudes of abundance, prosperity and growth with little understanding of environmental consequences (Dunlap & Van Liere, 1978). This more environmentally concerned worldview has been demonstrated to be increasing in strength and importance as global environmental issues such as climate change and ozone depletion have become more salient and more widely experienced (Dunlap et al., 2000; Gyberg & Palm, 2009).

Dunlap, in collaboration with other researchers, developed the NEP scale as a measure of an individual's ecological worldview or level of environmental concern (Dunlap, 2008; Dunlap & Van Liere, 1978; Dunlap et al., 2000). Despite ethical criticisms of its alleged anthropocentric focus and lack of a deep ecological perspective (Lundmark, 2007), the NEP has become the most widely used scale for measuring an individual's level of environmental concern (Dunlap, 2008). The scale has been diversely utilised to represent a measure of environmental attitudes (Schultz & Zelezny, 1999), environmental beliefs (Kennedy et al., 2009) and even as a measure of environmental values (Dunlap, Van Liere, Mertig, & Jones, 2000) despite evidence to suggest that it is a separate dimension "orthogonal to value orientations"(Stern et al., 1995, p. 734). Dunlap and van Liere (1978) termed their original measure one of 'environmental concern' and environmental concern will be the terminology used within this research.

In its various guises, environmental concern, as measured by the NEP scale, has been found to be connected to an individual's centrally held values whilst also demonstrating itself as a predictor of both behavioural intentions and behaviour itself (De Groot & Steg, 2008; Dunlap et al., 2000; Stern, 2000). For instance, the value type of power, which belongs to the self-enhancement dimension, has been seen to have a negative association with an individual's level of concern for the environment and this finding remained consistent across 10 different countries studied (Schultz et al., 2005). Research has also consistently shown that individuals with a greater level of environmental concern are more likely to engage in ESB (Casey & Scott, 2006; Clark, Kotchen, & Moore, 2003; Gadenne, Sharma, Kerr, & Smith, 2011; Mobley, Vagias, & DeWard, 2010; D. Scott & Willits, 1994). These relationships vary in their strength with some evidence suggesting that when there are significant barriers to behaviour, environmental concern lacks any predictability (Whitmarsh & O'Neill, 2010). This indicates that despite a strongly held concern for the environment, greater influences can result in an individual's inability to act on these concerns.

3.4 THE LINK BETWEEN VALUES, ENVIRONMENTAL CONCERN AND RESIDENTIAL ENERGY USE.

Before embarking on a summary of the role of both values and environmental concern in energy use, it is useful to first describe some of the other factors that exhibit a strong influence on residential energy consumption. Household energy use is determined by a number of contextual factors including climatic, physical, socio-demographic and institutional influences (Guerin, Yust, & Coopet, 2000). Climatic factors include weather conditions such as the outside air temperature or season, which directly influence household energy consumption. Physical factors refer to the

physical attributes of the housing situation i.e. how large the house is, the quality of the building envelope or structure and the heating appliances already fitted. Socio-demographic factors include social aspects of the household make-up i.e. household income, the number and age of the occupants as well as their level of education. Institutional factors refer to the institutional framework within which residential energy decisions sit e.g. how easy it is to obtain building consent for large housing retrofits or the availability of competitive power companies which offer smart metering information. These contextual and situational variables can exert a large influence on behaviour and can inhibit action even when an individual or household is highly motivated to act. Therefore, despite the importance of psychological determinants, they must be placed within a contextual framework (Steg, 2008).

The most influential structural factor found to have a direct and positive connection with residential energy use is the size of the property that a household lives in; with larger properties creating greater energy consumption (Thøgersen & Ölander, 2002). Socio-demographic predictors of energy use include income, family size, home ownership, level of education and occupant age (Abrahamse & Steg, 2009; Guerin et al., 2000; Poortinga, Steg, & Vlek, 2004; Thøgersen & Ölander, 2002). All of these factors exert a strong influence on energy consumption and can be a greater determinant of household energy use than psychological and behavioural variables (Abrahamse & Steg, 2011). However, whilst socio-demographics demonstrate large influences on energy consumption, research suggests that socio-demographic factors are far less influential on the *conservation* of energy (Abrahamse & Steg, 2009; Brandon & Lewis, 1999).

Abrahamse and Steg (2009) suggest this weaker influence of socio-demographic factors on energy conservation is due to energy changes requiring "some form of (cognitive) effort" (p. 711) and consequently psychological variables exert a stronger influence on energy conservation behaviour. So, whilst energy consumption is bounded by strong socio-demographic influences, energy conservation involves a reduction from this consumption base-line and thus it is psychological factors which may play the more significant role in this decision-making process.

3.4.1 Values and Energy Use

Research has found that the psychological variables of values and environmental concern are related to energy conservation behaviour and that "… a greater understanding of values will provide policymakers with more relevant information on which factors drive (and/or inhibit) people to use energy in a more sustainable way" (Mirosa, Lawson, & Gnoth, 2013, p. 470). Developing an understanding of values can help create value-based intervention campaigns which aid the uptake of energy conservation behaviour by appealing to those values which are salient and influential (Corner & Randall, 2011).

In line with the previous research on values and ESB, Abrahamse and Steg (2011) found that values of power and achievement which correspond to Schwartz's value dimension of self-enhancement were linked to a greater household energy use, along with the conservation dimension. This influence of values on behaviour which increased energy consumption was also found by Poortinga et al. (2004) whereby the values corresponding to 'family, health and safety' were associated with a higher household energy use. Guerin et al. (2000) in their review of energy research since

1975, additionally found that a desire for comfort as well as concerns for health were the strongest predictors of household energy behaviour.

Mirosa et al. (2013) in a qualitative study found that different energy behaviours could stem from different value types, with values associated with pleasure and cleanliness giving rise to energy intensive behaviours such as having longer showers or a warmer house. Surprisingly however, Mirosa et al. (2013) additionally found that the self-enhancement dimension could also activate energy conservation behaviours. This was demonstrated through the purchasing of energy efficient products being associated with the value of achievement which is contained within the self-enhancement dimension. This finding was attributed to the purchasing action embracing the feeling of "being capable and intelligent" (Mirosa et al., 2013, p. 470). Thus, it appears that self-enhancement can be activated in different ways to bring about both positive and negative consequences for energy conservation behaviour. This reflects the complexity of the relationship (and conflicts evident) between residential energy use as an ESB and the value priorities held by an individual.

Neuman's (1986) research reinforces the positive influence of values finding that values more often facilitated rather than blocked conservation behaviours and could be an important motivator not just to energy consumption but also to saving energy. In accordance with the findings relating values and ESB, values corresponding to the self-transcendence dimension have been found to be a positive determinant of energy conservation with Yeboah and Kaplowitz (2016) finding respondents from Michigan University were more likely to engage in energy conservation behaviour if they placed importance in self-transcendence values. Ibtissem (2010) found that self-transcendent values were also important predictors of the antecedents to behaviour,

in this case displaying a positive relationship with understanding the consequences of energy conservation and a feeling of obligation to save energy.

3.4.2 Environmental concern and energy use

Empirical evidence suggests that environmental concern plays a role in energy conservation with a positive relationship evident between environmental concern and energy conservation behaviour. Attari, DeKay, Davidson and De Bruin (2010) observed a link between environmental concern and perceptions of home energy savings amongst differing curtailment and efficiency behaviours in their USA study. Respondents with a higher level of environmental concern were more likely to hold accurate perceptions of energy use and energy changes from the different behaviours. Clark et al. (2003) in their study of a Detroit, USA, green electricity program, used a control group to examine whether there were any differences between those who participated in the program and those who did not. A positive relationship was found between the level of environmental concern held by a respondent and the likelihood of their participation in the green electricity scheme. Poortinga, Steg, Vlek, & Wiersma (2003) in a Dutch study revealed that prospective home energy saving measures were viewed as being more acceptable to those individuals who conveyed greater levels of environmental concern. Energy saving measures in this research involved both efficiency behaviours such as purchasing energy efficient appliances as well as curtailment behaviours such as drying washing outside. Findings from the same sample discovered environmental concern to be the strongest predictor of the acceptability of these home energy saving measures, above that of the other variables of values and specific concern for global warming (Poortinga et al., 2004). This shows

an important role for environmental concern within residential energy conservation behaviour.

3.5 Research Questions and Hypotheses

The literature presented in this chapter highlights the significance of behavioural determinants to energy conservation behaviour. Values as fundamental guiding principles and an individual's level of environmental concern are important and influential factors within this. Of the few studies which have linked energy conservation behaviour with values and environmental concern, none have examined their influence in the context of a home energy audit intervention. This presents an opportunity to develop a more complex understanding of energy conservation behaviour and its relationship to the provision of information.

The theories and relationships presented in the existing research leads to two further research questions in relation to the WHESP programme and three additional hypotheses.

Table 3-1: Research questions 2 and 3 and their corresponding hypotheses

Research Questions and Hypotheses
Research question 2: What relationships exist between the psychological variables and energy saving actions undertaken as part of the WHESP programme?
H_2: Self-transcendence values will be positively related to the number of efficiency measures, the number of curtailment behaviours and energy consumption savings following the WHESP programme.
H_3: Environmental concern will be positively related to the number of efficiency measures, the number of curtailment behaviours and energy consumption savings following the WHESP programme.
Research question 3: What role do socio-demographic factors and psychological variables play in energy conservation outcomes?
H_4: Psychological determinants will be a stronger predictor of energy conservation behaviour than socio-demographic variables.

4 METHODOLOGY

4.1 INTRODUCTION

This chapter outlines the quantitative approaches undertaken in this study to explore the relationships between residential energy use and psychological determinants of behaviour in the WHESP programme. First, the rationale for the structure and design of this research will be outlined along with the ethical considerations of the study. Data collection was undertaken in two phases and these phases are described separately:

Phase 1 – Household energy (electricity and gas) data collection through power company records.

Phase 2 – Online survey to examine the relationships between values, environmental concern and energy behaviours.

The participant recruitment process for each phase will be explained along with an outline of the key decisions made during the process. The first phase involves energy consumption data analysis methods, whilst for Phase 2, the survey design will be discussed.

4.2 EPISTEMOLOGICAL POSITION

The evaluation of an energy intervention lends itself to a quantitative approach through the gathering of energy use data. Therefore this research takes a quantitative approach, thus embracing a post-positivist epistemology which seeks to determine cause and effect through the reduction of behaviours and outcomes to an empirically measurable set of variables (Creswell, 2013). This allows for data collection of a large sample to examine relationships between variables and generalisations can be made to the wider population, provided the sample is representative of the population as a

whole (Creswell, 2013). The use of quantitative techniques will also allow comparisons between the New Zealand context and the international literature on energy use interventions.

Post-positivism recognises the imperfect nature of deterministic knowledge (Phillips & Burbules, 2000) and thus the conclusions drawn in this research are embedded in the language of probability rather than absolutes. This means that this research seeks to determine 'likely' relationships whilst acknowledging the complexity of human knowledge, perceptions and experiences of energy use.

4.3 Context and Collaboration

The Wellington Home Energy Saver Programme (WHESP) was initiated by Wellington City Council (WCC) with its delivery contracted to the Sustainability Trust in 2014. This research was designed in collaboration with both organisations and has meant that the study has developed dual objectives of both providing an evaluation of the programme for the benefit of WCC and the Sustainability Trust, as well as fulfilling the needs of this thesis project and gathering data to investigate the hypotheses outlined in Chapters 2 and 3.

4.4 Research Design

This research is a 'retrospective panel design' (De Vaus, 2013). This means that the collection of data happened at one point in time but explores the difference between two points in time by measuring changes retrospectively; in this case before and after the WHESP intervention. This approach was chosen because of the time frame of the thesis and a conventional panel design (whereby participants' opinions and energy use are tracked over time) was not feasible. This also made it impractical to include a

control group. This presents difficulties in concluding causality in the effect of the WHESP programme, as any changes in energy consumption could also have occurred in the wider population. However, the absence of a control group is not uncommon in energy conservation studies and still enables a before and after comparison to be made.

4.5 ETHICAL OBLIGATIONS

Ethics approval was gained through Victoria University Human Ethics committee on the 23rd May 2016 (Appendix A). The principal consideration for this research was the preservation of confidentiality for those participants who were supplying energy consumption data which is considered to be identifiable and sensitive information. Any identifiable data has been securely stored at the Sustainability Trust and the communication of these security measures and the assurance of anonymity in published results was made clear in information given to participants.

4.6 PHASE 1: ENERGY DATA COLLECTION

Gaining energy data from power companies has been historically difficult in New Zealand (Electricity Authority, 2014); however, new legislation came into effect on 1st February 2016 obligating power companies to provide two years of electricity data to customers, or an authorised agent, on customer request (Electricity Authority, 2016). While this legislation removed a significant barrier to data access, accessing this information from multiple energy companies was still challenging with different energy companies presenting different processes in both applying for their consumers' consumption data and becoming an 'authorised agent'. A generic form was created to overcome these varied procedures (Appendix B) which authorised the

Sustainability Trust to become an agent for the customer and receive their electricity and/or gas consumption data. This form was mailed out to the sample of households identified in order to gain their consent.

4.6.1 Participant Recruitment

Participants who had a WHESP audit between March and November 2015 were identified as a suitable group to sample as this would provide approximately 1 year of energy data from both before and after the intervention to enable changes in energy use to be examined. This time frame yielded a possible sample of 361 households who had received a WHESP audit. A number of measures were taken in line with previous research which has outlined methods to maximise the likelihood of response from participants in mail surveys (De Vaus, 2013; Dillman, 2011). First, an introductory email was sent out through the Sustainability Trust to the 361 WHESP customers identified. This email introduced the study, outlined the process of data collection and explained its rationale and usefulness to Wellington City Council and the Sustainability Trust as providers of the programme, as well as presenting my role through Victoria University and the study's academic purpose (Appendix C). This was followed up a week later with a personalised mailed letter which provided more extensive details of the study, addressed issues of confidentiality, anonymity and data storage (Appendix D), as well as enclosing the consent form and a pre-paid return envelope addressed to the Sustainability Trust.

An incentive was also offered by the Sustainability Trust to further encourage participation; on return of a completed consent form, respondents went in to a draw to win an energy efficient radiator worth $660. This type of incentivisation strategy can be effective when engaging participants that have been involved in a project for

a period of time and thus have an already established relationship with the organisation doing the research (Collins, Ellickson, Hays, & Mccaffrey, 2000). The letters were posted to participants with a two week deadline for return of the consent form. A reminder text was also sent by the Sustainability Trust a week before the final return date. In total, 76 of the 361 households completed and returned consent forms to allow access to their energy data for the purposes of this research. This gives a response rate of 21.1%.

4.6.2 Data Collection from Power Companies

The completed consent forms were scanned and emailed by the Sustainability Trust to the relevant power companies who were obligated to return the energy consumption data within 5 business days. However, two power companies noted that written consent was not sufficient for their processes. One company did not appear to have the resources to change from its online request system to a written request system. Another energy company, a leading energy supplier in the region, was unwilling to bypass its online request process despite Electricity Authority clarification that a written request should indeed be adequate to comply with the electricity code. This meant that energy data could not be gathered for 10 households and a further 3 households did not supply correct information. Once the energy data was received some households were then removed from the sample due to incomplete or insufficient data. These came under the following categories:

- An insufficient number of data points were available for some households.

  For the two analysis methods detailed later, a minimum of either four or six months of data before and after the WHESP intervention was necessary.

- One household had made an appointment to have a WHESP assessment but had never actually received the assessment.
- Three households had not lived at their property long enough to make a before and after analysis possible.

Due to the different data restrictions for the two methods of analysis, this resulted in a sample of 48 households with useable energy data for the first method and 50 households for the second analysis method. Each household had data in a standardised energy consumption output format (as specified by the Electricity Authority, 2016) which provided up to 2 years of monthly kWh energy consumption presented in an Excel spreadsheet. Each data point consisted of a start and end calendar date, whether the consumption was an estimate or an actual reading and a kWh energy output for that month.

4.6.3 Data Cleaning

Several decisions were made to ensure the analysis could be accurately undertaken with the gathered data. A synopsis of these decisions is provided in table 4.1 on the following page.

Table 4-1: Data cleaning decisions

Data Issue		Solution
1	'Estimates' instead of actual kWh consumption records.	The estimate was kept when it was not obviously different from surrounding kWh outputs and a similar sized actual reading was present in the subsequent month. When the estimate or the following actual reading look obviously different from the adjacent kWh outputs, (e.g. in one instance an actual output following an estimate was shown to have negative kWh), then an average of the estimate and the subsequent actual reading was taken and was used for both this output and the subsequent one. When the last monthly kWh data point(s) was an estimate, the estimated data points were omitted from the analysis.
2	The start and end date of each month cause a day to be missed in the calculations of each month length.	The date for the end of a month is changed to the match the start date of the following month. This means no days are missed out.
3	Incorrect date entries	If the year of a date entry was obviously a mistake (i.e. all aspects of the date matched the surrounding entries except for the year) then the year was changed to match the surrounding data.

4.6.4 Data Analysis

Residential energy consumption relies on a number of different factors which have been outlined in Chapter 2 and 3. In the context of this research, the assumption was made that the demographic composition of the household remained the same before and after the WHESP intervention. It is further assumed that any changes to the designed environment such as energy efficiency improvements, as well as any changes to the social environment, such as changes in behaviour vary primarily as a result of the WHESP intervention.

The research presented here uses a 'bottom-up' approach to modelling energy consumption with data collected and analysed at the individual household level and then aggregated to examine energy changes in the sample (Swan & Ugursal, 2009). The Princeton Scorekeeping Method (also referred to as PRISM; Fels, 1986) was identified as the most appropriate statistical model to perform analysis of energy savings from the WHESP programme (Swan & Ugursal, 2009) due to its utilisation of monthly energy data. Stemming from the extensive USA energy programmes of the 1980s, PRISM represents one of the first efforts to standardise the measurement of energy savings in order to effectively compare energy efficiency programmes and their impact (Fels, 1986).

PRISM creates a household model of energy consumption through regression analysis based on two variables –

1) Energy use through monthly energy outputs (kWh)
2) The outside air temperature measured using Heating/Cooling Degree Days (HDD/CDD)

PRISM thus incorporates climatic factors by including the frequent fluctuations of temperature which have a direct impact on energy use. For this research, only HDDs will be included in the regression analysis as cooling is not a common occurrence in Wellington while heating is a significant contributor to residential energy consumption (Isaacs & Camilleri, 2010)

The PRISM equation is defined as:

$$E_{it} = a_i + b_i HDD_{it}(\gamma) \quad (1)$$ (Belzer et al., 2007; Fels, 1986; Hwang, 1989)

Where:

E_{it} = total energy consumption for time period t for household i

a_i = non-weather dependent energy use for household i (this indicates a 'baseline' energy consumption)

b_i = weather dependent coefficient of energy use for household i with respect to HDDs

$HDD_{it}(\gamma)$ = the number of HDDs for household i over time period t for reference temperature (γ)

Heating degree days are calculated by finding the proportion of each day which goes below a reference temperature (γ). The reference temperature gives the outside air temperature which corresponds to the implementation of weather dependent energy use such as heating systems (Hirst & Goeltz, 1985). Some studies have used a fixed reference temperature (Allcott & Rogers, 2014) whilst the reference temperature has also been utilised as a variable recognising that each household is likely to initiate weather dependent aspects of energy use (such as turning the heating on) at a different air temperature and this is the approach taken in this study. Hirst and Goeltz (1985) in their use of PRISM originally used a reference temperature interval of 4-24°C, however, this seemed a wide range for Wellington's climate. Therefore, the temperatures 6 - 20°C have been chosen as the bounds of the reference temperature for this research reflecting Wellington's lowest minimum and highest maximum daily average temperature (NIWA, n.d).

Constants a_i and b_i are calculated by finding the linear regression model of each household's monthly kWh outputs with the corresponding HDDs for each of these months. The HDDs are calculated for reference temperatures between 6 and 20°C and then the most suitable reference temperature is selected by finding the model which

yields the largest explanatory power (i.e. has the largest R^2 – discounting any unrealistic models which have, for instance, a negative baseline energy usage a_i).

Weather data from the weather station at Wellington airport was utilised through the website www.degreedays.net (BizEE Degree Days, 2016) to calculate the relevant HDDs for this study. While different parts of Wellington have varying climatic conditions and temperatures (Chappell, 2014), the airport weather station provides the most accurate and reliable weather data and in conjunction with the use of a variable reference temperature, will still allow for a sound model to be estimated for each household.

4.6.4.1 Calculating Energy Changes

Once the regression model of energy use is constructed, the Normalised Annual Consumption (NAC) can be calculated for each household using the information from equation (1) in the following formula:

$$NAC = 365a_i + b_i HDD_0(\gamma) \qquad (2) \qquad \text{(Fels, 1986)}$$

Where:

$HDD_o(\gamma)$ = the long-run annual heating degree day average for the reference temperature γ. Here a 5 year HDD average has been used.

By using a long-run HDD average, the NAC gives a "reliable and stable *index* of consumption" (Fels, 1986, p. 11); thus the NAC reduces the overall error of the model which can be evident in the original calculations of a_i and b_i. The NAC from before the intervention can be compared with the NAC of a household calculated after an intervention to find the Normalised Energy Change (NEC) –

$$NEC = NAC_{pre} - NAC_{post} \qquad (3) \qquad \text{(Fels, 1986)}$$

While a 12 month period is recommended to create the NAC (Fels, 1986), the different assessment times of the participating households in this study meant that time periods from before and after the assessment varied between 3 and 18 months. Six months before and after the WHESP assessment was decided as the minimum number of data points necessary to complete the regression and thus calculate the NAC.

4.6.4.2 Data Analysis Decisions

A total of 29 households had solely electricity consumption data and 19 households had both electricity and gas data. Ideally, the NAC would be calculated for the total monthly energy consumption using all relevant sources of energy to the household but this was unachievable in some cases for a number of reasons. Firstly, the ability to match monthly records of electricity and gas data for a household was often impossible due to differing start and end dates for each month for the two power supplies. Secondly, complete energy data records were not always obtained; one power company was only able to supply electricity data despite some of their customers also receiving gas from the company (gas data was not compulsory to provide). This meant that gas and electricity records were separately analysed using the NAC calculations and then the total energy consumption for the household was calculated by adding the NAC results for all energy sources available for a household.

Only households where NAC calculations gave a confident model were used in analysis. A confident model was one which had an $R^2 > 0.75$ in line with research conducted by Hirst and Goeltz (1985). Only 26 households met this criterion and were used in the analysis. There are multiple reasons why household energy use could fluctuate beyond the influence of temperature; however, the most likely reason for

the model providing a poor explanation of a household's energy consumption behaviour is if the fuel type being analysed is predominantly used for reasons other than heating. PRISM provides the most confident explanations of energy use for the fuel type which changes in response to the weather (Hwang, 1989). Thus, if a household uses an electric heat pump as their primary source of heating, PRISM is likely to provide a good model for their electricity consumption but is unlikely to offer a valid model for their gas consumption which is not related to weather dependent aspects of energy use.

4.6.4.3 Alternative Analysis Methods

A second method of analysis was conducted to allow for a greater sample size to be analysed. This did not involve correcting for the outside air temperature but instead calculated a simple before and after average energy consumption for each household based on their monthly billing as in Alberini and Towe (2015). Seasonality was still considered in this method, with only corresponding months before and after the intervention being compared to make sure that winter and summer months did not distort the analysis (i.e. a June to December energy consumption average for a household was compared with the June to December average following the intervention - similar to (Chapman, Howden-Chapman, Viggers, O'Dea, & Kennedy, 2009). A minimum of four months of matching before and after data was required. Before and after energy consumption was compared using a 'per day' consumption (PDC) average to account for the differing lengths of some billing periods. This method enabled 50 households to be included in analysis.

4.7 PHASE 2: ONLINE SURVEY

An online survey was conducted to understand the behaviours undertaken in response to the WHESP programme as well as explore the relationship between values, levels of environmental concern and self-reported behaviour. Conducting an online survey has the benefit of being easy to administer, allows for quick returns and also gathers the data electronically which further facilitates analysis (Creswell, 2013; Sue & Ritter, 2012). The disadvantage of an online approach is that only those in the population with access to the internet can participate; however, this survey was aimed at households already participating in the programme and more than 99% of WHESP customers had a contact email address and so exclusion of participants was minimal.

4.7.1 Participant Recruitment

The target population were households who had received an assessment between January 2014 and July 2015 which gave a population of approximately 1,300 households. Before this time period it was thought that potential respondents' memory of the WHESP assessment was likely to be more limited and potential respondents could have already been sampled in the previous evaluation (WCC, 2014). The survey link was emailed to customers through the Sustainability Trust in July 2016. It quickly became apparent that the email had been sent to many customers who had not received a WHESP audit, giving a much larger total sample space than expected of 3,196 households. Of these households, 52% (1,584 customers) had opened the email within two days of the link being sent and 26% of these (408 customers) had clicked on the survey link. The survey was open for completion between 27th July and 17th September. A reminder email was sent in

August to those households who had contributed a consent form for the energy consumption data collection but who had not yet completed the online survey.

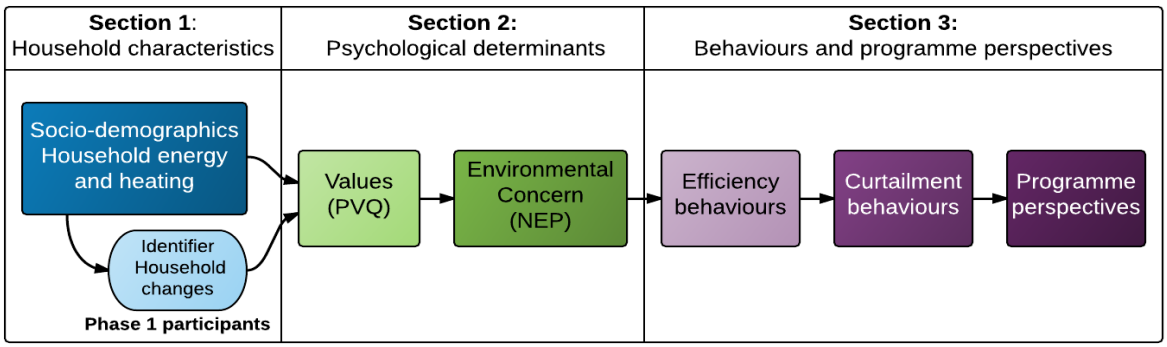
A total of 417 respondents started the survey online. Only those respondents who finished the survey were included in the analysis. Further, respondents who completed the survey but indicated in any of their survey comments that they had not received a WHESP assessment were also excluded. This gave a total sample size of 292 households.

4.7.2 Survey Design and Development

The survey was divided into three sections as outlined in Figure 4-1 (see Appendix D for a full version of the survey; some of the questions were used for Wellington City Council purposes and are beyond the scope of this thesis. Only relevant questions have been detailed in this study). The first section determined if the household had taken part in Phase 1 of the energy consumption data collection. It also gathered information on a household's socio-demographic variables and physical aspects of the building structure and heating. The second section assessed the respondent's values and their level of concern for the environment. Section three examined the uptake of efficiency behaviours and curtailment behaviours following the WHESP audit as well as opinions of programme delivery and usefulness.

A pilot survey was conducted with a sample of 30 people of differing ages, income and education levels. Feedback from this process enabled minor changes which allowed the survey to be more easily read and understood.

Figure 4-1: Survey structure



4.7.3 Section 1: Socio-demographics, energy and heating sources.

The first section of the survey included questions about the socio-demographic characteristics of the household occupants and examined the household's energy and heating sources. The questions included the number of people living in the household and the household's total income as both these variables had been identified in the literature as key contributors to residential energy consumption (Guerin et al., 2000). The formulation of these questions was based on the 2013 New Zealand census to allow a comparison with national and local statistics (Statistics NZ, 2013a).

The sample had 60.0% female and 39.0% male respondents indicating that female respondents are overrepresented. The mean number of occupants in a household was 2.7 which is the same as the national average and similar to the Wellington City average of 2.6 (Statistics NZ, 2013b); however, one person households are under-represented compared to national and Wellington statistics (Figure 4-2) and three person households are slightly over represented in this sample (Statistics NZ, 2013b) showing that the programme is more attractive to families and multi-person households. The income distribution (Figure 4-3) shows the sample to have a slightly higher proportion of households earning over $100,000 compared to Wellington City

income statistics (Statistics NZ, 2013b). The income bracket $50 - $100,000 is under-represented and lower income households ($0 - $50,000) appear to be largely representative of Wellington City income statistics.

Figure 4-2: Number in the household compared to Wellington city statistics

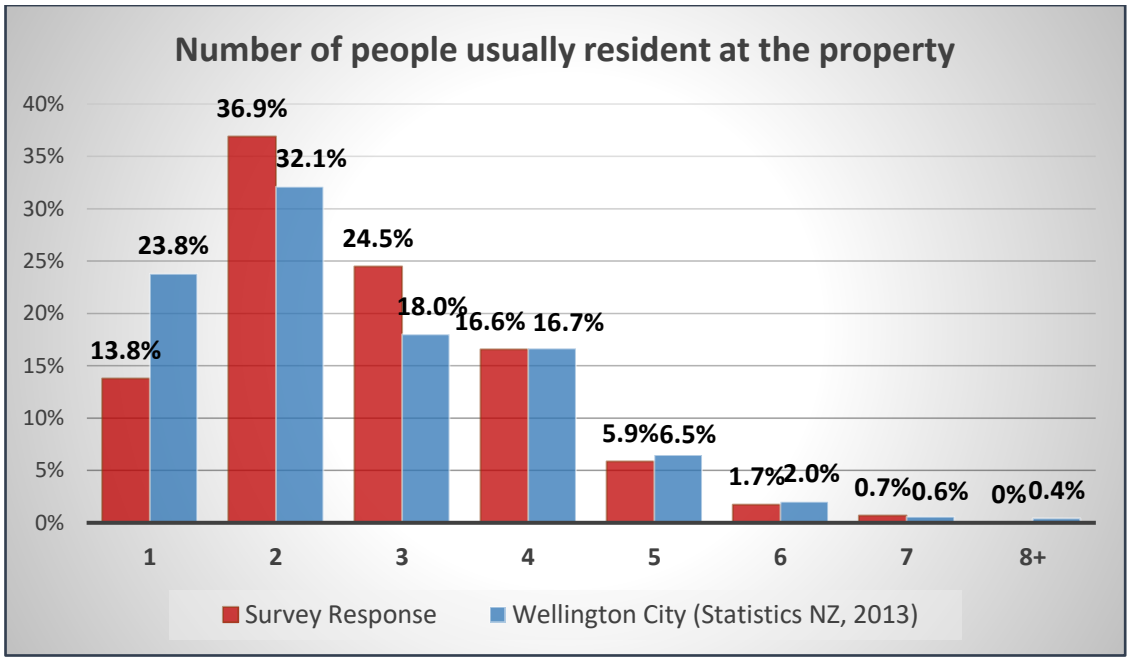
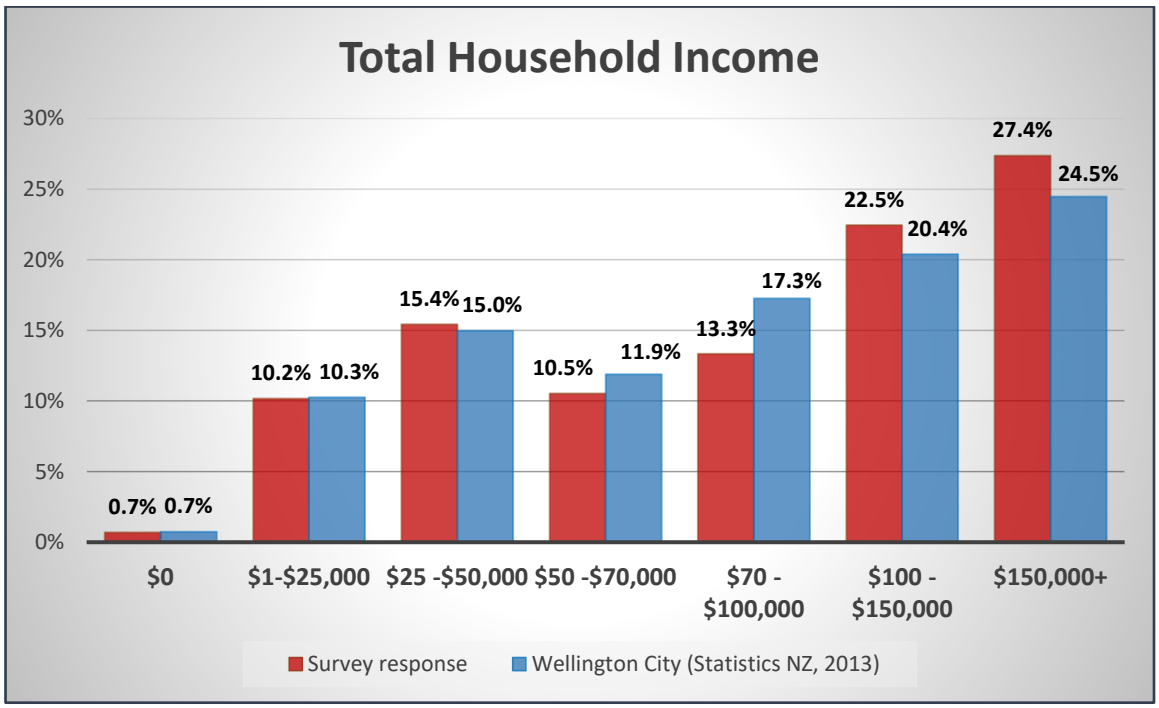


Figure 4-3: Total household income compared to Wellington City statistics



Further questions in this section included the tenure of the household as well as its energy and heating sources and these are discussed further in the results section.

4.7.4 Section 2: Values

To measure respondents' values, Schwartz's Portrait Value Questionnaire (PVQ) was used (Schwartz, 2003) as this is recommended for use in online surveys (Schwartz, 2012). The PVQ has been widely applied and validated across multiple nationalities and populations (Schwartz, 2003) and presents a comprehensive way of measuring the 10 value types and four value dimensions outlined in Chapter 3.

The PVQ has 21 items, framing each item as a 'portrait' of a third person and asking the respondent how much like them this person is. This allows for the indirect measurement of people's values through inference (Schwartz et al., 2001). The questions are gender specific in their use of 'he'/'she'/'they' and therefore respondents were directed to the male, female or other version of the online survey. The PVQ presents the items as different statements relating to different value types; e.g. "Being very successful is important to her. She likes to impress other people" is one item which represents the value of 'achievement'. Responses are given on a 6 point Likert scale with 1 ="Not like me at all", 2 = "Not like me", 3 = A little like me", 4 = "Somewhat like me", 5 = "Like me" and 6 = "Very much like me".

For this research, three questions were added to the 21 item PVQ based on items from a longer version of the questionnaire (Schwartz, 2003). This was to allow for inclusion of a greater number of items in the self-enhancement and self-transcendence value dimensions as these dimensions were of particular interest to

this project. Table 4-2 below outlines the value dimensions and associated question in the survey (see Appendix E for the survey questions).

Table 4-2: Value types of survey questions

Value Types		Question number				Value dimension	No. of Items
1	Benevolence	12	18			**Self-Transcendence**	6
2	Universalism	3	8	19	24		
3	Self-direction	1	11			**Openness to Change**	6
4	Stimulation	6	15				
5	Hedonism	10	21				
6	Achievement	4	13	22		**Self-Enhancement**	5
7	Power	2	17				
8	Security	5	14	23		**Conservation**	7
9	Conformity	7	16				
10	Tradition	9	20				
						Total	24

The internal reliabilities of each of these value types and dimensions are outlined in table 4-3. The Cronbach's alpha values for the four higher order dimensions are considered acceptable and are not dissimilar to previous literature on value types and their dimensions (Schwartz, 2003, 2007).

Table 4-3: Reliability of the four value dimensions

		N	Mean score (/6)	SD	Cronbach's alpha (α)
Value Dimension	Self-transcendence	275	4.65	.70	0.717
	Openness to change	271	3.78	.71	0.632
	Self-enhancement	269	2.99	.89	0.781
	Conservation	266	3.56	.76	0.682

For analysis, it is suggested that the value scores for each respondent are 'centred' to account for differing individual use of the response scale (Schwartz, 2009). This is done

by calculating the mean response from the 24 items for each respondent and then subtracting this score from the mean of each value type. These centred scores were used for analysis. To further account for response bias, respondents who gave the same response (e.g. “like me”) 15 or more times out of the 24 items have been removed from analysis (Schwartz, 2009).

4.7.5 Section 2: Environmental Concern

To measure participants’ concern for the environment, Dunlap’s “New Ecological Paradigm” (NEP) questionnaire was utilised (Dunlap, Van Liere, Mertig & Jones, 2000). The NEP is a widely employed and validated indicator of the level of environmental concern or ‘ecological worldview’ that a person holds (Dunlap, 2008). The NEP is comprised of 15 items which captures how a respondent views humans’ interaction with and governance of nature; e.g. “We are approaching the limit of the number of people the earth can support”. Respondents are asked to rate their level of agreement with each statement using a 5 point Likert scale: 1 = “Strongly disagree”, 2 = “Mildly disagree”, 3 = “Unsure”, 4 = “Mildly agree”, 5 = “Strongly agree”.

All items were recoded to make a higher score reflect a higher level of environmental concern. The mean NEP score for the sample was 3.81 ± 0.57 (n=276; all averages are accompanied by ± standard deviation). This mean is comparable with other New Zealand studies as outlined in the meta-analysis of the NEP conducted by Hawcroft and Milfont (2010). The internal reliability of the NEP as a scale is represented by α = 0.81 which is consistent with the original validation of the NEP in its revised form by Dunlap et al. (2000) and is relatively high in relation to other studies (Hawcroft & Milfont, 2010).

4.7.6 Section 3: Actions, behaviours and programme perspectives

Survey respondents were presented with a list of 22 energy efficiency improvements that had been recommended through the WHESP programme and were asked to indicate which recommendations they had implemented. These options represent efficiency behaviours which range from large and costly renovations such as installing insulation to smaller efficiency improvements such as wrapping hot water pipes. Households had implemented an average of 3.51 ± 2.41 recommendations after the WHESP audit (n = 276).

To capture any changes in curtailment behaviours, which represent changes in household habits and repeated actions which do not require a financial investment, a question was asked regarding six curtailment behaviours. The six curtailment behaviours were based on recommendations commonly made by the WHESP programme and previous energy research (Gardner & Stern, 2008; Karlin et al., 2014; Poortinga et al., 2003). The behaviours included "Turn off lights when leaving the room", and "Dry washing outdoors whenever possible". Respondents were asked to indicate whether they performed the behaviour 1 = "A lot less often", 2 = "Less Often", 3 = "About the same as before", 4 = "More often", or 5 = "A lot more often" since the WHESP assessment. Reliability analysis of these 6 items gave a Cronbach's alpha α = .77 showing acceptable internal consistency. The mean of each individual's scores for these six items was calculated to give each respondent an average curtailment behaviour score. The average curtailment behaviour score for the sample was 3.3 ± 0.43 (n = 276).

4.7.7 Survey Analysis

Data cleaning and descriptive statistics were undertaken in Microsoft Excel. Inspection of the survey resulted in some recoded responses; e.g. when an answer was indicated as 'other' but the qualitative response indicated that it did indeed fall in to one of the categories provided by a question. IBM's software package SPSS was used for statistical analysis with categorical data being converted to numerical data. Associations between variables were computed through correlation analysis using the Pearson product-moment correlation coefficient and the Spearman's rank correlation where non-normality was evident. A model of the predictive power of factors contributing to energy behaviours was estimated using linear regression analysis.

4.8 SUMMARY

The methodology of this study outlines two distinct phases of research. Firstly, energy data collection, aggregation and approach to analysis was established in order that a before and after energy consumption comparison could be made. Secondly, survey design and administration was ascertained to measure efficiency and curtailment behaviours, socio-demographic variables and the psychological determinants of values and environmental concern from WHESP participants. With the methods established, data inspected and cleaned, reliabilities of scale examined and deemed acceptable, analysis was then conducted to begin answering the research questions and hypotheses.

5 RESULTS

5.1 INTRODUCTION

The results are structured in order of the research questions and hypotheses outlined in Chapters 2 and 3. Results of Phase 1, the analysis of energy data, are presented first and will examine differences in energy use before and after the WHESP assessment. Results of Phase 2 will then be presented which include the associations between values, environmental concern, and socio-demographics with the number of efficiency and curtailment behaviours undertaken. Finally, the predictive nature of these variables on both efficiency and curtailment behaviours will be examined via regression analysis.

5.2 ENERGY PROFILE OF THE RESPONDENTS

Of the 291 respondents to the survey, 91.1% both owned the property and lived there or the property was in a family trust and they lived there. Less than 5% of those surveyed were tenants. This is not representative of home ownership in Wellington which is a much smaller proportion of dwelling tenure in the city at 59.1% (Statistics NZ, 2013b); however, the high rate of home ownership and occupancy amongst WHESP customers would be expected due to their ability to make the types of retrofit changes that are promoted by the programme and also receive the benefits of any changes made.

Figure 5-1: What sources of power does the property have? Tick all that apply.

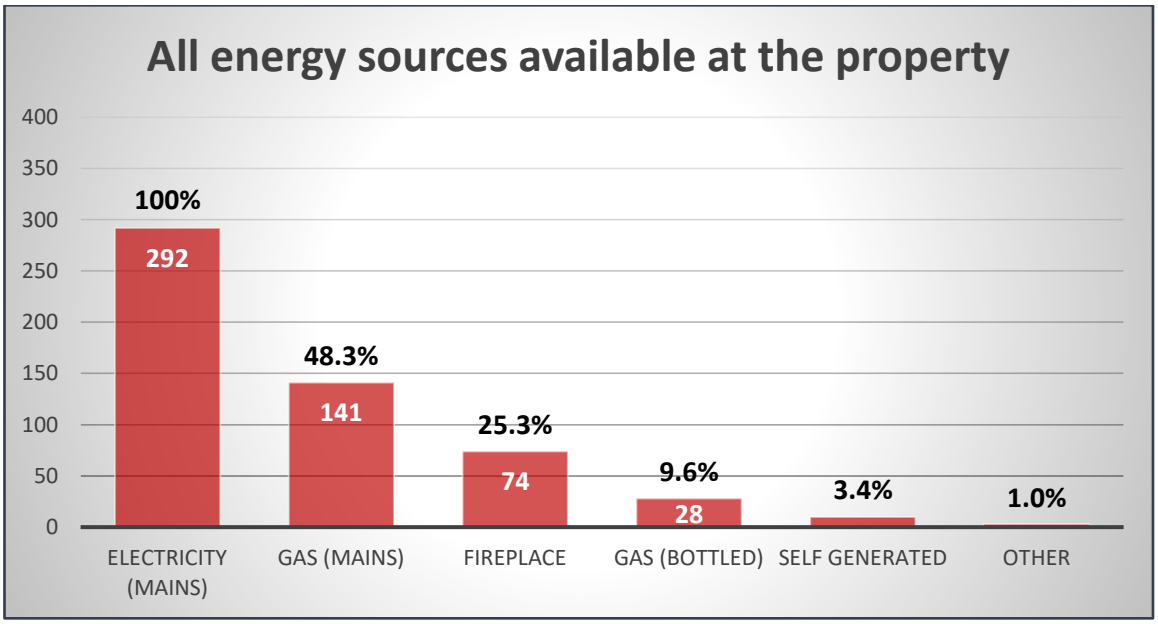
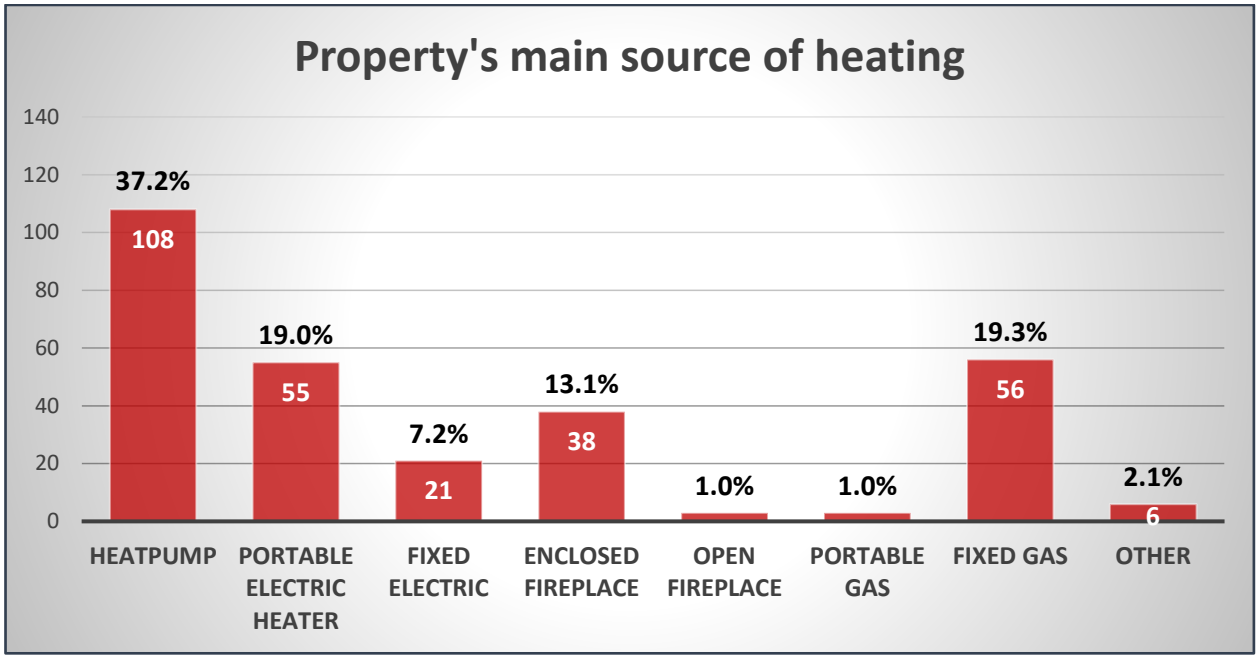


Figure 5-1 shows that all respondents were connected to mains electricity with almost half of the properties also connected to mains gas (48.3%). Gas (either mains or bottled) was primarily used for hot water (78.4% of gas users) and cooking (65.3% of gas users), though 20.3% of respondents cited that gas was used as their main fuel for heating (see Figure 5-2). This is high compared to a New Zealand wide study which found only 11% use of gas as a main heating source (Wooliscroft, 2015). However, the findings in this study reflect that of the New Zealand Household Energy End-Use Project which found that most gas using properties are in urban areas and that Wellington households have the highest gas use of all cities (Isaacs & Camilleri, 2010). Only one quarter of the properties surveyed (25.3%) had access to a fireplace (open or enclosed) for solid fuel heating. This is in contrast to the wider Wellington region where 30.8% households have access to solid fuel heating, though this figure is lower for Wellington City at 18.5% (Statistics NZ, 2013b). However, only 14.1% of respondents used solid fuel as their main source of heating which is lower than trends evident across the country (Wooliscroft, 2015). The most common primary heating

source was a heat pump with 37.2% of respondents indicating this was the main way of heating their home.

Figure 5-2: What is your current main source of heating?



5.3 Energy Data Households: Consumption Changes

Research question 1: Did the Wellington Home Energy Saver Programme (WHESP) through its home audit intervention produce significant changes in energy use for the participating households?

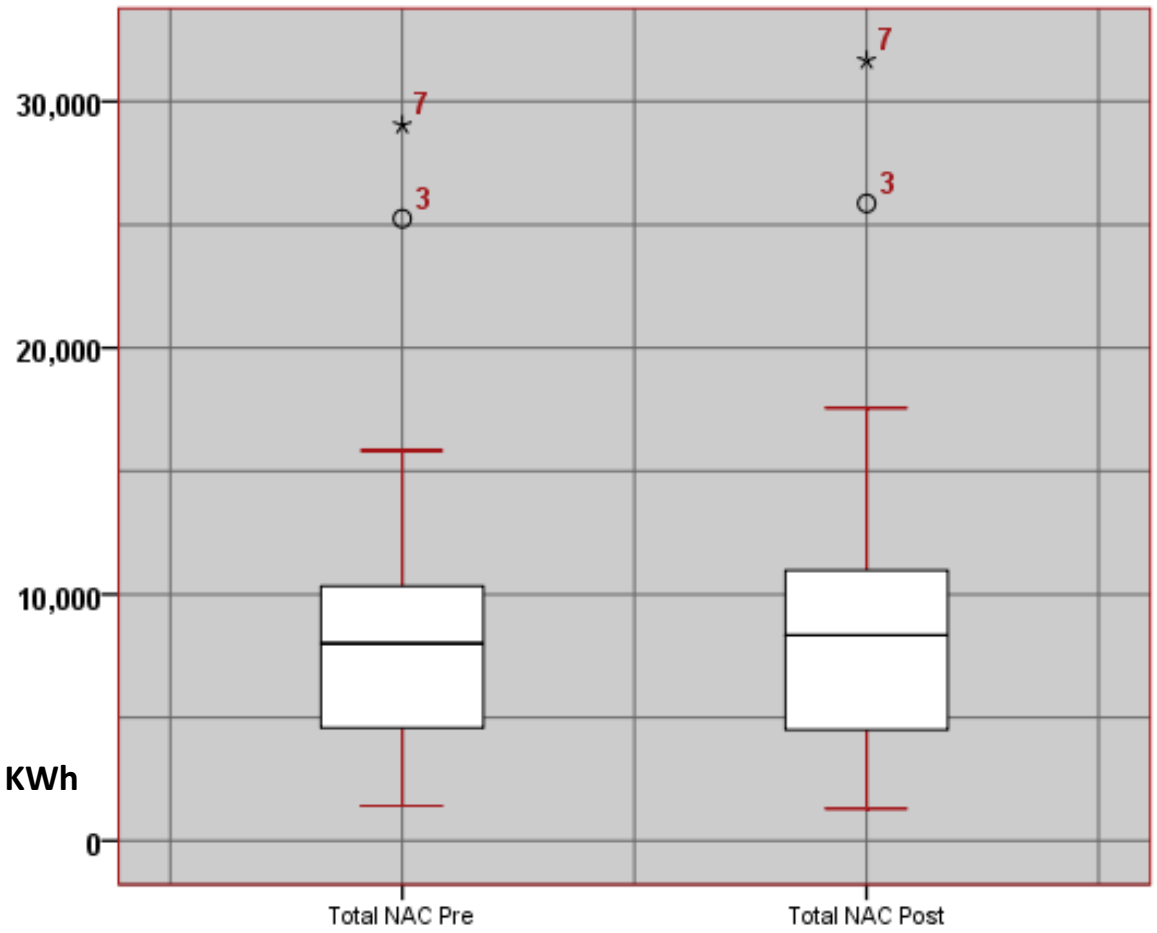
H_1: Households participating in the WHESP will consume less energy following the home energy audit than before the intervention took place.

5.3.1 Using the PRISM method of analysis

As outlined in section 4.6.4, the PRISM method incorporates outside air temperatures to estimate a Normalised Annual Consumption (NAC) for each household both before and after the intervention. Only households which met the criteria for sufficiency (i.e. with a model R^2 >0.75) were included in analysis. This reduced the sample size to 26 households. On closer examination, one additional household's Normalised Energy

Change (NEC) presented a value greater than three standard deviations from the mean and thus was considered an outlier (Field, 2013) and was removed from the sample to avoid undue influence. This gave a final sample size of 25 households analysed below.

Figure 5-3: Box and whisker graph and statistics for Normalised Annual Consumption pre- and post- WHESP



NAC Pre		NAC Post
25	N	25
8899.67	Mean	9460.24
6487.30	Std. Deviation	6997.16
1297.46	Std. Error Mean	1399.43
29043.17	Max	31665.55
8009.24	Median	8346.53
1417.20	Min	1304.27

As expected, both pre- and post- NAC correlate strongly with each other having a significant Pearson's Product Moment Correlation Coefficient of 0.992 ($p<0.001$); i.e. higher energy consumption before the intervention is associated with higher energy consumption after the intervention. The box and whisker graphs above (Figure 5-3) however, show the large variability in energy consumption amongst the households both before and after the WHESP audit with a large range (NAC_{pre} Range = 27,625.97 kWh, NAC_{post} Range = 30,361.28 kWh) and standard deviation (NAC_{pre} SD = 6487.30 kWh, NAC_{post} SD = 6997.16 kWh) at both time points. This large variability makes it difficult to detect differences between the two time points.

The mean and median consumption figures at both time points show that the average consumption for households in this survey is between 8,000kWh and 9,500kWh per year. This is lower than the 10,860kWh average estimated for the Wellington region by the Household Energy End-use Project (Isaacs & Camilleri, 2010) but could be explained by the incomplete gathering of gas data for some of the households. The small minimum value for both time points of NAC_{pre} Min = 1,417.20 kWh and NAC_{post} Min = 1,304.27 kWh is further evidence of the incompleteness of the data; it is highly unlikely that a household uses less than 1,500 kWh of energy per year. However, evidence of a difference can still be detected even if the energy source is not the sole contributor to household power.

The data was tested for the assumption of normality before conducting a t-test using the Kolmogorov-Smirnov test. The NAC_{pre} and NAC_{post} exhibited non-normality with both showing statistical significance ($p<0.05$). However, in order to perform a paired t-test only the difference, NEC needs to be normally distributed and here the

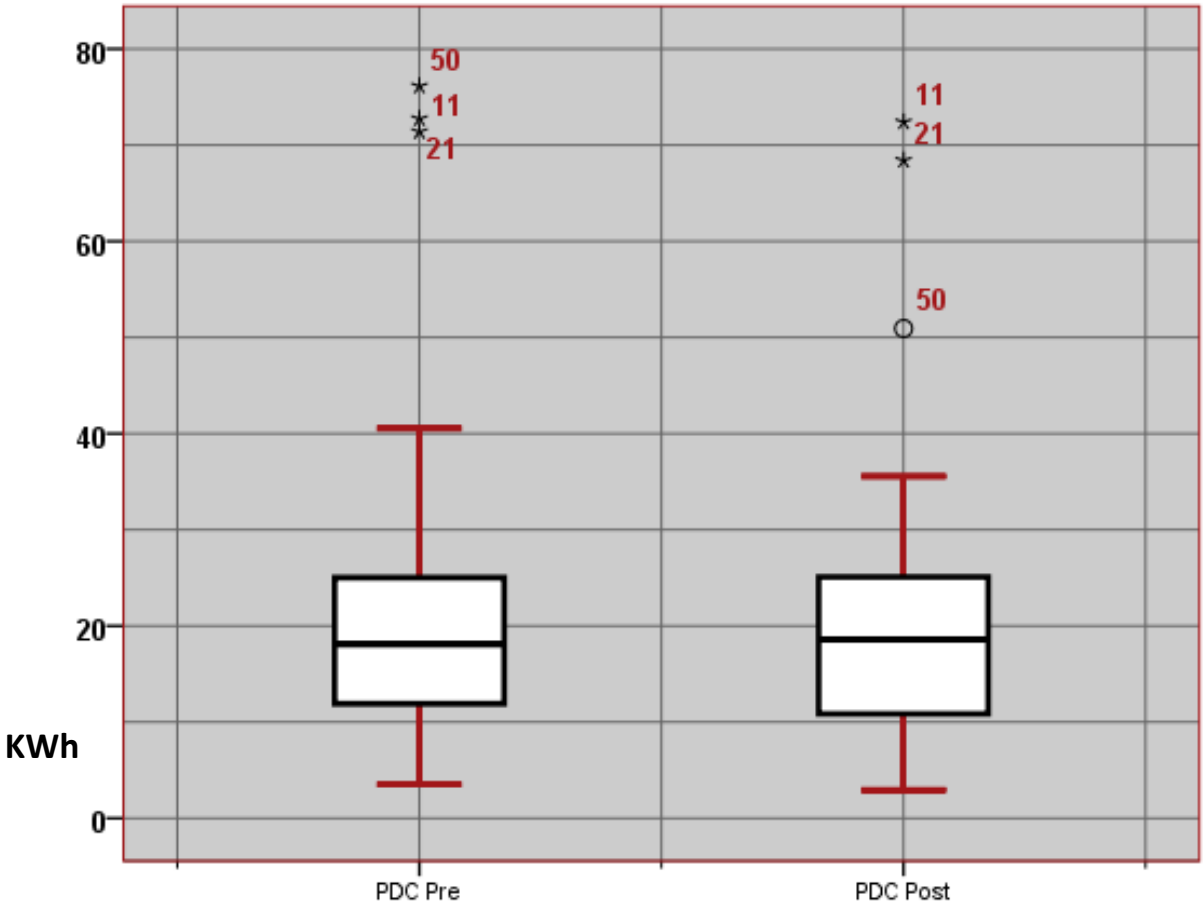
Kolmogorov-Smirnov did not show evidence of deviating significantly from a normal distribution (D(25) = 0.157, p=0.112) and thus a t-test could be used with confidence.

A paired-samples t-test was used to examine whether there was a significant change in energy consumption after the WHESP audit. On average, NAC_{post} was greater (Mean = 9460.24 kWh, SE = 1399.43kWh) than NAC_{pre} (Mean = 8,899.67 kWh, SE = 1297.46 kWh). The mean difference was 560.57 kWh (95% CI [155.98, 965.15]) and was found to be significant, t(24) = 2.86, p = 0.009 but represents a very small effect size, d = 0.086 due to the large variance in the NAC results. This result indicates that for this sample of households, the average energy consumption increased after the WHESP audit took place.

5.3.2 Using a per day average

The second method of energy consumption analysis calculates a Per Day Consumption (PDC) for the corresponding months before and after the intervention (PDC_{pre} and PDC_{post}), as outlined in section 4.6.4.3. A Per Day Energy Change (PDEC) is then calculated by finding the difference between the PDC_{post} and PDC_{pre}. This was able to be completed for 50 households in the sample. However, one household's PDEC presented a value greater than three standard deviations from the mean and thus was considered an outlier (Field, 2013) and was removed from the sample to avoid undue influence. This gave a sample size of 49.

Figure 5-4: Box and whisker graph and statistics for Per Day Consumption pre- and post- WHESP



PDC Pre		PDC Post
49	N	49
21.62	Mean	21.17
15.59	Std. Deviation	14.00
0.34	Std. Error Mean	0.34
76.13	Max	72.40
18.06	Median	18.59
3.50	Min	2.94

As above, both pre- and post- PDC correlate strongly with each other having a significant Pearson's Product Moment Correlation Coefficient of 0.983 ($p<0.001$). The PDC results from before and after the WHESP intervention are displayed in the box

and whisker graph, Figure 5-4. These graphs show a similar pattern to the NAC results, displaying a large variability in energy consumption both before and after the WHESP audit with a large daily range (PDC_{pre} Range = 72.63 kWh, PDC_{post} Range = 69.46 kWh) and standard deviation (NAC_{pre} SD = 15.59 kWh, NAC_{post} SD = 14.00 kWh) at both time points.

The data was tested for normality before analysis using the Kolmogorov-Smirnov test. The PDC_{pre}, PDC_{post} and PDEC all showed to be non-normal in nature with all three being statistically significant ($p<0.005$). This meant that the non-parametric Wilcoxon Signed Rank Test was also completed for this data.

A paired-samples t-test was first used to examine whether there was a significant change in energy consumption after the WHESP audit (Fig. 6-6). Results suggest that there were no statistically significant differences between PDC_{post} (Mean = 20.55 kWh, SE = 1.94 kWh) and PDC_{pre} (Mean = 20.48 kWh, SE = 1.96 kWh); the mean difference was 0.07kWh (95% CI [-0.66, 0.80], t (47) = 0.188, p = 0.852). This shows that for this sample of households, there were no significant changes in average energy consumption between before and after the WHESP intervention. This finding was confirmed by the non-parametric Wilcoxon Signed Rank Test which also showed the difference between the two time points to be non-significant (t = 570, p = 0.854, r = -0.02).

Both methods of analysis outlined above make it difficult to form a conclusion of the first hypothesis 1 which expected a reduction in energy consumption. The PRISM analysis showed a significant increase in energy consumption which rejects the first hypothesis H_1. However, the small sample size (n = 25), large variability and very small

effect size of this analysis means that it is problematic to assume that this finding is representative of all participants of the programme. The larger sample size (n = 49) of the second method makes drawing conclusions on the effectiveness of the WHESP programme more reasonable with results showing no evidence to suggest a change in consumption after the WHESP audit. However, the lack of accountability for climatic controls in the second method means that differences in weather between before and after the audit could have influenced the data. Thus, the two methods do not bring an overall conclusion for hypothesis 1 and it is neither accepted or rejected, with further research needed to verify these findings.

5.4 Values, Environmental Concern and Changes due to the Programme

5.4.1 Correlations between dependent and independent variables

Research question 2: What relationships exist between the psychological variables and energy saving actions undertaken as part of the WHESP programme?

H_2: Self-transcendence values will be positively related to the number of efficiency measures, the number of curtailment behaviours and energy consumption savings following the WHESP programme.

H_3: Environmental concern will be positively related to the number of efficiency measures, the number of curtailment behaviours and energy consumption savings following the WHESP programme.

The relationship between values, environmental concern and efficiency and curtailment behaviours undertaken as part of the programme was assessed using a Pearson product moment correlation coefficient. The correlations and their significance are displayed in Table 5-1. The four values (self-transcendence, openness to change, self-enhancement and conservation) were found to be normally distributed using the Kolmogorov-Smirnov test (all showing non-significance, $p > .05$).

Using the same test, the three other variables however, were all found to be significantly different from a normal distribution and so their relationships were also analysed using a non-parametric test: Spearman's rank correlation. This correlation analysis displayed similar results to the Pearson product moment coefficient across all coefficients and so the Pearson correlation results are reported below.

A reminder of how each variable was measured can be seen in table 5-1 –

Table 5-1: Variable measurement

Variable	Measurement
Efficiency behaviours	The number of recommendations implemented following the programme
Curtailment behaviours	An average score based on the frequency of six behaviours performed since the WHESP audit (1 = a lot less often to 5 = a lot more often)
Environmental Concern	Average NEP score based on a scale from 1 (strongly disagree with pro-environmental statement) to 5 (strongly agree with pro-environmental statement)
Values	Scale from 1 (not like me at all) to 6 (very much like me). These scores were centred as outlined in section 4.7.4.

Table 5-2 shows that the four value dimensions display correlations in accordance with Schwartz's theory presented in Chapter 3; i.e. those value dimensions opposite each other on Schwartz's scale tend to be negatively correlated. Those participants who more strongly endorsed self-transcendence values tended to have lower self-enhancement values ($r = -.54$, $p < .01$) and those with stronger openness to change values tended to have lower conservation values ($r = -.65$, $p < .01$).

Table 5-2: Pearson correlation statistics of psychological variables and behaviours

	M	SD	N	1	2	3	4	5	6
1 Efficiency behaviours	3.51	2.41	276						
2 Curtailment behaviours	3.30	0.43	276	.115					
3 Environmental Concern	3.81	0.57	276	.133*	.083				
4 Self-transcendence	0.90	0.52	278	.171**	.022	.398**			
5 Openness to Change	0.02	0.55	277	.023	-.133*	.048	-.108		
6 Self-enhancement	-0.76	0.66	278	-.088	.016	-.177**	-.535**	-.071	
7 Conservation	-0.19	0.58	278	-.029	.103	-.227**	-.168**	-.653**	-.330**

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Efficiency behaviours were significantly positively associated with self-transcendence values ($r = .171$, $p < .01$). This suggests that participants who more strongly endorse self-transcendence values were more likely to undertake a higher number of efficiency behaviours. This reflects previous literature on values and environmentally significant behaviour and supports hypothesis H_2. However, none of the other values displayed a statistically significant correlation with the number of recommendations undertaken.

Curtailment behaviours showed a significant but small negative correlation with openness to change values ($r = -.133$, $p < .05$). This means the higher the endorsement for openness to change values, the lower the likely frequency of curtailment behaviours. This seems counterintuitive given that this value dimension embodies the embracement of change within a person's life and is contradictory to the values literature outlined earlier. There was no significant relationship with any of the other value dimensions. The relationship between self-transcendence values and uptake of

efficiency behaviours lends partial support to the second hypothesis. In contrast to this hypothesis, values were not related to the uptake of curtailment behaviours.

As expected, environmental concern showed a significant and relatively strong correlation with self-transcendence values ($r = .40$, $p < .01$). This shows that those who held more altruistic values were more likely to show higher levels of concern for the environment. The opposite trend was also apparent with a significant negative correlation between environmental concern and self-enhancement values ($r = -.18$, $p < .01$). There was also a relationship between environmental concern and the conservation value dimension ($r = -.23$, $p < .01$) which suggests that participants who more strongly showed a preference for tradition and status quo tended to have lower levels of environmental concern.

Environmental concern shows a significant and weak positive correlation with the number of efficiency behaviours undertaken ($r = .13$, $p < .05$). This shows that a greater level of concern for the environment is associated with a greater number of efficiency behaviours being implemented as part of the WHESP programme and supports hypothesis H_3. However, there was no statistically significant relationship between environmental concern and curtailment behaviours ($r = .08$, $p > .05$).

Thus, H_3 can be partially confirmed: there was a positive relationship between levels of environmental concern and efficiency behaviours in the WHESP programme but there was no relationship between environmental concern and curtailment behaviours.

5.4.2 Energy consumption changes

The relationship between actual energy consumption changes and the differing values and levels of concern for the environment were analysed using the results from the second energy analysis methodology outlined above which had the larger sample size available. The 'Per Day Consumption' changes were then calculated as a Percentage Energy Saving (%ES). These energy savings were coupled with the survey answers for those households who had provided both their energy data and responded to the survey. This gave a sample of only 21 households meaning that the results are indicative only.

A Kolmogrov-Smirnov test was performed on the variables to check for normality. The NEP, four value dimensions, number of recommendations and the %ES were all non-significant ($p > .05$) and therefore suitably normally distributed to perform a Pearson product moment correlation analysis.

Reflecting the findings above, table 5-3 shows that self-enhancement and self-transcendence values were significantly strongly negatively correlated ($r = .614$, $p < .01$) as too were the openness to change and conservation values ($r = .518$, $p < .05$). Levels of environmental concern were also strongly positively correlated with self-transendence values as expected ($r = .694$, $p < .01$), but environmental concern was not significantly correlated with any of the other values.

Table 5-3: Pearson correlation statistics of psychological variables and percentage energy savings

	M	SD	N	1	2	3	4	5
1 % Energy Savings	1.79	15.39	20					
2 Environmental Concern	3.94	0.80	21	.322				
3 Self-transcendence	0.92	0.77	21	.125	.694**			
4 Openness to Change	0.15	0.64	20	.154	-.124	.263		
5 Self-enhancement	-0.85	0.83	21	.121	-.206	-.614**	-0.4	
6 Conservation	-0.15	0.64	21	-.508*	-.328	-.231	-.518*	-.201

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Percentage energy savings from the programme were not significantly correlated with self-transcendence, openness to change and self-enhancement values. However, there was a relatively strong and significant negative relationship with the value dimension of conservation ($r = -.508$, $p < .05$). This means that the greater the conservation values evident in the participant, the less energy savings were made. Previous research does suggest that a negative relationship with conservation and behaviour is also evident. However, the lack of influence of self-transcendence values on percentage energy savings means that hypothesis H_2 cannot be confirmed.

Environmental concern was not signficantly related to percentage energy savings, thus H_3 can also not be confirmed; there is not enough evidence to suggest that a greater level of environmental concern results in greater energy savings.

5.5 PSYCHOLOGICAL DETERMINANTS AND SOCIO-DEMOGRAPHICS

Research question 3: What role do socio-demographic factors and psychological variables play in energy conservation outcomes?

H_4: Psychological determinants will be a stronger predictor of energy conservation behaviour than socio-demographic variables.

The relationship between the socio-demographic variables (number in the household, total household income and gender of respondent), the psychological variables (values and environmental concern) and the efficiency and curtailment behaviours undertaken as part of the programme were first assessed using a Pearson product moment coefficient. The correlations and their significance are displayed in table 5-4.

As would be expected, the total household income correlates significantly and positively with the number of people in the house ($r = .332$, $p < .01$). Household income also shows a statistically significant positive correlation with self-enhancement values ($r = .294$, $p < .01$) as well as a significant negative association with conservation values ($r = -.237$, $p < .01$). Gender is positively and significantly associated with environmental concern ($r = .178$, $p < .01$) with females more likely to express a greater concern for the environment than male respondents.

Table 5-4: Pearson correlation statistics between socio-demographic factors and the behaviour and psychological variables

		M	SD	N	1	2	3
1	Number in household	2.71	1.21	277			
2	Household Income	5.21	1.95	273	.332**		
3	Gender	1.62	0.49	278	-.101	-.067	
4	Efficiency behaviours	3.51	2.41	276	.080	.089	.046
5	Curtailment behaviours	3.30	0.43	276	-.031	-.065	.000
6	Environmental concern	3.81	0.57	276	-.033	.048	.178**
7	Self-transcendence	0.90	0.52	278	-.056	-.062	.155**
8	Openness to Change	0.02	0.55	277	-.081	.027	.009
9	Self-enhancement	-0.76	0.66	278	.112	.294**	-.035
10	Conservation	-0.19	0.58	278	-.010	-.237**	-.063

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

To determine the relative contribution of socio-demographic and psychological factors on energy behaviour, a hierarchical regression analysis was performed. The psychological determinants represented by the four value dimensions and environmental concern were grouped in Model 1. The socio-demographic variables included the gender of the respondent, the number of people usually present in the household and the household income were gathered into Model 2 of the regression. There were two dependent variables which represented the resulting energy conservation behaviour; efficiency behaviours as represented by the number of

recommendations undertaken by the household, and curtailment behaviours as represented by the average behaviour score.

Diagnostic tests were completed for both regression analyses to test for multicollinearity within the variables, unduly influential data points as well as the assumptions of normality and homoscedasticity. Both regression analyses showed little evidence of multicollinearity with variance inflation factors for all variables below the recommended threshold value of 10 and tolerance statistics all greater than 0.1. Influential data points were initially assessed using standardised residuals and the leverage statistic which both showed a small number of potential highly influential data points in each regression; however, all data points demonstrated a Cook's distance of substantially below 1 which suggests that multicollinearity did not appear to be an issue for this sample and thus all data points were kept for the analysis (Field, 2013).

The normality of the residuals was assessed through inspection of the residual histogram and normal P-P plot. The regression analysis for both dependent variables showed evidence of non-normality and a positive skew amongst the residuals. The assumption of homoscedasticity was also violated for both regression analyses with residual scatterplots showing patterns consistent with heteroscedasticity. The violation of these assumptions was overcome by the use of the robust method of 'bootstrapping' which does not rely on the assumptions violated above (Field, 2013). Bootstrapping treats the sample as a population and then samples this population 1000 times to gain an estimate for the parameters. The results presented below are the bootstrap regression results.

5.5.1 Dependent variable: Efficiency behaviours

Table 5-5 presents a summary of the regression results for the efficiency behaviours undertaken after the WHESP. Model 1 shows that 4.6% of the variability in the number of efficiency behaviours undertaken can be explained by the four value dimensions and environmental concern and this is significant at the 5% level (R^2= .046, p = .028*). The strongest and only significant predictor of the efficiency behaviours, in line with the earlier literature, was that of self-transcendence values (B = 1.434, [- .132, 2.706], p = 0.033*). This result shows that as the centred self-transcendence score increases by one unit, the number of efficiency recommendations increases by 1.434 and thus greater self-transcendence values are a positive predictor of efficiency behaviours if all other variables are held constant.

The addition of socio-demographic variables to Model 2 was not statistically significant (R^2 = .046, ΔR^2 = 0.14, p = 0.265). Self-transcendence values remained the strongest and only significant predictor of the number of recommendations when socio-demographics were controlled for (B = 1.473, [- .085, 2,749], p = 0.024*). This predictive power of self-transcendence values on efficiency behaviour gives further evidence to support the second hypothesis above.

Table 5-5: Bootstrapped regression models for efficiency behaviour

		R^2	ΔR^2	B	SE B	95% Confidence Interval		β	p
						Lower	Upper		
Model 1	Environmental Concern	.046	.046*	0.370	.271	-.210	.888	.088	.159
	Self-transcendence			1.434	.741	-.132	2.706	.309	.033*
	Openness to change			0.948	.771	-.745	2.196	.221	.188
	Self-enhancement			0.675	.629	-.674	1.775	.186	.246
	Conservation			0.998	.903	-.940	2.570	.240	.242
Model 2	Environmental Concern	.061	.014	0.360	.285	-.250	.893	.086	.201
	Self-transcendence			1.473	.727	-.085	2.749	.318	.024*
	Openness to change			1.048	.759	-.711	2.292	.244	.134
	Self-enhancement			0.620	.620	-.725	1.713	.171	.267
	Conservation			1.117	.897	-.847	2.638	.269	.168
	Number in household			0.145	.128	-.096	.412	.073	.252
	Household income			0.099	.082	-.056	.264	.080	.225
	Gender			0.028	.336	-.675	.638	.006	.937

Confidence intervals and standard errors based on 1000 bootstrap samples.

*. Correlation is significant at the 0.05 level (2-tailed).

The top five recommendations implemented after the WHESP as indicated by the survey, are outlined in Table 5-6. Three of these recommendations are relatively low-cost efficiency behaviours such as thermal blocker curtains whilst two are for larger renovations of ceiling and floor insulation. Given that different values can influence different behaviours, a logistic regression was conducted to examine whether the psychological and socio-demographic variables provide any predictive power for each

of the individual efficiency behaviours. The logistic regression used the same two models from above and each of the top five recommendations indicated by the survey.

Table 5-6: Top 5 recommendations implemented after the WHESP

Recommendation	% uptake
Energy efficient lighting	43.3
Floor insulation	41.9
Ceiling insulation	40.1
Draught excluders	26.1
Thermal blocker curtains	22.9

The models showed no significant explanation for any of these five recommendations individually. The B values for all variables in the model were also non-significant except for one recommendation - Model 2 when regressed with ceiling insulation showed 'income' to be a significant negative predictor of the installation of ceiling insulation (B = -.202, [- .392, -.045], p = 0.015*). This means that the higher the household income, the less likely that household was to install ceiling insulation following the WHESP.

Overall, hypothesis H_4 is confirmed by the efficiency behaviour results; the predictive influence of the psychological variables in the regression model, whilst relatively small, was greater than that of the socio-demographic variables.

5.5.2 Dependent variable: Curtailment behaviours

Table 5-7 presents a summary of the regression results for the average curtailment behaviour score of respondents. Model 1 shows that only 3.0% of the variability in behaviour could be explained by the four value dimensions and environmental concern. This was not statistically significant (R^2= .030, p = .162). None of the variables were significant predictors of curtailment behaviours, though environmental concern

was approaching significance when all other variables were held constant (B = 0.085, [-.003, .172], p = .056).

The addition of socio-demographic variables to Model 2 did increase the explained variance of the behaviour score (R^2 = .034, ΔR^2 = 0.04, p = 0.764) though this remained insignificant. However, the inclusion of socio-demographics meant that environmental concern became a significant predictor of curtailment behaviour (B = 0.089, [-.001, .175], p = 0.046*). This result shows that as the mean environmental concern increases by one unit, the mean curtailment behaviour score increases by 0.1 units. This provides some support for hypothesis H_3 and suggests that greater environmental concern is a positive predictor of curtailment behaviours when all other variables (including socio-demographics) are held constant. However, this result should be taken with caution as the overall model is not significant.

A logistic regression was conducted to see if any of the models were able to predict any of the individual curtailment behaviours. The models showed no significant explanation for any of the six curtailment behaviours individually. The B values for all variables in the model were also non-significant.

Hypothesis H_4 is partially confirmed by the results; the predictive influence of the psychological variables in the regression model was greater than that of the socio-demographic variables, however, these results should be interpreted with caution given that the overall R^2 was not statistically significant. This suggests that other variables not included in this survey may be influential. The discussion chapter will explore these findings in more detail.

Table 5-7: Bootstrapped regression models for curtailment behaviour

		R^2	ΔR^2	B	SE B	95% Confidence Interval		β	p
						Lower	Upper		
Model 1	Environmental Concern	.030	.030	0.085	.044	-.003	.172	.116	.056
	Self-transcendence			-0.016	.081	-.177	0.156	-.019	.839
	Openness to change			-0.074	.089	-.248	0.114	-.099	.367
	Self-enhancement			0.045	.077	-.096	0.206	.072	.516
	Conservation			0.035	.110	-.160	0.264	.049	.734
Model 2	Environmental Concern	.034	.004	0.089	.045	-.001	.175	.122	.046*
	Self-transcendence			-0.014	.082	-.180	0.153	-.017	.855
	Openness to change			-0.078	.091	-.262	0.113	-.104	.354
	Self-enhancement			0.056	.077	-.095	0.218	.089	.440
	Conservation			0.026	.111	-.187	0.257	.036	.803
	Number in household			0.000	.023	-.047	.046	.001	.994
	Household income			-0.015	.014	-.043	.014	-.068	.301
	Gender			-0.017	.050	-.116	.081	-.020	.730

Confidence intervals and standard errors based on 1000 bootstrap samples.

*. Correlation is significant at the 0.05 level (2-tailed).

5.6 SUMMARY

Results Summary

Research question 1: Did the Wellington Home Energy Saver Programme (WHESP) through its home audit intervention produce significant changes in energy use for the participating households?

Small sample size and large variability in the energy consumption data analysis mean that the impact of the WHESP on energy consumption remains inconclusive.

Research question 2: What relationships exist between the psychological variables and energy saving actions undertaken as part of the WHESP programme?

Self-transcendence values and environmental concern both show a positive relationship with efficiency behaviours. Self-transcendence was also a positive predictor of efficiency behaviours whereas environmental concern was a positive predictor of curtailment behaviour when all other variables were controlled for. Curtailment behaviour showed a negative relationship with openness to change values.

Research question 3: What role do socio-demographic factors and psychological variables play in energy conservation outcomes?

The psychological variables of values and environmental concern explained greater variance in efficiency behaviours than the socio-demographic variables. No significant explanation of variance was found between psychological or socio-demographic variables and curtailment behaviour. No significant explanation of variance was found between the two models and specific individual efficiency or curtailment behaviours.

6 DISCUSSION

6.1 INTRODUCTION

This chapter discusses the findings of the research in the order of the hypotheses presented above, synthesising relevant literature to compare, contrast and consider explanations for the results and relationships found. Limitations of the study are expanded upon in conjunction with opportunities for future energy intervention research. The chapter culminates in a list of recommendations arising from the research with implications for policy and intervention design.

6.2 ENERGY CONSUMPTION

Household energy consumption before and after the WHESP was calculated via two methods which presented differing results. The PRISM method of analysis used more robust methodology through the inclusion of climatic controls but proved a poor model for several households and resulted in a very small sample size. Analysis from this method indicated a statistically significant increase in energy use of 561 kWh in the year after the WHESP audit was conducted. However, the effect size of this increase was small with large variability evident within the sample of both energy consumption and energy change. The second method of analysis used a per day before and after average, which allowed for the inclusion of a slightly larger sample size. In contrast to the PRISM findings, this method found no statistically significant changes in average energy consumption between before and after the WHESP intervention.

Hypothesis 1 was neither accepted or rejected based on these findings due to the limitations evident in the data. The small sample size, large variability and small effect

size for the PRISM analysis meant that the observed increase in energy use does not necessarily indicate that an increase is evident across all participants of the program. The large variability in energy changes for the second method also means that there is a higher probability of accepting the null hypothesis (that there is no change in energy consumption) when energy savings could be evident within the population of WHESP customers. A much larger sample would be necessary to validate any energy changes attributable to the WHESP program and this will be discussed further in the limitations below. However, previous literature does suggest some possible explanations for the findings presented.

A number of studies discussed in Chapter 3 found little change or even increased energy consumption as a result of residential energy interventions (Abrahamse et al., 2005) and energy audits (McDougall et al., 1982; McMakin et al., 2002). Grimes et al. (2012) found an increase in energy consumption to be apparent in New Zealand households who had installed a heat pump following a clean heating intervention and indicated this could be due to an increased level of warmth and comfort now available and desired by the households. In another New Zealand intervention Howden-Chapman et al. (2009) found that whilst the majority of participants before the installation of insulation indicated they would take the monetary savings received from the increased energy efficiency of their house, on experiencing the effects of the insulation actually took the gains as increased temperature. An increased level of warmth and comfort within participating households following the WHESP could provide the explanation for the lack of energy savings evident in the results of this study, with almost three quarters of the survey respondents agreeing that their home was warmer following the WHESP assessment. Whilst an increase in energy

consumption is not desirable for efficiency objectives, due to New Zealand's persistent home under heating and frequent heating of only one room in a house, an increase in energy use for space heating can contribute to other beneficial outcomes through warmer and thus healthier homes (Howden-Chapman et al., 2009). Indeed, taking some of the energy savings as increased warmth may be a necessary and desirable outcome if an increase in health and wellbeing in New Zealand houses is to be achieved. Ürge-Vorsatz and Herrero (2012) call for a strong integration of climate change and energy poverty mitigation in policy so that there is synergy instead of conflict between these two goals. They indicate that increased consumption, especially from low income houses, should be better understood and incorporated into energy efficiency policy whereby wider health and wellbeing benefits should not be undermined by strict efficiency goals.

Two additional factors could influence the results of this study. First is the short time period of energy consumption data available following the WHESP intervention. The impact of an energy intervention could take longer to become evident, especially considering the extended time period with which households implement changes from an energy audit, with evidence to suggest that energy savings are greater in the second or even third year after an intervention (Clinton et al., 1986; O'Connell et al., 2010). Secondly, energy consumption from solid fuel such as a wood burner was not accounted for in this study. If, due to the WHESP programme, a household had changed its primary heating source from wood to an electrical source such as a heat pump then this may have resulted in an increased electricity consumption for this household. Thus, a deeper understanding of energy supply changes in the household

would be necessary to examine the extent to which substitution of energy sources affects energy consumption.

6.3 Relationship of Values and Energy Behaviour

The relationship between the psychological variables and energy conservation behaviour was examined through correlation and regression analysis. In line with previous research, a significant positive correlation was evident between self-transcendent values and levels of environmental concern. This means that respondents who placed importance in altruistic values and collective interests were more likely to express higher levels of environmental concern. An examination of the relationship between values and actions taken by respondents after the WHESP audit found that self-transcendence values were significantly but weakly positively correlated with efficiency behaviours (measured by the number of recommendations undertaken). This means that the greater the importance of self-transcendence values to a WHESP participant the greater the number of recommendations undertaken. When all other variables were controlled for in the regression analysis, self-transcendence values were the only significant predictor of efficiency behaviours. These correlation and regression results contributed to acceptance of the second hypothesis in relation to efficiency behaviours.

The positive influence of self-transcendence values on environmentally significant behaviour has been widely reported in previous literature (Nordlund & Garvill, 2002; Schultz et al., 2005; Thøgersen & Ölander, 2002). Whilst there is evidence of positive relationships between self-transcendence values and energy conservation behaviour (Ibtissem, 2010; Yeboah & Kaplowitz, 2016), there is much less energy conservation

specific evidence and none relating to an energy audit intervention. Thus, the relationship between self-transcendence and efficiency behaviours in this study indicates that energy efficiency behaviours form a similar positive relationship with self-transcendence as presented by more general environmentally significant behaviours. This indicates that an embracement of values related to altruism and collective interests is a significant contributor to energy conservation behaviour. Previous research has indicated that other values can be triggered in the case of energy conservation; for example, those related to more self-oriented, or self-enhancement values such as home comfort and financial security (Kennedy et al., 2009; Poortinga et al., 2004). This relationship did not emerge from this research and self-enhancement values were not significantly correlated with efficiency behaviours.

In contrast to the findings of efficiency behaviours, self-transcendence values were not significantly correlated with curtailment behaviours which led to the rejection of the second hypothesis in relation to curtailment behaviours. Curtailment behaviours were instead negatively correlated with openness to change values suggesting that participants with stronger openness to change values were less likely to engage in curtailment behaviours following the WHESP. This negative relationship with openness to change is contradictory to other studies of environmentally significant behaviour (Karp, 1996) and energy conservation (Abrahamse & Steg, 2011) and seems counterintuitive given that this value dimension embodies the embracement of change within a person's life suggesting that changing behaviour should be more welcomed by these respondents. Poortinga, Steg, and Vlek (2004) found a similar negative relationship between openness to change values and transport behaviour and hypothesised that this could be due to the importance of transport in facilitating

a varied and changing life. Thus, energy consumption (rather than conservation) could be an enabler of experiences which promote aspects of openness to change values and curtailing energy behaviour could be seen to inhibit this need for self-direction and stimulation. However, openness to change did not significantly predict curtailment behaviour when other variables were controlled for in regression analysis.

For a small subset of the sample (21 households), the survey data on values was matched with energy savings. Self-transcendence values were not significantly related to actual energy savings (measured as a percentage energy saving from a before and after per day average) and so the second hypothesis was also rejected in relation to energy savings However, conservation values were strongly negatively correlated with energy savings. The value dimension of conservation opposes the value dimension of openness to change, and represents traditional values, self-restriction and preservation of the past (Schwartz, 2012). It has been shown to be a strong negative predictor of environmentally significant behaviour (Karp, 1996) and thus its negative association with energy conservation in this study is not unexpected. However, given the strength of the relationships evident in previous literature between the self-transcendence vs self-enhancement dimension and environmentally significant behaviour, it is surprising that self-transcendence and self-enhancement values dimension does not relate to energy savings. I can find no literature which examines values in relation to quantified energy savings and more research would be necessary to understand whether this negative relationship between conservation and energy saving is reproduced in other studies. Also, these results are indicative only as the sample size of 21 is small and a much larger sample is needed to replicate these findings.

6.4 Relationship between Environmental Concern and Energy Behaviour

Correlation analysis showed that environmental concern was significantly positively related with efficiency behaviours, though this relationship was weak. This corresponds to previous research linking a higher concern for the environment with a higher uptake of environmentally significant behaviour. Environmental concern was not found to be significantly correlated with curtailment behaviours but regression analysis revealed environmental concern as the only significant predictor of curtailment behaviour when all other variables were controlled, though the increase in curtailment behaviour predicted by environmental concern was small. Percentage energy savings did not correlate with environmental concern, though a small sample size may have impacted on these results. Hypothesis 3 was thus partially confirmed for efficiency and curtailment behaviours.

Reflecting the results of this study, Scott and Willits (1994) also found a weak relationship between environmental concern and environmental behaviour and Gardner and Stern (1996) highlight the difficulty in finding strong relationships between these variables given the barriers that influence environmental action. Stern, Dietz, Abel, Guagnano and Kalof (1999) illustrate some of these barriers by outlining that the link between environmentalism and behaviour is mediated by a number of other factors such as an understanding of the consequences of a behaviour, its effect on alleviating environmental problems and the moral obligation one feels to act. These other factors were not measured in this research and could help explain the weak relationship found between environmental concern and energy conservation behaviour. It has also been highlighted that energy conservation can be driven by

multiple influential concerns such as a desire to reduce energy bills, to increase home warmth and comfort or to improve the health of the family (Stern, 1992). This means that energy conservation is not always viewed through an environmental lens or motivated by environmental concerns and a weak relationship implies that other concerns could be more prominent influencers of residential energy behaviour.

Karlin et al. (2014) found that environmental concern had a greater positive influence on curtailment behaviours than efficiency behaviours. This was explained as being due to the comparative ease with which curtailment behaviours are able to be undertaken over efficiency behaviours, with fewer contextual factors (such as income) inhibiting action. Given that a number of the efficiency recommendations in the research presented here were very low-cost, 'easy' behaviours to undertake with low contextual constraints (such as installing energy efficient lighting which was the top recommendation implemented), this could explain the positive relationship found between the environmental concern of participants and efficiency behaviours as well as the significant predictive relationship with curtailment behaviour.

6.5 The influence of Socio-demographics

Correlation analysis of the psychological and socio-demographic variables revealed a significant positive correlation between the number of people in the household and the total household income. Income significantly correlated positively with self-enhancement values and negatively with conservation values. Self-enhancement values embrace the importance placed on personal interests and success and so a positive association with household income seems logical; those who pursue success and achievement are more likely to earn a greater income. Conservation values

represent an importance placed in tradition and self-restriction, and a negative relationship with income here also seems reasonably logical; those with a lower income are more likely to embrace more conservation oriented values. None of the other socio-demographic variables were found to be related to values. Gender was significantly correlated with environmental concern, with female respondents more likely to display a higher concern for the environment than male respondents. This relationship has also been found in previous New Zealand studies (Wooliscroft, 2015) and international research (Olli, Grendstad, & Wollebaek, 2001).

Regression analysis was used to examine the predictive nature of both the psychological variables (values and environmental concern) and socio-demographic variables (total household income, household size and gender) on energy conservation behaviour. The psychological variables explained 4.6% of the variance in efficiency behaviours whilst the addition of the socio-demographic variables led to a small but non-significant increase in explained variance. For curtailment behaviours, values and environmental concern explained only 3.0% of the variance and this was not significant. The addition of socio-demographics led to a very small and non-significant increase in explained variance. These findings reinforce previous research which found that whilst socio-demographic variables were strong predictors of energy consumption, they were less influential in predicting energy conservation (Guerin et al., 2000) and thus hypothesis four was confirmed.

The amount of explained variance for both efficiency and curtailment behaviours was small given the large explained variances evident in other studies that modelled psychological variables against environmental and energy behaviour such as Abrahamse and Steg (2011) and Mobley et al. (2010). However, both of these studies

utilised a number of other psychological variables beyond that of just values and environmental concern. Indeed, a study of ecological behaviour by Casey and Scott (2006) found a similar amount of explained variance (3.2%) when using only environmental concern and socio-demographic factors. This reinforces the supposition that energy behaviour is a much more complex picture with further unmeasured variables which mediate the relationship between values, environmental concern and energy conservation behaviour and could explain why a large portion of both efficiency and curtailment behaviour remained unexplained by the variables in this study. Further investigation which includes other variables found to mediate the relationship between values and behaviour, (such as the activation of personal norms which is the moral obligation one feels to act; Ibtissem, 2010; Nordlund & Garvill, 2002), could help explain a greater variance of energy behaviour.

Logistic regression of each of the top five recommendations and each of the curtailment behaviours did not yield any significant explained variance of either values and environmental concern or socio-demographic factors. Given that it has been found that different values can be activated by different situations and behaviours (De Groot & Steg, 2008), it is interesting that no significant explanation of variance is apparent when it would be expected that values would have more explanation once the behaviours were separated individually. However, both the environmental concern and values scales provide general measures not related to specific behaviours. Therefore, which values were specifically related to which behaviour is likely to be difficult to uncover without interviewing the participant directly. Mirosa et al. (2013) explain the difficulty in finding a relationship between values and behaviour through the vast complexity of value activation with a specific

value able to drive both efficient and inefficient energy behaviour in an individual. For example, the value of pleasure can drive the acquisition of a warm and energy efficient house but can also drive the desire for long hot showers (Mirosa et al., 2013). This makes establishing relationships with values difficult and could indicate a reason for the small predictive power of values presented in this study.

One socio-demographic variable was a significant negative predictor of the installation of ceiling insulation; the lower total household income the more likely the household was to have installed ceiling insulation. Given that ceiling insulation is a high cost efficiency behaviour this seems counterintuitive; however, this could be due to government subsidies available to low-income households for the installation of insulation as part of the Warm Up New Zealand scheme. Of the other four 'top 5 recommendations', three were low-cost efficiency behaviours. This reflects the findings of Bartiaux (2008) and Revell (2014) whereby the easiest and least costly efficiency behaviours were the largest contributors to energy behaviour changes in households. This could have also been influenced by the subsidy available for small efficiency behaviours at the time of the WHESP audit and suggests there may be an important role for incentives in combination with tailored information provision.

6.6 LIMITATIONS AND FUTURE RESEARCH

6.6.1 Sampling

The self-selected population of WHESP customers means that the sample presented here is not representative of Wellington households with home owners and households with more than one occupant over-represented. Whilst this might be expected for a home improvement programme such as this, it is unclear if the sample forms a representative group of WHESP customers and thus whether the results can

be generalised to the WHESP programme as a whole. The higher number of female respondents suggests that men could be under-represented in this sample. Also, participants may have been less likely to respond if they had made few or no changes, which could have influenced the results.

There were only 21 households who contributed both their energy data to the study and filled out the online survey, despite email prompts. This affected the potential for finding relationships and explained variance of energy use changes through the socio-demographic and psychological variables as well as also limiting the validity of the conclusions drawn. It also restricted the ability to identify households who should have been removed from the energy part of the study for reasons of shortness of tenure or significant household changes during the study period. Securing a larger sample size for this subset of households would increase the statistical power of the findings whilst also enabling a more in-depth analysis which could compare different groups of interest such as high and low income households or electric vs gas primary heating sources.

This research utilised a before and after study design to compare energy consumption following the WHESP audit. This approach was used due to the time-frame and resources available for the study. However, this meant that causality in any relationships could not be established. The use of a control group is more desirable as it establishes any energy consumption patterns or changes which are present in the wider population; for example, higher energy prices could contribute to an overall reduction in energy use which would be evident in both the control group and the intervention group. The inclusion of a control group would be recommended for future energy consumption analysis.

6.6.2 Energy Data

There were a number of limitations with regards to gathering, using and analysing the energy data for this study.

The collection of energy consumption information from power companies proved to be challenging despite the introduction of new legislation which was designed to both mandate the provision of information as well as standardise the process of doing so. The lack of energy data from one large company considerably reduced the sample size for this part of the research. This was further compounded by the provision of only partial data from another company who were unable to supply gas consumption information. These factors impacted the size of the sample as well completeness of the data. This contributed to the large variability evident in energy consumption data, e.g., a household with a very low energy usage was likely a result of this missing information. The challenge in gaining energy consumption data for research represents a significant barrier to the evaluation of energy interventions. With previous research supporting the importance of acquiring energy data to understand programme effectiveness (Abrahamse et al., 2005), overcoming or removing this barrier will be necessary to enable comprehensive future energy evaluations.

The use of the PRISM method appeared to be the most robust way of analysing the energy data given the type of data collected and its use of temperature controls to account for weather dependent energy changes. However, the models to estimate energy consumption created via this method did not adequately describe the energy use of a large portion of households, reducing the sample size able to be analysed. This may have been influenced by the incompleteness of some households' energy records or could have meant there were more variables contributing to energy

consumption change than just temperature. Alberini and Towe (2015) suggest that other household characteristics such as the size of the house and the age of the occupants, are important factors to include when analysing energy consumption changes to complement a before and after energy analysis. Future research could explore the inclusion of variables such as these in to a household energy consumption model to help create a more complete understanding of household energy changes following an intervention.

6.6.3 Survey responses

Values and environmental concern explained only a small amount of variance in energy behaviour suggesting there are variables beyond those measured here which contribute to energy conservation. The 'Values Belief Norm' theory (VBN; Stern, 2000) uses values and environmental concern as the first two variables in a causal chain, with navigation of the successive three variables theorised as necessary before behaviour will be instigated. Measuring these other variables (awareness of action consequences, ascription of responsibility for those actions and any moral or social obligation felt towards undertaking the action) would extend the research conducted here to develop a more complex picture of the psychological variables which contribute to energy conservation in an audit intervention.

Difficulty in uncovering relationships was also apparent when both the efficiency and curtailment behaviours were separated into individual behaviours. This is likely due to the general measurement of the value items making it difficult to uncover the salient values activated for each specific behaviour. Including a qualitative component in a future study would allow a more in-depth perspective of the relationships between values and different energy conservation behaviours (Karlin, Ford, Wu,

Nasser, & Frantz, 2015; Mirosa et al., 2013). This would also enable the incorporation of social context to energy conservation behaviour (such as family dynamics and energy practices; Shove & Walker, 2014; Thøgersen & Grønhøj, 2010) which are unable to be captured through a survey. Olli et al. (2001) cite a lack of understanding of this social context as one of the reasons for weak relationships between attitudes and behaviour. Stephenson et al. (2010) offer a multi-disciplinary framework of energy use which incorporates practices along with psychological and contextual factors to make up a home 'energy culture'. This highlights an important role for social context in future energy conservation research which would offer further insights into household energy behaviour along with psychological and contextual factors. The survey conducted here also captured an individual's perspective on values whilst the reported behaviours undertaken after the programme were household-wide. Thus, the incorporation of a qualitative component would aid in gathering a household and family-wide perspective.

6.7 Policy Recommendations

The wider implications of the findings from this study lead to recommendations for policy. These provide suggestions to facilitate the intervention evaluation process as well as how the findings could help improve residential energy conservation outcomes.

Access to energy data is crucial to enabling sound evaluation of energy conservation programmes to take place. The challenges of access to and the process of gaining complete energy consumption data for this study limited the sample size and affected the statistical power of the results. With evaluation using energy consumption already

infrequent in intervention studies (Abrahamse et al., 2005), this challenge of access presents a significant barrier to researching energy interventions and working towards understanding their impact and effectiveness. Whilst the new legislation mandating electricity consumption data in New Zealand does contribute significantly to addressing this issue, a more widely accepted common process and acknowledgement of the vital role of energy consumption data (including gas) amongst power companies is necessary to facilitate and enable effective future evaluations.

The energy results from my research indicate that it is important to understand the nature of energy consumption changes in relation to health and well-being and the consequent effect on energy conservation goals. Ürge-Vorsatz and Herrero (2012) highlight the importance of strong integration between the two policy goals of energy efficiency to mitigate climate change and improvement of energy poverty outcomes. This is a salient issue in New Zealand (Howden-Chapman et al., 2009) and a deeper understanding of the nature of the trade-offs involved between these two goals in New Zealand households would aid in aligning these policy goals. Energy efficiency policies should enable the promotion of energy conservation whilst not undermining the benefits of also supporting warm and healthy households.

This research shows that for the Wellington Home Energy Saver Project, self-transcendence values were significantly related to an increase in efficiency behaviours following the programme. Creating value based intervention campaigns have been recommended in other literature to help promote energy efficiency (Corner & Randall, 2011) and imply that appealing to the altruistic concerns and collective interests salient within the self-transcendence value dimension when designing and

implementing an intervention could aid uptake of energy conservation behaviour. Whilst this might not appeal to those who don't necessarily place importance in self-transcendence values, Corner and Randall (2011) argue that techniques need to be employed that are conducive to solving bigger picture issues. For instance, appealing to self-enhancement values could be used to promote energy efficiency but ultimately be counterproductive to building a sustainable lifestyle. Therefore, discovering ways to activate and appeal to these self-transcendence values in households is likely to aid in the uptake of energy conservation behaviour and contribute to better environmental outcomes.

Participants who engage in energy conservation programmes such as the WHESP are already highly-motivated to act. One of the most prominent challenges to such interventions beyond eliciting energy efficiency changes, is getting households to take part in the first place. Previous research has highlighted the often small response rate of eligible households for energy conservation interventions (Clinton et al., 1986; Palmer et al., 2013; Tonn et al., 2013) even when the service is free or big subsidies or incentives are offered. A greater understanding of the barriers to uptake of the WHESP programme by eligible Wellington households would help the programme reach a wider audience and provide a greater opportunity for energy conservation behaviour change.

7 CONCLUSION

Recognition of the need for a transformation in our global energy systems to combat climate change has brought about an increased focus on curbing consumption and increasing energy efficiency. The residential sector is a prominent energy user and a key focus for this transition to a low carbon future. Wider societal benefits such as increased health and wellbeing and reduced energy poverty provide additional support for energy conservation strategies and have contributed to the promotion of residential energy efficiency policies. Psychology has played an increasingly important role in energy policy with an understanding that individuals act on motivators beyond those the prevalent economic perspective provides. Thus, understanding the salient psychological determinants of energy conservation behaviour develops a deeper understanding of how and why energy interventions succeed (or indeed fail) and how interventions can be made more effective.

The aim of this study was to contribute a psychological evaluation of energy consumption and behaviour following a home energy audit intervention programme in Wellington City. The evaluation investigated the changes in energy consumption and behaviour following the WHESP programme in conjunction with the psychological determinants of these behaviours. The determinants explored were the fundamental values held by programme participants as well as their level of concern for the environment. These were examined in order to provide a deeper understanding of motivations for residential energy conservation behaviour and to contribute a unique insight into a tailored information programme in a New Zealand context. Behaviour was measured through self-reported efficiency and curtailment behaviours with a

quantitative measure of household energy change also calculated to explore any differences in consumption following the programme.

The findings presented here showed large variability in energy changes following the WHESP programme with analysis of household energy consumption changes inconclusive. This was due in part to the large variability in consumption data as well as the small sample size and limitations of complete energy data collection. Further research is necessary to establish whether these findings are verifiable and attributable to the WHESP programme with easier access to energy consumption data a key policy recommendation to enable effective intervention evaluation. Whilst the results were ultimately inconclusive, they did highlight the need for a better understanding of the trade-offs involved in residential energy use. New Zealand's unique relationship with energy means that warmer homes bring significant health and wellbeing benefits and the alignment of energy poverty and energy efficiency policies is key to achieving the interconnected goals of healthier homes and decreased environmental impacts of energy use.

The psychological variable of values demonstrated the expected relationship with efficiency behaviour, with self-transcendence values positively related to the number of recommendations implemented following the WHESP audit and being a significant and positive predictor of energy efficiency when all other variables were controlled for. This suggests that appealing to the altruistic concerns and collective interests salient within the self-transcendence value dimension when designing and implementing an intervention could aid uptake of energy conservation behaviour. However, values relationship with curtailment behaviours was less clear and

developing an understanding of these behaviours within the social context of the household could aid in generating a deeper insight into this relationship.

Whilst there was some evidence to suggest a link between environmental concern and energy conservation behaviour, environmental concern was not as influential on behaviour as expected. This demonstrates that motivations for energy conservation behaviour could stem from wider concerns beyond that of environmental issues. Indeed, it was difficult to uncover strong relationships between the psychological variables and behaviour with a small amount of explained variance evident between values, environmental concern and energy behaviour. These results show the complexity of motivations surrounding energy consumption choices and suggests there are variables beyond those measured here which contribute to energy conservation. The inclusion of behaviour-specific (instead of general) variables that may mediate the relationship between values, environmental concern and behaviour would help gain a more complete picture of the cognitive processes involved when engaging in energy conservation actions. Integration of a qualitative component to an energy evaluation would also aid in gathering a more complex understanding of a household's energy changes and their behaviour specific motivations.

It is lastly important to recognise that a significant barrier still exists in securing the participation of households to energy conservation programmes. Households that take part in programmes such as the WHESP are already highly motivated to act and often only represent a small portion of eligible participants. Gaining insights into why it is that households do not sign up, whether it is through lack of knowledge or awareness or a lack of interest in energy efficiency, would contribute to programme planning and marketing and enable a wider audience to be reached.

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APPENDIX A: ETHICS APPROVAL

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Phone 0-4-463 5205
Email stephen.marshall@vuw.ac.nz

MEMORANDUM

TO	Leanne Jenkins
COPY TO	
FROM	Dr Stephen Marshall, Acting Convener, Human Ethics Committee
DATE	23 May 2016
PAGES	1
SUBJECT	**Ethics Approval: 23037** Residential energy conservation: Understanding values, environmental concern and behaviour in the Wellington Home Energy Saver Project.

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 1 March 2017. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Stephen Marshall,
Acting Convener, Victoria University Human Ethics Committee

APPENDIX B: ENERGY DATA CUSTOMER CONSENT FORM

AUTHORISATION FOR THE RELEASE OF INFORMATION

1. Customer details:

Name of person giving authorisation.....

Address of property.....

Power Company 1..... Account Name.....

Customer Number..... Account Number.....

Electricity ICP numbers related to this account (found on your energy bill)

.....

.....

Gas Meter number (if applicable) .....

If applicable -

Power Company 2..... Account Name.....

Customer Number..... Account Number.....

Electricity ICP numbers related to this account (found on your energy bill)

.....

.....

Gas Meter number (if applicable) .....

2. Agent details:

Agency Name: **Sustainability Trust**

Agent Contact details: **Sustainability Trust**
2 Forresters Lane
Te Aro, Wellington
04 385 0500 x 722
jonny@sustaintrust.org.nz

3. Information authorised for disclosure (please delete as applicable):

- The past 24 months electricity usage data Yes/No
- The past 24 months gas usage data Yes/No

4. Signature

By signing this form, you are authorising your power supplier(s) as indicated in Section 1 of this form to disclose the information specified in section 3 to the Agent named in Section 2.

Signature..... Date.....

APPENDIX C: INTRODUCTORY EMAIL

Wellington Home Energy Saver Programme Evaluation: Invitation to Participate

Kia ora,

An evaluation of the Wellington Home Energy Saver Programme is currently being undertaken and we are looking to gather some information from you as a past participant of the project. Leanne Jenkins is a Masters student at Victoria University and will be conducting the research as part of her thesis project which has been approved by the Victoria University Human Ethics Committee as well as the Sustainability Trust and Wellington City Council.

The research will form an important evaluation of the project's aims and your perspective and opinions are an important contribution to this.

What does the research involve?

In the first instance we are looking to analyse both electricity and gas consumption data to see what the effects of the programme have been on energy use. This involves a selection of households such as yours giving consent for their last 24 months energy data to be obtained for the purposes of this project. The data will be obtained with written consent from you through a signed consent form. The data collected will remain anonymous and confidential in all published research and documentation, and will provide a vital component of the evaluation process.

In the second instance, a short online survey will be sent out to you. This survey will look to gather some of your personal perspectives of the WHESP and to gain an understanding of the factors involved in any changes made because of the programme.

As a token of appreciation for your contribution, each participant in this research will go into a draw for a Sustainability Trust endorsed Tatou radiator worth $660.
http://www.sustaintrust.org.nz/shop/home-heating/tatou-radiant-heater-digital-model-with-built-in-timer/

What happens next?

During the next week, you will receive some more information by mail, along with a consent form to sign and a freepost envelope which will return the form to the Sustainability Trust. After completion of the energy data gathering, an online survey link will be emailed to participant. If you have any questions about taking part in this research please don't hesitate to contact Leanne Jenkins or Jonny Parker on the details below.

Many thanks in advance, your help is much appreciated.

Leanne Jenkins
Victoria University Masters Student
jenkinlean@myvuw.ac.nz

Jonny Parker
Sustainability Trust Business
Development Manager
jonny@sustaintrust.org.nz

APPENDIX D: PARTICIPANT LETTER AND INFORMATION

Wellington Home Energy Saver Programme Evaluation

Dear [Recipient]

Further to the email invitation sent last week, please find enclosed some more information about the research and evaluation being undertaken into the Wellington Home Energy Saver Programme (WHESP). As participants in this programme, your household has been selected to take part in this study and we would be really grateful for your contribution.

Please find enclosed a consent form for your power provider(s) along with a prepaid envelope which will return your form to the Sustainability Trust and an information sheet providing further details of the project. Please note that it is important to this research that you have been resident in your property for the previous 24 months and haven't moved address. **Please return this consent form to the Sustainability Trust by Wednesday 20th July** to go in to the prize draw for a Tatou radiator worth $660 (see attached information sheet for radiator details). The winner will be drawn at the Sustainability Trust on Wednesday 17th August from the returned consent forms of the approximately 400 participants contacted.

What information will be received and what will we do with your data?

The form enclosed requests your energy data records for the last 24 months from your power company. This will be received by the Sustainability Trust in a monthly kWh/m^3 format. The Trust will keep the raw and identifiable consumption data confidentially and securely at the Trust for further project evaluation. The survey responses will be received by Victoria University Masters student Leanne Jenkins and will require your address as an identifier. The Sustainability Trust will match these survey responses with the energy data and then remove all unique identifying information. The data retained and used by Leanne for the purposes of her research will not be personally identifiable. All published research will thus maintain confidentiality and anonymity.

What happens next?

When all of the forms have been received, an online survey link will be sent out to you via email to gather your personal perspectives on the WHESP and gain an understanding of the factors involved in any changes made because of the programme. We anticipate this survey will take approximately 10 - 15 minutes to complete.

If you have any questions about filling in the form or any general queries about the research please don't hesitate to contact Leanne Jenkins or Jonny Parker on the details below, we will be happy to help.

Thank you for your time and support with this research.

Sincerely,

Leanne Jenkins
Victoria University Masters Student
jenkinlean@myvuw.ac.nz

Jonny Parker
Sustainability Trust Business
Development Manager
jonny@sustaintrust.org.nz

Research Information Sheet

An evaluation of the Wellington Home Energy Saver Programme (WHESP) is currently being undertaken and we are looking to gather some information from past participants of the project. Leanne Jenkins is a Masters student at Victoria University and will be conducting the research as part of her thesis project which has been approved by the Victoria University Human Ethics Committee (approval #23037) as well as the Sustainability Trust and Wellington City Council.

The objectives of the research are to gain a better understanding of the impact of the Home Energy Saver Programme on Wellington households and also the underlying motivations behind any changes made. Your perspective and opinions are an important contribution to this.

What does the research involve?

The research will be undertaken in two parts

1. Electricity and gas consumption data will be gathered from households who participated in the programme between May and October 2015. These months have been picked as they will allow almost a year's worth of consumption data to be gathered before and after the home assessment was completed.
2. An online survey will be administered to the houses who took part in phase 1 as well as all other households who participated in the programme since the beginning of 2015.

Who will use the data?

The data will be used by Leanne Jenkins for her academic research as well as to provide the Sustainability Trust and Wellington City Council with an understanding of the programme's effectiveness. The data will be kept by the Sustainability Trust in a secure electronic format and could be used for further analysis by the Trust in the future. You are able to withdraw participation from the study at any point within 3 weeks of the survey completion by contacting Leanne Jenkins directly on the details provided below.

Can I find out the results?

Summary results of the research will be published through the Sustainability Trust and we will endeavour to contact the project participants once these results have been made available.

Who can I contact if I have any questions?

If you have any questions about taking part in this research please don't hesitate to contact any of the following people on the details below.

Leanne Jenkins
Masters Student
Victoria University
jenkinlean@myvuw.ac.nz

Dr Wokje Abrahamse
Lecturer Environmental Studies
Victoria University
Wokje.abrahamse@vuw.ac.nz

Jonny Parker
Business Development Manager
Sustainability Trust
04 385 0500 x 722
jonny@sustaintrust.org.nz

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Associate Professor Susan Corbett - susan.corbett@vuw.ac.nz +64 4 463 5480

APPENDIX E: ONLINE SURVEY

(The male version of the values question is provided)

Wellington Home Energy Saver Evaluation

Thank you for participating in this research and evaluation of the Wellington Home Energy Saver Programme.

This survey should take approximately 10 - 15 minutes to complete and consists of questions about your household characteristics, your personal values and views, and your observations and actions following participation in the programme. There are no right or wrong answers; we are interested in your opinion.

The answers you provide will be treated with confidence and any published findings will be completely anonymous.

Household Characteristics

This section asks for some general information about your household.

How many people usually live in your household?

DON'T count as usually living here university or other tertiary students who live somewhere else for most of the year.

DO Count as usually living here people who are away on holiday, away for work, in hospital for a short time, etc

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8+

Some households have been asked to supply details of their energy consumption. Did your household complete and return a consent form for energy data from your power company as part of this project?

(This was mailed out approximately 2 weeks ago - Answer 'No' if you did not receive this letter and also answer 'No' if you received this letter but did not return the consent form)

- ○ Yes
- ○ No

What is the address of the property which you supplied a power consent form for?

(This will only be used to match your survey answers with your energy consumption data. Your address and personal information will not be published in any documentation or research and will be removed from the data for analysis)

Address Line 1	
Address Line 2	
Suburb	

Have your household been resident at this property for the last 24 months?

- ○ Yes
- ○ No

How many months have you been resident at this property?

Have there been any significant changes in your household over the last 2 years which would affect your energy use?
(E.g. a new baby or a household member moving out)

- ○ Yes
- ○ No

Please specify what type of change happened and indicate approximately when the change occurred.
(E.g. a household member moved out in October 2015)

Do you own or rent the property where the Home Energy Saver Assessment took place?

- ○ I/We own the property (with or without a mortgage) and live there
- ○ I/we own the property (with or without a mortgage) and rent the property out to tenants
- ○ The property is in a family trust and I/we live there
- ○ The property is in a family trust and I/we rent the property out to tenants
- ○ I/we are tenants of the property to a private landlord
- ○ I/we are tenants of the property to a public entity (e.g. Housing New Zealand)
- ○ Other

What sources of power does the property have?
Tick all that apply

- ☐ Electricity from a company
- ☐ Self generated electricity (e.g. Solar PV, personal wind generation)
- ☐ Self generated hot water (e.g. Solar hot water)
- ☐ Gas (mains)
- ☐ Gas (bottled)
- ☐ Fireplace (e.g. wood, coal, pellet)
- ☐ Other

What is the gas used for?
Tick all that apply

- ☐ Hot water
- ☐ Cooking
- ☐ Other

What is your current main source of heating?

- ○ Heatpump
- ○ Portable electric heaters
- ○ Fixed electric heaters (e.g. radiators fixed to the wall)
- ○ Enclosed fireplace
- ○ Open fireplace
- ○ Portable gas heaters
- ○ Fixed gas heaters
- ○ Other

Household Income

Why do we want to know your income?

We will use the income data to look at the relationship between household income and any changes made due to the programme. All of the answers you give will be kept confidential.

Total household income is income before the deduction of income tax, levies or withholding payments, and includes such items as income sourced from wages and salaries, self-employed income, property and rental income, dividends and investments, social insurance, superannuation, government assistance schemes and private transfers such as child support.

DO count any payments that are taken out of your income before you get it, such as repayments of student loans, union fees, fines or child support.

DON'T count income from loans (including student loans), inheritances, sale of household or business assets, lottery wins, matrimonial / civil union / de facto property settlements or one-off lump sum payments.

DON'T count money given by members of the same household to each other. For example, pocket money given to children, or money given for housekeeping expenses by a flatmate.

What is your total household income (before tax)?

- ○ Zero income
- ○ $1 - $25,000
- ○ $25,001 - $50,000
- ○ $50,001 - $70,000
- ○ $70,001 - $100,000
- ○ $100,001 - $150,000
- ○ $150,001 - $200,000
- ○ $200,001 - $250,000
- ○ $250,001 or more

Your values.

We are looking at the relationship between values and energy behaviour. The following questions will ask you to think about your beliefs compared to the person described. There are no right or wrong answers; we are interested in your opinion.

Please first choose which gender you most strongly identify with. From here you will be directed to the associated version of the survey.

- ○ Male
- ○ Female
- ○ Other

Here we briefly describe some people. Please read each description and think about how much each person is or is not like you. Indicate on the scale how much the person in the description is like you.

		Not like me at all	Not like me	A little like me	Somewhat like me	Like me	Very much like me
1	Thinking up new ideas and being creative is important to him. He likes to do things his own original way.	○	○	○	○	○	○
2	It is important to him to be rich. He wants to have a lot of money and expensive things.	○	○	○	○	○	○
3	He thinks it is important that every person in the world be treated equally. He wants justice for everybody, even for people he doesn't know.	○	○	○	○	○	○
4	It is very important to him to show his abilities. He wants people to admire what he does.	○	○	○	○	○	○
5	It is important to him to live in secure surroundings. He avoids anything that might endanger his safety.	○	○	○	○	○	○
6	He likes surprises and is always looking for new things to do. He thinks it is important to do lots of different things in life.	○	○	○	○	○	○
7	He believes that people should do what they're told. He thinks people should follow rules at all times, even when no one is watching.	○	○	○	○	○	○
8	It is important to him to listen to people who are different from him. Even when he disagrees with them, he still wants to understand them.	○	○	○	○	○	○

9	He thinks it's important not to ask for more than what you have. He believes that people should be satisfied with what they have.	○	○	○	○	○	○
10	Having a good time is important to him. He likes to "spoil" himself.	○	○	○	○	○	○
11	It is important to him to make his own decisions about what he does. He likes to be free to plan and to choose activities for himself.	○	○	○	○	○	○
12	It is very important to him to help the people around him. He wants to care for other people.	○	○	○	○	○	○
13	Being very successful is important to him. He likes to impress other people.	○	○	○	○	○	○
14	It is very important to him that his country be safe from threats from within and without. He is concerned that social order be protected.	○	○	○	○	○	○
15	He looks for adventures and likes to take risks. He wants to have an exciting life.	○	○	○	○	○	○
16	It is important to him always to behave properly. He wants to avoid doing anything people would say is wrong.	○	○	○	○	○	○
17	It is important to him to be in charge and tell others what to do. He wants people to do what he says.	○	○	○	○	○	○
18	It is important to him to be loyal to his friends. He wants to devote himself to people close to him.	○	○	○	○	○	○
19	He strongly believes that people should care for nature. Looking after the environment is important to him.	○	○	○	○	○	○
20	Religious belief is important to him. He tries hard to do what his religion requires.	○	○	○	○	○	○
21	He seeks every chance he can to have fun. It is important to him to do things that give him pleasure.	○	○	○	○	○	○
22	He thinks it is important to be ambitious. He wants to show how capable he is.	○	○	○	○	○	○
23	He tries hard to avoid getting sick. Staying healthy is very important to him.	○	○	○	○	○	○
24	It is important to him to adapt to nature and to fit into it. He believes that people should not change nature.	○	○	○	○	○	○

The Environment

We are interested in your views on the environment. The following section will ask you some questions about your environmental attitudes. There are no 'good' or 'bad' answers; we are interested in what you think.

Listed below are statements about the relationship between humans and the environment. For each one, please indicate on the scale how much you agree or disagree with each statement.

	Strongly disagree	Mildly Disagree	Unsure	Mildly agree	Strongly agree
We are approaching the limit of the number of people the earth can support.	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs.	○	○	○	○	○
When humans interfere with nature it often produces disastrous consequences.	○	○	○	○	○
Human ingenuity will ensure that we do NOT make the earth unlivable.	○	○	○	○	○
Humans are severely abusing the environment.	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them.	○	○	○	○	○
Plants and animals have as much right as humans to exist	○	○	○	○	○
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	○	○	○	○	○
Despite our special abilities, humans are still subject to the laws of nature.	○	○	○	○	○
The so-called "ecological crisis" facing humankind has been greatly exaggerated.	○	○	○	○	○
The earth is like a spaceship with very limited room and resources.	○	○	○	○	○
Humans were meant to rule over the rest of nature.	○	○	○	○	○
The balance of nature is very delicate and easily upset.	○	○	○	○	○
Humans will eventually learn enough about how nature works to be able to control it.	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe.	○	○	○	○	○

The Home Energy Saver Programme

This section asks for your thoughts and opinions of the Home Energy Saver Programme. This includes the in-home assessment conducted as well as the action plan and list of recommendations which were emailed to you afterwards.

When did you have the home energy assessment?

- ○ 0 - 5 months ago
- ○ 6 - 11 months ago
- ○ 12 - 17 months ago
- ○ 18 - 24 months ago

Of the recommendations you received from the home assessment, roughly how many have you implemented?

- ○ None
- ○ One or two
- ○ Three or four
- ○ Five or six
- ○ Seven or eight
- ○ Nine or more

Which of the following recommendations have you implemented since your home assessment? (Please indicate all that apply)

- ☐ Installed wall insulation
- ☐ Installed underfloor insulation
- ☐ Installed ceiling insulation
- ☐ Installed cover blanket for existing ceiling insulation
- ☐

- [ ] Installed infinity gas hot water system
- [ ] Installed hot water cylinder
- [ ] Installed draught excluders/blockers
- [ ] Improved or installed a bathroom extractor fan
- [ ] Wrapped hot water pipes with lagging
- [ ] Installed shower dome
- [ ] Installed heat pump
- [ ] Installed radiant heaters
- [ ] Installed other heating solution
- [ ] Put up thermal blocker curtains
- [ ] Replaced windows with double glazing
- [ ] Fixed up window gaps with putty seals
- [ ] Replaced current lighting with energy efficient lighting
- [ ] Replaced old appliances with energy efficient ones
- [ ] Installed external vent for drier
- [ ] Installed hot water heat pump
- [ ] Installed timers e.g. on towel rails
- [ ] Installed ground vapor barrier/damp proofing
- [ ] Other

Since your home energy assessment, does your household take these actions more or less often than before the assessment?

(Not all members of the household will act in the same way, give an estimate for the overall changes in your household)

	A lot less often	Less Often	About the same as before	More often	A lot more often
Turn off lights when leaving the room	○	○	○	○	○
Wait until the dishwasher or washing machine is full before running	○	○	○	○	○
Turn off appliances at the wall when not in use	○	○	○	○	○
Dry washing outdoors whenever possible	○	○	○	○	○
Ventilate the home naturally (i.e. by opening the windows)	○	○	○	○	○
Wash clothes at lower temperatures	○	○	○	○	○

Has participation in the Home Energy Saver Programme prompted any changes (other than the ones listed above) in your household behaviour?

- Yes
- No
- Unsure

Please indicate what these other changes in your household behaviour have been.

Altogether, how much money did you spend implementing changes as a result of the assessment? (Excluding any subsidies)

- None
- Below $100
- $101 - $250
- $251 - $500
- $501 - $1000
- $1001 - $2000
- $2001 - $3000
- $3001 - $4000
- Over $4000

Have you made any other significant energy efficiency changes to your property in the last 2 years which are not directly due to the Home Energy Saver Programme?

- Yes
- No

Please specify what these changes were.

To what extent do you agree with the following statements about the Home Energy Saver Programme?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I found the information provided easy to understand	○	○	○	○	○
I found the information provided a clear direction to move forward	○	○	○	○	○
I feel that the advice given was impartial	○	○	○	○	○
I feel more knowledgeable and confident on how to reduce energy use at home	○	○	○	○	○
I found it useful that the assessor could arrange the installation services	○	○	○	○	○
I would recommend the assessment to friends	○	○	○	○	○
The assessment resulted in a change of behaviours in my home	○	○	○	○	○
My home is warmer as a result of the assessment	○	○	○	○	○
My energy bills are cheaper following the changes made from the assessment	○	○	○	○	○
The assessment highlighted some safety issues in my home	○	○	○	○	○
The assessment changed the way my household consumes water	○	○	○	○	○
I am getting better value for money on my energy bills following the home energy assessment	○	○	○	○	○

Do you have any further feedback or comments on the Home Energy Saver Programme?