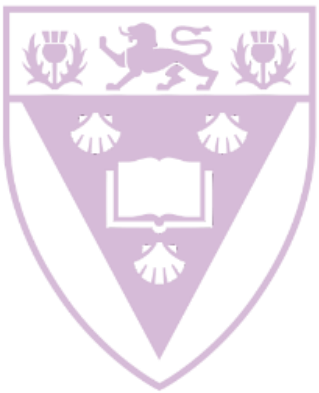

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INVESTIGATING HOUSEHOLD ENERGY CONSERVATION BEHAVIOURS IN JOHANNESBURG, SOUTH AFRICA

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Abstract

Behavioural change is increasingly anticipated as an important pathway towards the reduction of the human footprint on the environment. Monitoring resource consumption at the household scale is essential as a basis for evaluating current performance and supports the understanding of how behaviour change interventions can be implemented. Yet, there are comparatively fewer studies on pro-environmental behaviour (PEB) in developing country contexts than in developed countries. Further, where research efforts have been made in developing countries, these have mainly focussed on low-income households. This means the extant literature on PEB is limited across a geographic and economic gradient, making generalisations about PEB problematic and limiting the scope for thinking about interventions for promoting pro-environmental behaviour in developing countries. In response to this, the study focuses on high-income households in Johannesburg, South Africa. Overall, the findings show a high level of heterogeneity in reported pro-environmental energy use behaviour, attributed to a suit of socio-demographic and value factors. Mainly, age, number of dependents, household size. Valuing leisure time were negatively correlated to energy use behaviours, while valuing environmental quality positively correlated to energy use behaviours. The provision of information energy-saving interventions yielded positive behavioural change as shown by reduced energy consumption of up to 12% in the Treatment group. However, no significant correlations were found between energy reduction and socio-demographic and personal value factors, which can be attributed to a different cultural context. The study discusses the implications of the findings on debates around pro-environmental behaviour and factors influencing pro-environmental behaviour, and provides further recommendations for future energy policies related to the household sector.

Keywords: Pro-environmental behaviour, energy consumption, households, personal values, interventions, sustainability

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Table of Contents

LIST OF ANNEXURES

CHAPTER 1: BACKGROUND TO THE STUDY

1.1 Introduction

The unsustainable use of fossil fuels and their impact on the environment have brought about a crucial need to examine pathways towards energy sustainability (UNCSD, 2001; Carlson and van Staden, 2006; Shafiee and Topal, 2009; UNEP, 2009; Steffen et al. 2015). In particular, empirical evidence on the contribution of fossil fuel use to global warming makes the stakes on encouraging sustainable energy consumption higher than before (Kua and Wong, 2012; Liu and Quek, 2013; Cooke et al. 2016). Such a focus is relevant in countries with energy-intensive economies that rely on low-cost coal to power energy-hungry sectors such as South Africa (Douglas and Schaffler, 2006). Globally, major energy consumers include industries, commercial enterprises and households. Households, in particular contribute to greenhouse gas emissions through unsustainable energy use behaviours related to gas and electricity consumption, and the use of energy-intensive products and services (Abrahamse et al. 2007). For example, in the US households alone are responsible for about 21% of greenhouse gas emissions (Abrahamse et al. 2007). Households in South Africa consume a substantial proportion of energy, up to 20% of total national energy demands (Steg, 2008; He and Kua, 2013; Thondhlana and Kua, 2016). Beyond technical factors, high consumption of energy at the household level is rooted in human behaviour (Abrahamse et al. 2007; Steg and Vlek, 2009; Kua and Wong, 2012). Thus, a wide array of changes in household energy use behaviour is a pre-requisite for realising pathways towards sustainable energy use (Steg et al. 2015).

Relative to the developed world, there are limited knowledge levels in developing countries on (1) the energy use behaviours within households, (2) factors that influence electricity use behaviour, and (3) the potential for interventions to encourage efficient energy use (Thondhlana and Kua, 2016). Consequently, there are limited investments in promoting pro-environmental energy use at the household level in developing countries (Rice, 2006; Troschinetz and Mihelcic, 2009; Thondhlana and Kua, 2016). Yet, promoting household energy consumption in households can be an important component of national energy conservation strategies (Davis and Ward, 1995; Davis and Durbach, 2010; Thondhlana and Kua, 2016). From both an environmental and economic standpoint, promoting energy use efficiency can be a lever through which the dual goals of energy consumption and affordability can be reduced and ensured respectively (Abrahamse et al. 2005; Laubinger, 2015).

Understanding and promoting sustainable and efficient household energy consumption can be greatly enhanced through knowledge of factors which contribute to pro-environmental behaviour (PEB) (Poortinga et al. 2004; Anderson et al. 2013). Pro-environmental behaviour is "behaviour that consciously seeks to minimise the negative impact of one's actions on the natural and built world" (Kollmuss and Agyeman, 2002: 240). Factors that have been shown to influence PEB are personal values (Stern, 2000; Clark et al. 2003; Poortinga et al. 2004) and situational factors (Barr, 2007; Harland et al. 2007; Steg et al. 2014). The personal values of an individual such as comfort, status and effort may result in various attitudes and behavioural choices which can further assist in understanding the possibility of an individual being willing to participate in PEB (Kua and Ashford, 2004). Situational factors specify a personal situation and then reflect on the various contexts in which a person resides and makes decisions (Plonsey and Barr, 2007; Thondhlana and Kua, 2016). There is a wide range of situational factors which include socio-demographics such as gender, education level, income level, age and general awareness about environmental consequences of given actions (Gifford and Nilsson, 2014; Thondhlana and Kua, 2016). Household awareness of energy problems and knowledge of how to reduce these problems have been shown to be combated through the provision of information (Geller, 1981; Purcell and Magette, 2010; Kua and Wong, 2012; He and Kua, 2013). Therefore, a better understanding of personal values and situational factors is crucial if intervention strategies aimed at generating PEB are to be tailored to suit local contexts (Kua and Wong, 2012; Frederiks et al. 2015).

1.2 The South African Energy Context

In South Africa, nearly 90% of households are connected to the electricity grid and because of this, the country is said to have one of the highest percentages of household with access to electricity in Africa (Department of Energy, 2016). Against a history of unequal access to services based on race (Department of Energy, 2016), the first democratically elected government embarked on a socioeconomic restructuring programme, including addressing unequal access to electricity (Department of Energy, 2016). The National Electricity Forum of 1991-1993 gave special attention towards combatting inequalities in access to electricity services for households (Ziramba, 2008). It was during this time that Eskom (the South African public utility responsible for generating and distributing energy) embarked on a rapid electrification programme where between 1994 and 1999 about 2.8 million households were connected to the national grid (Ziramba, 2008). Among household energy users, high-income

households have been proven to be high energy consumers (Fritzsche, 1981; Huang, 2015; Poruschi and Ambrey, 2016), especially when compared to lower income households.

Despite significant strides in providing electricity 'to all', the country's dependence on cheap coal-fired electricity is no longer sustainable (Sebitosi and Pillay, 2008; Baker et al. 2014). With an energy-intensive economy, South Africa is one of the primary producers of greenhouse gases and is included in the top 20 global carbon dioxide emitters (Department of National Treasury, 2010; Thondhlana and Kua, 2016). Regardless of the fact that electricity consumption over the past twenty years has been slower than was predicted in the late 1970s, the increased economic growth and improved supply of electricity to households, has actually generated substantial increases in electricity demand (Douglas and Schaffler, 2006; Winkler and Marquand, 2012). Approximately 66% of Africa's electricity is produced by South Africa, adding to this the country is one of the most inexpensive electricity manufacturers in the world (Department of Energy, 2016). Until the energy supply crises in 2008, the country had the cheapest electricity prices in the world at an average of ZAR 0.25 (US$ 0.021 as of April 2018 exchange rate) per kWh (Edkins et al. 2010). However, since 2008 these prices have been steadily increasing, which has rendered parts of the population incapable of utilising their connection to the electricity grid even though they technically have access. In 2009, a ZAR 0.02 (US$ 0.0017) kWh levy in South African Rands was introduced on electricity generated from non-renewable sources (Edkins et al. 2010). This levy has continuously gained an approved year on year increase of approximately 25% over three years between 2010 and 2013 (Baker, 2011). Although imposing a levy on non-renewable resources could be a positive step towards discouraging increased carbon emissions, alternative renewable energy sources are not heavily supported in South Africa even though the theoretical potential for renewable energy is enormous (Winkler, 2005). A combination of cheap electricity generated from locally available coal and the scarce supply of energy from non-renewable resources in South Africa may lead to higher electricity consumption. In this case, there would be a lacking incentive for people to engage in energy conservation because the monetary value or benefit for doing so is negligible (Bradley et al. 2016; Mizobuchi and Takeuchi, 2013; Faruqui et al. 2010). Consequently, this can inadvertently promote negative and high-consuming behaviours. In the Netherlands, it was found that when energy consumption was considered 'free' households appear less conscious or concerned with how much energy they consume (Beunder and Groot, 2015: 141), thereby revealing that perhaps households are less conscious of their energy consumption when there is little financial reward to conserve or reduce energy consumption.

In addition, Musango (2014) found that for households in Gauteng, South Africa, an increase in income will not necessarily result in those households transferring to renewable energy sources Thus, households' motivations for consuming or conserving energy need to be properly understood.

Therefore, in light of increased carbon emissions, expensive investments in non-renewable energy and their unreliable uptake, and heavy consumption levels perpetuated by cheap energy sources of coal, promoting energy conservation is gaining traction as a pathway towards sustainable energy use in households, in both the short and the long-term (Thondhlana and Kua, 2016). Although in South Africa the unit price of electricity may still be considered low relative to other countries in the region, the overall cost per unit to many households is high because of the energy-intensive nature of their appliances and larger size of the high-income household (Department of Minerals and Energy, 2005). Therefore, energy efficiency in the residential sector makes sound environmental and economic sense. Education and awareness programs have been stated as the first steps towards energy efficiency practices and overcoming the barriers associated with such practices (Department of Minerals and Energy, 2005).

A 2012 survey on energy-related behaviour and perceptions in the residential sector, however found that awareness of energy conservation did not always result in the same measured performance of energy conservation (Statistics South Africa, 2013). For example, there was a 75% reported awareness that switching off lights when leaving the house saves household energy, but only 50% often did this (Statistics South Africa, 2013). This revealed that even though households may be aware of energy conservation interventions, households may not always engage in energy-saving practices. In a report by the Department of Minerals and Energy (2005), various barriers that prevented engagement in energy-saving practices were identified. The first barrier identified was the unit cost of electricity in South Africa, which was still considered low compared to global standards. Therefore, reducing electricity consumption may not always be seen as a priority because the difference in monthly energy bills would not be that noticeable or beneficial, especially for high-income households. A lack of knowledge and understanding of energy efficiency was also identified as a barrier. Institutional barriers and resistance to change were further said to inhibit energy-saving. There was also a misconception that energy efficiency will disrupt processes in industries and household activities (Department of Minerals and Energy, 2005). This potential disruption of existing

habits and patterns of living would include issues related to perceived fixed forms of home-based electricity using practices such as cooking, watching TV or having access to hot water (Torriti, 2012). Adjusting or changing particular energy-using practices can be perceived or experienced as being uncomfortable, inconvenient and causing disruption (Shove, 2003). However, the nature of this research uses non-investment information provision measures aimed at being convenient, easy to implement and cost effective.

Going forward, the debate about the possibilities of promoting sustainable energy use at the household level is generally undermined by lack of detailed and systematic information on the reported energy use behaviour and effect of energy-saving interventions. There is a shortage of literature with a focus on household energy consumption in the context of developing nations such as South Africa (Davis and Durbach, 2010; Thondhlana and Kua, 2016).

1.3 Research Questions

In light of this, this study seeks to explore energy use practices and the effectiveness of and potential for intervention measures aimed at promoting household energy conservation in Johannesburg, South Africa. Key questions include:

1. What are the reported energy use behaviours of households?
2. What factors influence energy use behaviours in households?
3. What are the effects of different intervention strategies on reported household energy use behaviour and actual reductions in energy consumption?
4. What factors influence actual reductions in energy consumption?
5. Based on the findings, what are the implications for future integrated energy policy directions in South Africa and beyond?

1.4 Research Objectives

In light of the above mentioned research questions, the objectives of the study are to:

a) Investigate energy consumptive behaviours and actual energy consumption in high-income households. This objective relates to research questions 1 and 2 and forms Chapter 2 of the thesis.

b) To examine the effectiveness of interventions in promoting pro-environmental energy-use behaviour and energy savings within households. This objective relates to research questions 3 and 4 and forms Chapter 3 of the thesis.
c) Synthesise and discuss the implications of the findings on policies aimed at promoting pro-environmental energy use at the household level. This objective relates to research question 5 and is covered in Chapter 4.

By examining energy use behaviours at the household level, behaviours that need to be changed via interventions can be identified, and the effectiveness of interventions can be tested which may result in energy being used more efficiently in households and the subsequent reduction of households' impact on the environment (Becker, 1987; McCalley and Midden, 2002; Abrahamse et al. 2005, 2007; Kua and Wong, 2012; He and Kua, 2013; Steg et al. 2015; Thondhlana and Kua, 2016). It should be noted that 'energy use' or 'energy consumption' refers to the electricity consumption. Therefore, this study focuses purely on the electricity consumed in each household and does not include other types of energy uses such as transportation fuel and natural gas used for heating.

1.5 Thesis Structure

The rest of the thesis is based on and presented in two different results chapters, formatted as individual journal articles and a synthesis chapter. Owing to the nature of the thesis structure, some of the content could be repetition of what has been discussed in the individual manuscripts. In all the chapters, I had the responsibility for study design, field work, data collection and analysis, and writing while my supervisor provided constructive feedback and suggestions. Chapter 1 provides relevant background to the study, broader research goals and a brief outline of the thesis. Chapter 2 looks at reported energy use behaviour and the factors shaping this behaviour. Chapter 3 examines the effectiveness of intervention strategies employed to promote pro-environmental energy use in households. In Chapter 4 the overall results are synthesised, as a basis for providing general conclusions and recommendations for future research and household energy policies and intervention strategies.

CHAPTER 2: ANALYSIS OF REPORTED HOUSEHOLD ENERGY USE BEHAVIOUR IN EDENVALE, JOHANNESBURG, SOUTH AFRICA

2.1 Introduction

Globally, there is agreement that most of the 'wicked' environmental problems are a result of anthropogenic causes including human resource consumption behaviour (Lazarus, 2008; Balint et al. 2011; Levin et al. 2012). The environmental challenges and economic costs associated with energy consumption at the household level are well documented (Heslop et al. 1981; OECD, 2001; Steg, 2008; Swan and Urgursal, 2009; Taherian et al. 2010; Wang et al. 2011; Huang, 2015; Nakamura, 2016). The environmental impact of household consumption has been discussed since 1982 where growing impacts were attributed to changes in societal consumptive styles (Uusitalo, 1982; Reid et al. 2010). It is predicted that these impacts will increase alongside the rising number of households and the added purchasing of furniture, electronic goods and fuel consumption (Caird and Roy, 2006; Reid et al. 2010). Given this context, understanding reported behaviour of households is considered a useful tool in ensuring that "the family home as the locus of consumption [does not] fair to cause the ultimate disruption, destruction of the earth as the home of humanity" (Taylor, 1999: 23).

Interventions aimed at the long-term implementation of pro-environmental behaviour (PEB) need to reduce their chances of failure. In order to do so the facilitators, conditions, and barriers to PEB need to be considered (Gaspar, 2013). This is of importance owing to majority of environmental education, behaviour modification projects and models continue to be predisposed to a misjudgement (Stern, 2000; Gaspar et al. 2010; Gaspar, 2013) that assumes that if people hold correct attitudes, intentions, skills, information, etc. the correct PEB should continue (Gaspar et al. 2010). Unfortunately, the social science literature reflects a discrepancy between attitudes and behaviours and that the difficulty in changing behaviours is underestimated (Schultz, 2011; Gaspar, 2013). Settings and factors outside the individual are said to have far more influence on what people do than the drivers of attitudes such as beliefs, knowledge, or emotion (Herberlein, 2012). This could explain why the reported level of concern for environmental issues does not always translate to environmental protection or conservation behaviour (Axelrod and Lehman, 1993; Kollmuss and Agyeman, 2002;

Whitmarsh, 2009; Herberlein, 2012). Therefore, attitude is often a required, but insufficient condition for behaviour (Herberlein, 2012).

Although the practical value of understanding PEB is not argued against, the methods in which these behaviours are administered and critically evaluated have differentiated substantially (Larson et al. 2015). Studies focused on PEB are often constrained because they fail to recognise the perceptions and perspectives of the individuals who engage in conservation-orientated behaviour, which has caused a need for research to identify types of PEBs that are validated by study participants i.e. members of the general population (Larson et al. 2015). Therefore, confirming or elaborating on, the types of PEBs, perceptions and perspectives present in individuals who choose to take part in pro-environmental energy conservation behaviour can enhance and contribute to studies aimed at understanding PEB.

The household provides appropriate attention for PEB research because it is a unit supervised or controlled by the owner (Dumreicher and Kolb, 2008). By recognising households at the meso level[1], one recognises the role of households interacting between macro and micro levels, and therefore understanding those interactions can also aid the understanding of PEB (Reid et al. 2010). Thus, when central focus is given to households it allows research to admit how important large-scale social processes are, and the negotiation that takes place within a social unit (Krantz, 2005) which structure micro level activities.

When looking specifically at energy consumption, however there is a need for understanding reported behaviour in order to ensure that policies aimed at conserving energy address specific behaviours. In response to this, there is a growing trend toward the promotion of pro-environmental energy use behaviour in households, for economic and environmental reasons (Kollmuss and Agyeman, 2002; Hubacek et al. 2007; Steg and Vlek, 2009; Sanquist et al. 2012; Kua and Wong, 2012; Frederiks et al. 2015; Steg et al. 2015; Thondhlana and Kua, 2016). Consequently, analysis of energy consumption behaviours at the household is increasingly being considered as the first step towards developing pathways for promoting pro-environmental behaviour. Analysing why some households consume more or less electricity is

[1]Micro level behaviour is considered individual behaviour while macro level behaviour is considered on a larger scale such as a whole population group i.e. a provincial area. Households can be considered at the meso level because they fall somewhere in between. Households are part of a household social group and are typically made up of more than one member and as a result, are not solely analysed as an individual or a large population group.

necessary because an individual's needs and activities within a household influence electricity use and consumption. Crabb (1992: 816) states that "people do not use energy, they use devices and products". Therefore, how people use electricity consumptive appliances in their households due to their needs and activities, is an important research enquiry since this can affect their level of energy consumption (Steg et al. 2015).

However, studies conducting research on determinants of consumer's environmental behaviour are predominantly conducted in Western countries (Morren and Grinstein, 2016; Thondhlana and Kua, 2016) hence comparatively the literature on energy use behaviour is rare and limited in developing countries. Previous policies using various types of intervention strategies cannot be applied universally and across all different types of households and contexts. In other words, the dearth of knowledge from the developing world limits the generalisability of the findings and their ability to test various relationships across a larger set of country and national culture characteristics (Morren and Grinstein, 2016). Therefore, there has been a call for research in non-Western settings which are considered rare (Cho et al. 2013). One major point of debate and research enquiry in the energy use behaviour literature in general, is around what factors affect pro-environmental behaviour (PEB) and how PEB can be encouraged (Blok et al. 2015).

2.2 Theoretical Framework

Theoretical approaches to decision making around promoting sustainable energy use at the household level have two core roles. First, they assist in clarifying behaviour and identifying the chief behavioural drivers to understand why some people act pro-environmentally and others do not, which provides the basis for interventions to target (Wilson and Dowlatabadi, 2007; Steg and Vlek, 2009; Turaga and Howarth, 2010; Frederiks et al. 2015). Second, they offer a framework for empirical research on the effect of these interventions (Wilson and Dowlatabadi, 2007). Over the last few decades, theories aimed at understanding PEB at the household level have been developed from various perspectives including psychological (Stern, 2000; Abrahamse and Steg, 2009), sociological (Schwartz, 1977; Hargreaves, 2011) and behavioural economics standpoints (Brown and Hagen, 2010). Due to varied backgrounds, these theorists attempt to explain the factors that influence behaviour from different positions. For instance, behavioural economics attribute human behaviour to external factors like income, the effect of price and other socioeconomic characteristics (Brekke and Johansson-Stenman, 2008; Brown and Hagen, 2010; Wilkinson and Klaes, 2017), while behavioural psychologists

identify internal or psychological factors like norms, values, beliefs and attitudes to explain human behaviour (Stern, 2000; Poortinga et al. 2004; Abrahamse and Steg, 2009; Gifford and Nilsson, 2014). Adding to this are demographic factors which focus on the socioeconomic characteristics of a given population such as age, sex, education level, income etc., and external factors which relate to aspects outside of the individuals control such availability of infrastructure, leadership support etc. (Blok et al. 2015).

In this way, PEB and its theories can be viewed as a mixture of self-interest and concern for others (Bamberg and Moser, 2007). For example, rational choice theories are based on a rational decision-making framework (Turuga et al. 2010) where "human behaviour is a continual process of making deliberate choices between distinct courses of action" (McDonald, 2014: 278). Here, pros and cons are weighed against each other with a result of an individual pursuing a choice which has the overall highest benefit and least cost (Jackson, 2005). Unlike rational choice models, moral theories explain environmental values to be the primary drivers of PEB and hold that altruistic (concern for things other than the self) and moral reasons determine PEB (Schwartz, 1977; McDonald, 2014). The largest number of studies concentrate directly on the individual as the particular area of study for behaviour (Lucas et al. 2008). This is most likely because behaviour is conceptualised as an outcome of opposing influences which are adjusted and decided upon by the individual (Heimlich and Ardoin, 2008).

Following a systematic review of PEB literature, Kollmuss and Agyeman (2002) provide a thorough assessment of various PEB models as a basis for explaining why people act or do not act pro-environmentally. Their review and other more recent studies (e.g. Clark et al. 2003; Steg and Vlek, 2009; Klockner, 2013; Gifford and Nilsson, 2014; Coelho et al. 2017; Bulunga and Thondhlana, 2018) highlight a complex interplay of factors affecting PEB but generally categorise these factors into 3 main groups namely, demographic, internal and external factors. Theories on individual behaviour highlight the internal factors of an individual which produce PEB and have sprung from the field of Social Psychology (McDonald, 2014). These internal factors are categorised into moral theories, rational choice theories and non-rational choice theories. Hence, the individual decision-making models differ noticeably. There are models founded on informed rationality or psychological variables, however there are different models that assess individual and social scales and as a result emphasise physical or contextual factors (Wilson and Dowlatabadi, 2007). This means that there are overlaps between theories aimed at understanding human behaviour, and these theories are as complex as the behaviour they try

to explain. Therefore, there is value in understanding and integrating personal and contextual factors when studying individual behaviour to foster pro-environmental action. This study considers socio-demographics, personal (internal) and contextual (external) factors, as they are all envisaged to influence PEB at the household level, and it is hoped a deeper understanding of these might help provide certain lessons for designing interventions to promote PEB in households. In this study, the point of departure in examining the factors that influence PEB at the household level is the Value-Belief-Norm (VBN) theory.

2.2.1 The Value-Belief-Norm Theory

The VBN theory (Figure 2.1) is now considered one of the most comprehensive moral theories explaining PEB (Stern, 2000; McDonald, 2014). The VBN theory holds that motivation to behave in an environmentally relevant way is often defined in terms of beliefs, attitudes, intention and social norms (Stern, 2000).

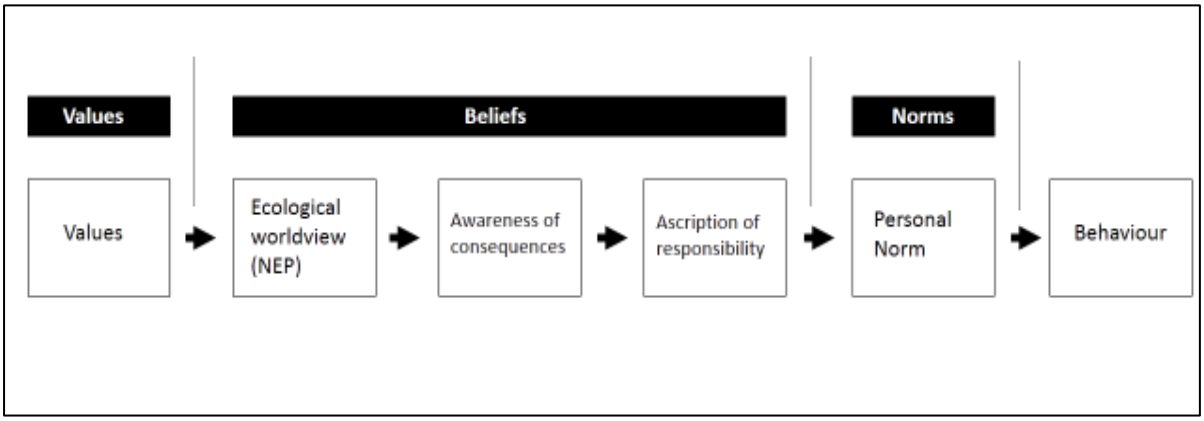

Figure 2.1: *Overview of the Value-Belief-Norm Theory (Stern, 2000).*

Over the years a growing body of research has attempted to understand what antecedents affect PEB. One of the many factors theorised to promulgate such behaviours are values. According to Poortinga et al. (2004) values can be understood as key life goals or standards that act as guiding principles that describe worldviews. Kollmuss and Agyeman, (2002) state that values are responsible for shaping much of our intrinsic motivation. It has been shown that interventions aimed at promoting pro-environmental behaviours are often unsuccessful because they do not include the significance of values and the connection concerning behaviour (e.g. reducing electricity consumption) and value fulfilment (Smallbone, 2005; Oreg and Katz-Gerro, 2006).

In greater detail, the VBN theory links value theory (understanding how, why, and to what degree people value things), beliefs, and norms (Figure 2.1) through an underlying chain of five variables which bring about behaviour. These variables are personal values (especially altruistic values), people's ecological worldview, awareness of adverse consequences for valued objects, and perceived capacity to diminish threat beliefs concerning broad circumstances in the biophysical environment and personal norms for PEB (Stern, 2000). According to Stern (2000), each variable in the chain directly affects the ensuing variable and could further affect variables further down the chain directly. Therefore, in the VBN theory different values impact a person's beliefs, which subsequently creates personal and social norms.

2.2.1.1 Personal Values

According to the VBN theory, the first set of internal factors that affect PEB relate to personal values, worldviews and attitudes (Dunlap et al. 2000; Stern, 2000; Poortinga et al. 2004). Values form the foundation of attitudes and function as guidelines for behaviour based on people considering repercussions of behavioural choices for what they may value (Poortinga et al. 2004). Stern et al. (1995) developed a hierarchical framework to study the relationship between values and environmental behaviour. A hierarchical model typically displays aspects on an upper level that are projected to directly affect aspects on the lesser level. Therefore, higher level factors may lead to direct effects on those lower in the hierarchy (Nordlund and Garvill, 2002). Stern et al.'s (1995) framework argue that values and worldviews act as filters for new information so that corresponding attitudes and beliefs (i.e. concern about specific environmental problems or attitudes toward certain behaviours) have a more probable chance of occurring. Oreg and Katz-Gerro (2006) found post-materialistic values, except for harmony, influence one's concern for the environment; likewise, environmental concern, perceived threat, and perceived behavioural control determine one's readiness to sacrifice, which in turn impacts on a wide range of pro-environmental behaviours. De Groot and Steg (2008) found those who held egoistic values explained attitudes concerning recycling behaviour, and the intention to donate to humanitarian organisations when compared to environmental organisations was related to altruistic and biospheric values. De Groot and Steg (2008) concluded that individuals who classified themselves as altruistic had more supportive

inclinations to donate to humanitarian organisations, whereas those who classified themselves as biospheric tended to donate towards environmental organisations.

Poortinga et al. (2004) list 22 Quality of Life (QoL) value factors that shape human behaviour. These individual factors relate to values of: aesthetic beauty, challenge and excitement, changes in daily life, comfort level, education, environmental quality, freedom, health, self-identity, leisure time, material beauty, money, nature and biodiversity, partner and family, privacy, safety, security, social justice, social relations, spirituality and religion, social status and work. Briefly, an individual's relation to these values is said to predict their intention to behave pro-environmentally. This representation of a "value scale" has been used to explain general environmental concern and more specific environmental attitudes and beliefs. The QoL value factors relate to Schwartz's (1994) integration of several universal values into four larger groups: 1) openness to change, 2) conservatism (traditionalism), 3) self-transcendence or altruism (measured by statements about social justice, equality and peace) and 4) self-enhancement (self-interest). The groups can be adjusted so that human values are structured in two motivational dimensions: Openness to Change versus Conservation and Self-Enhancement versus Self-Transcendence (Gifford and Nilsson, 2014). Schultz and Zelezny (1999) found self-transcendent values, chiefly universalism to be the core values linked to the New Environmental Paradigm (NEP) (positive) and ecocentrism (positive); and the self-enhancement value of power was negatively related to NEP and ecocentrism, and positively related to anthropocentrism. De Groot and Steg (2010) also found values to be significantly predictive of pro-environmental intentions. The more altruistically and biospherically oriented a person is, the more likely they are to act pro-environmentally, and when people endorse egoistic values, the less likely they are to act pro-environmentally (De Groot and Steg, 2010). Schultz et al. (2005) found in their examination concerning links between values and environmental behaviour, data showing norm activation solely for self-transcendence, while self-enhancement values reflected a frequently inverse connection towards environmental behaviour.

From Schwartz's model, research shows that values relating to self-transcendence (altruistic) and openness to change are generally strong predictors of PEB (Stern et al. 1999; Blok et al. 2015). This was confirmed by Joireman et al. (2001) who found that people displaying altruistic values such as being pro-social, expressed stronger pro-environmental intentions and a stronger belief in the social consequences of environmental conditions. Klockner (2013) also found that

people who embraced self-transcendent values felt morally obligated to behave pro-environmentally. In particular, certain groups of self-transcendence like environmental values – (measured by statements about environmental protection, environmental quality, harmony with nature and respect for the earth) are known to have a positive relationship with PEB. For example, Frederiks et al. (2015) found that people driven by certain goals such as self-transcendence or gain frames and motives were usually inclined toward energy-saving behaviour. In contrast, values related to self-enhancement and conservatism have been found to be negative predictors of PEB (Frederiks et al. 2015). Similarly, Clark et al. (2003) found that pro-environmental values were necessary pre-conditions for promoting PEB. De Groot and Steg (2008) also found promoting altruistic beliefs to be central to promoting larger scale PEBs. Based on the preceding review of the literature, it is expected that people's personal values will have an influence on PEB at the household level in the following ways: values related to openness to change and self-transcendence are positively related to pro-environmental energy use behaviour while values related to conservatism and self-enhancement are negatively related to pro-environmental energy use behaviour in the household. Thus, a thorough analysis of personal factors may be useful in our understanding of energy use behaviours at the household level.

2.2.1.2 Beliefs

According to the VBN theory, the second set of internal factors that affect PEB relates to people's level of environmental awareness and belief that they can control the situation. These are often referred to as cognitive factors (Blok et al. 2015). Environmental awareness refers to the level of knowledge related to environmental aspects and appreciation of environmental problems. There is growing empirical evidence in the literature of the positive relationship between high levels of environmental awareness and PEB (Anderson et al. 2013; Thondhlana and Kua, 2016). For example, a person may have a more in-depth knowledge or skills relating to environmental issues and therefore could feel more strongly towards environmental protection. Schwartz (2012) found that people with high levels of awareness about the negative consequences of unsustainable behaviour exhibited pro-environmental behaviour. Similarly, other studies have shown that high level of environmental awareness created by educational programmes and awareness campaigns promotes pro-environmental behaviour in food waste reduction (Whitehair et al. 2013), waste separation (Saladié and Santos-Lacueva, 2016) and energy-saving (Kua and Wong, 2012; Thondhlana and Kua, 2016). It has also been found that

the intention to act pro-environmentally is shaped by perceived behaviour control – i.e. how an individual perceives their ability to produce change through their own behaviour (Kollmuss and Agyeman, 2002). People exhibiting a robust internal locus of control trust that their actions can bring about change whilst those with an external locus of control believe their actions are irrelevant and feel that change can only be produced by powerful others (Kollmuss and Agyeman, 2002). In household settings, it has been proven that one of the most important factors that shape PEB is the perceived impact of one's actions. For example, Kaiser and Gutscher (2003) found that perceived behaviour control was a strong predictor of ecological behaviour. Tonglet et al. (2004) found that previous recycling experience, and a concern for the community and the consequence of recycling to be significant predictors of recycling behaviour. Whitmarsh (2009) found those who hold climate change as a threat to the non-human world, and value it were more inclined to mitigate climate change. Based on the literature review, it is hypothesised that high environmental awareness will have a positive relation to pro-environmental energy use behaviour at the household level.

2.2.1.3 Norms

Personal and social norms define individuals' expectations about their behaviour in a given social setting (Schwartz, 1977). Depending on what these norms are, they translate into various types of behaviours, pro-environmental or not. However, attitudes have been shown to be prerequisites to norms. Therefore, a person's attitude towards the environment or environmental problems can influence their 'norm' to the same thing. Clark et al. (2003) found that after controlling for altruistic attitudes, environmental attitudes independently influence the decision to participate in a green electricity programme, and vice versa. Therefore, participants that have positive pro-environmental values were more likely to participate in the green electricity programme. Interestingly**,** Gronhoj and Thorgersen (2012) found that the attitudes of parents in households toward PEB in the household significantly impact the attitudes of the children within that household. Households that had parents with more positive environmental attitudes and behaviours, also "passed down" these attitudes to their children and thus produced more PEBs within the household. This shows how significant determinants of behaviour such as attitudes and norms are in producing and sustaining long-term pro-environmental behaviour.

2.2.1.4 External Factors Influencing Pro-Environmental Behaviour

Internal factors (e.g. environmental awareness, attitudes, beliefs, values) alone do not explain PEB but aspects beyond the control of individuals may constrain PEB (Heberlein, 2012; Mtutu and Thondhlana, 2016). Drawing on the VBN theory, "the more difficult, time-consuming, or expensive the behaviour - the weaker its dependence on attitudinal factors" (Stern, 2000: 416). Actions that are easy to do promote PEB while actions that are difficult to do because of the situational settings constrain PEB. For example, if a light switch is located in a position that is difficult to reach or if recycling bins are located further away, people may not act pro-environmentally (switch off lights or recycle respectively) despite their intentions to do so (Mtutu and Thondhlana, 2016). Thus, contextual factors could influence habit or routine if PEB is seen as effortless.

A survey of South African attitudes towards the environment found varied perceptions regarding the importance of environmental issues in different locations (Struwig, 2010). The study proposes environmental attitudes and the status of environmental protection to be moulded by various factors such as social and physical location which causes environmental attitudes to be rooted within a socioeconomic and political culture (Struwig, 2010). It was found that environmental perceptions vary depending on race, geographic location, locus of control and other aspects (Struwig, 2010). For example, White people displayed a higher index of environmental concern than Black people, and those with higher incomes also tended to have greater concern for the environment (Struwig, 2010). In this survey income levels and race in South Africa were found to have correlations due to the historical injustice and discrimination implemented during the apartheid era, which clearly has still left great discrepancies in socioeconomic statuses. However, in contrast, Dunlap and Mertig (1995) found that residents of poorer nations tended to see environmental problems as most serious and were more supportive of efforts to improve environmental problems.

Interestingly, Danielson et al. (1995) found the location and rural-urban character of the household might influence environmental perceptions. However, the connection is unclear and complex. On the one hand, small towns are typically less developed which may lead to higher environmental dependency and therefore positive environmental values (Struwig, 2010). For example, a farming community that is highly dependent on water supply may be more conscious about not wasting water. Although, medium-sized and big cities are further involved when it comes to applying environmental policies (Struwig, 2010). People and households

living in urban areas may also be more conscious of conserving electricity due to consistent load shedding, while other households in more rural areas may make more use of alternative energy sources like paraffin and candles for financial reasons than electricity. This provides some insight into the influence of externals factors i.e. location, and its effect on PEB. For example, how a community uses various resources such as water and electricity, and their access to these resources can shape their attitudes to the environment, and consequently their pro-environmental behaviours.

With regards to age, Kanagy et al. (1994) found younger age groups to be more pro-environmental and suggested that on average, concern for the environment has grown as younger generations replace older generations that seem less concerned with environmental issues. However, Mtutu and Thondhland (2016) found older, further educated individuals engaging more in PEB. In contrast, Todes et al. (2003) found those to be highly educated were not environmentally conscious owing to their belief that nature can recover on its own and the resourcefulness of humans will generate technologies and solutions capable of combating any potential problems. Such studies reflect the diversity of possible explanations as to why people do or do not develop pro-environmental attitudes and choose (or choose not) to behave pro-environmentally. This highlights the need to understand the determinants of pro-environmental behaviour in various settings in order to tailor interventions that will be more effective in specific contexts.

The combination of attitudinal factors, contextual factors, personal capabilities, and habit or routine (Stern, 2000) are the causal factors that determine the different types of environmentally relevant behaviour. Taken together, the VBN theory posits that PEB is caused by a combination of "particular personal values, beliefs that things important to those values are under threat, and beliefs that actions made by the individual can reduce the threat and restore the values" (Oreg and Katz-Gerri, 2006: 464). The different internal and external factors affecting PEB in the context of this study can be summarised as follows:

- Internal factors: personal values (22 QoL factors from Poortinga et al. 2004), perceived behavioural control, environmental awareness (information provision), self-reporting and monitoring.

- External factors: household size, household income, number of dependents, education level and location.

Within this context, the aim of this study was to examine the reported energy use behaviour of households in Edenvale, a suburb of Johannesburg, South Africa as the first step towards encouraging PEB with a focus on energy use. Specific questions included; (i) what are the reported energy use behaviours (ii) what are the links between reported energy use behaviour and internal (personal) and external (situational/contextual) factors, and (iii) what are the implications of the findings on assumptions underlying PEB and practical efforts for encouraging pro-environmental energy use behaviour in high-income households?

This study attempts to contribute to the extant literature on PEB, by providing an energy use perspective from well-off households in a developing country context, which comparatively is underrepresented in the literature. Its novelty lies in the fact that the study focuses solely on high-income households in Johannesburg which, to the best of our knowledge, has not been previously undertaken. Similar research conducted in South Africa has focused on low-income households (Thondhlana and Kua, 2016) or within a University context (Mtutu and Thondhlana, 2016; Bulunga and Thondhlana, 2018) all of which were conducted in the Eastern Cape of South Africa. It is also one of the few energy behaviour studies taken place within a developing context and therefore contributes to knowledge of behaviour theories concerning the influence of personal values and demographic factors within an African context. Such a study, therefore has the potential to contribute to the understanding of how and why pro-environmental energy use behaviour may be fostered within a different social context (i.e. high-income households within an African urbanised setting). Therefore assisting in illuminating the complex determinants of pro-environmental behaviour. At the local level, such an analysis can be useful for municipal managers in understanding which specific factors influence PEB and identifying which behaviour can be targeted for interventions.

2.3 Methodology

2.3.1 The Study Area and Participants

The study took place in Edenvale, a medium-sized suburban area located in Johannesburg, the commercial capital of South Africa.

The residents of this area fall within the Ekurhuleni Municipality which is known as the eastern area of Johannesburg. Considering that 99.4% of Ekurhuleni's population resides in urban

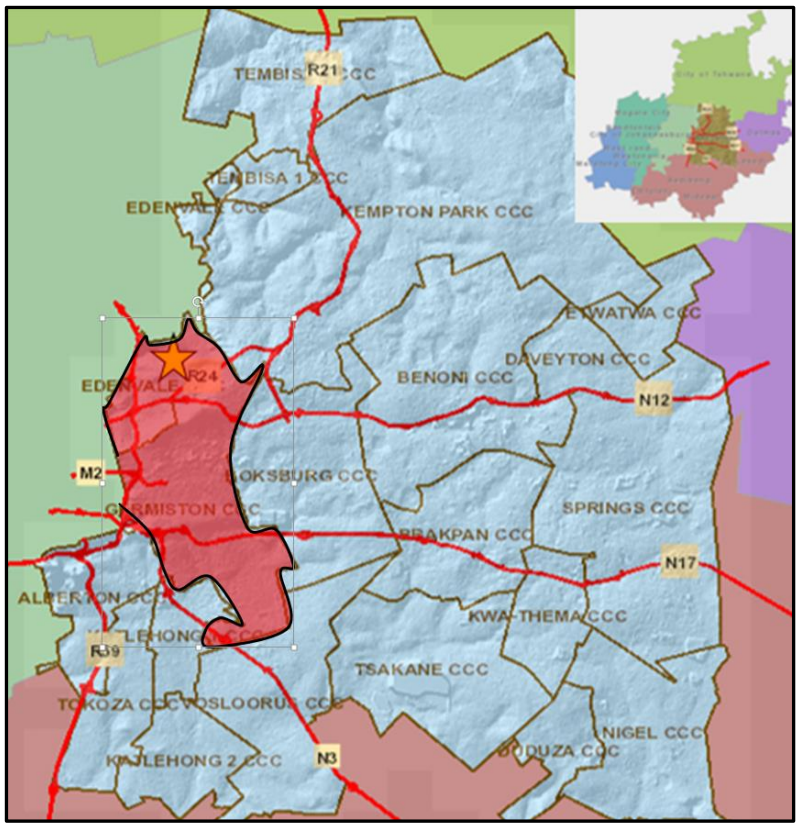

Figure 2.2: *Map depicting the study area of Johannesburg, South Africa (Source: http:// gis.ekurhuleni.gov.za/mapviewer/).*

settlements stretching from informal settlements to well-off urban residential suburbs, the area is categorised as highly urbanised (Statistics South Africa, 2017a). The unemployment rate within the municipality is 29% and those with higher education levels aged 20 and above are reported at 15%. Around 82% of the population is reported to have access to electricity (Statistics South Africa, 2017a). The study area is typically characterised by high-income households living in a closed-off boomed area called an extension. Out of all the residential extensions located in Edenvale, four extensions were selected for the study via a convenience sampling approach. A total of 120 households were invited to participate in the study but only 91 households responded positively. The study targeted household heads and in their absence, adult members of the household who had a good understanding of household dynamics. It should be noted that while the household was targeted as a unit, the household analysis is of a single user owing to the fact that it contributes to an arduous comparison due to household size varying across the households.

2.3.2 Data Collection

During the first month of data collection in January 2017, each household head completed a questionnaire. The questionnaires were completed once the households were approached and the purpose of the study explained to the participants. The researcher herself approached the households face-to-face. The participants who volunteered to partake in the study were then given a hard copy of the questionnaire (see Annexure 1) and a logbook to record monthly energy consumption (see Chapter 3 Section 3.3.2). All participants had the survey questions explained to them in detail by going through each of the questions to avoid confusion or errors. Depending on the respondent's preference, the surveys were either completed face-to-face by hand with the researcher or by themselves later that day and emailed through or collected by the researcher the following week.

The questionnaires focused on three main aspects concerning energy consumption within the household: socio-demographics, energy use behaviour and personal values. The first section of the questionnaire captured the socio-demographic information of the respondents and their respective households including age, gender, education level, monthly household income, household size and number of dependents. The second section of the questionnaire had a list of energy use actions related to the use of household electronic appliances such as fridges, washing machines, dishwashers, geysers, etc. (Annexure 1), and asked the respondents to indicate how often they engaged in a given PEB. The responses to these questions were recorded using a scale of 1-5 (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always). In this scale, any behaviour close to 1 was considered poor pro-environmental behaviour and 5 was considered good pro-environmental behaviour. The questions were developed based on the methodology applied by Staats et al. (1996) and Kua and Wong (2012).

The last section of the questionnaire was designed to gather information on the personal values of the respondents (Annexure 2). To assess whether various personal values can influence a household's decision to engage in pro-environmental behaviour (PEB), respondents were asked to indicate the level of importance given to a list of personal value factors based on the 22 Quality of life (QoL) factors following Poortinga et al. (2004). These factors relate to individuals' values on aesthetic beauty, challenge and excitement, changes in daily life, comfort level, education, environmental quality, freedom, health, self-identity, leisure time,

material beauty, money, nature and biodiversity, partner and family, privacy, safety, security, social justice, social relations, spirituality and religion, social status and work. These values broadly relate to openness to change, 2) conservatism (traditionalism), 3) self-transcendence (altruism) and 4) self-enhancement (self-interest) (Schwartz, 1994). The respondents indicated the importance placed on a set of personal values on a 5 point Likert Scale as follows; 1= Unimportant; 2 = Slightly important; 3 = Important, 4= Very important and 5 = Critical.

2.3.4 Data Analysis

Data was first captured in an excel spreadsheet and then coded and categorised. After this, non-parametric tests were used for analysis. Descriptive statistics such as frequency counts and tables were used to show the proportion of respondents who engaged in a given energy use behaviour. To explore the relationships between the reported energy use behaviour (action scores) and the Likert scores assigned to the different internal and external factors (including socio-demographic variables), a Spearman's rank correlation coefficient was performed. The Likert scores were measured using a PEB scale where 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always. The modal responses are presented as they indicate the most popular responses to a specific behaviour.

2.3.5 Limitations

The limitations of this section of the study are threefold. First, even though the reported behaviour is considered a worthy indicator to measure the genuine behaviour of participants, there can be a discrepancy between reported behaviour and actual behaviour. Secondly, there is a potential yes-saying bias for socially desirable behaviours (Bowling, 2005; Menton et al. 2010) and self-reported bias in the survey sample. Thus, the respondents may have exaggerated the extent to which they engaged in PEB such as switching off lights and appliances when not in use due to the ‘social pressure’ to reflect socially acceptable ‘pro-environmental behaviour’ within the household. A third limitation is that the questionnaire was completed by one member of the household (typically the head). Therefore, the reported energy use behaviour may not accurately reflect the energy use behaviour of the household as a whole. However, though individual characteristics could be different within the same household, Fisher (1987) argues that values shown by individual members of the households are often a representation of and provide insights into family values. Gronhoj and Thorgersen (2009) corroborate this in their study where it was found that family socialisation exerted a noteworthy influence on young

consumers' pro-environmental orientation. In Matthies et al.'s (2012) study which took place in Germany, it was noted that children participated in recycling more often when their parents did as well. Further, Melo et al. (2018) found positive and strong correlations for intra-household spill over effects in pro-environmental behaviour. Taken together, despite these limitations, it is hoped the study can provide valuable insights into household energy use dynamics from the context of a developing country - especially given that electricity forms the largest portion of energy consumption within high income households (Department of Energy, 2012). Therefore, providing insights into energy use and energy-saving interventions within higher income households could still contribute to understanding energy use within a demographic group that significantly contributes to energy consumption.

2.4 Results

2.4.1 Socio-Demographics of the Sample

A summary of the socio-demographic characteristics of the sample population is presented in Table 2.1.

***Table 2.1**: Summary of the socio-demographic characteristics of the study sample*

Variable	Values
Income	93% (ZAR30 000+ pm)
Gender	54%
Males	46%
Females	
Household size	3.4 ± 1
Age of respondent	56 ± 13
Education level	
Matric	24%
Diploma	13%
Degree	63%
No. of dependents	2 ± 1
Employment status	
Permanently employed	85.7%
Part-time employment	5.5%
Not employed	8.8%
Rooms in household	9 ± 1.4

Out of all the respondents, about 54% were males and the remaining proportion were females. The average age of the respondent was 56 ± 13 years. The average household size, i.e. the

number of people living within the household permanently was 3.4 ± 1) and the average number of dependents per household was 2 ± 1), which is higher than the average household size of 2.8 reported in Edenvale (Statistics South Africa, 2017b) and the national average of 3.3 (Statistics South Africa, 2017). The overall education level of the respondents was generally high, with more than two-thirds (63%) of the respondents having received tertiary education, followed by matric certificate (highest secondary education before entry into tertiary education) holders (24%) and diploma holders (13%). Eighty-six percent (86%) of the respondents were employed on a full-time basis, while the remainder were either employed on a part-time basis or unemployed. These unemployment figures are lower than the national unemployment rate of 27.7% (Statistics South Africa, 2017). About 93% of the households earned an average monthly household income of at least ZAR30 000 or US$ 2202.63. These earnings are generally higher than the country's national average, where a sizeable proportion of South African's (48.3%) who are categorised as middle-income earners, earn between ZAR1600 (US$ 1117.74) and ZAR25 600 (US$ 1879.58) per month. According to Statistics South Africa (2011), the most common (over 22.5 %) average income for households in Edenvale are earnings between ZAR25 633 - ZAR51 200 (US$ 1882 – US$ 3759.16) per month. These findings are not surprising as South African households in urban areas were reported to receive on average the highest annual income in 2015 (Statistics South Africa, 2017a). Due to the nature of the study targeting high-income households, it was also expected that houses would be fairly large in size. This was consistent with findings that respondents lived in fairly large houses, with an average of 9 rooms per household.

It should be noted that Edenvale was used as a representative sample of high income households within Johannesburg and purely as a basis for future studies due to few studies of this kind being undertaken in South Africa. Further studies will need to be conducted within the same context to draw conclusive findings and reinforce any generalisations regarding energy consumption for high income households in Johannesburg. This study was meant as the first step towards achieving that goal.

2.4.2 Reported Energy Use Behaviour

The average reported energy use behaviours of the households were calculated according to the PEB scale where 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always, and then grouped according to the household appliance investigated (Table 2.2). The reported behaviour

relating to household energy consumption is grouped into the following common categories of household energy consumptive appliances: air conditioner/fan, heaters, refrigerator, water heating, electric kettle/jug, lighting, home electronics, geyser, tumbler dryer, pool pumps, washing machines, dishwashers, and electric blanket.

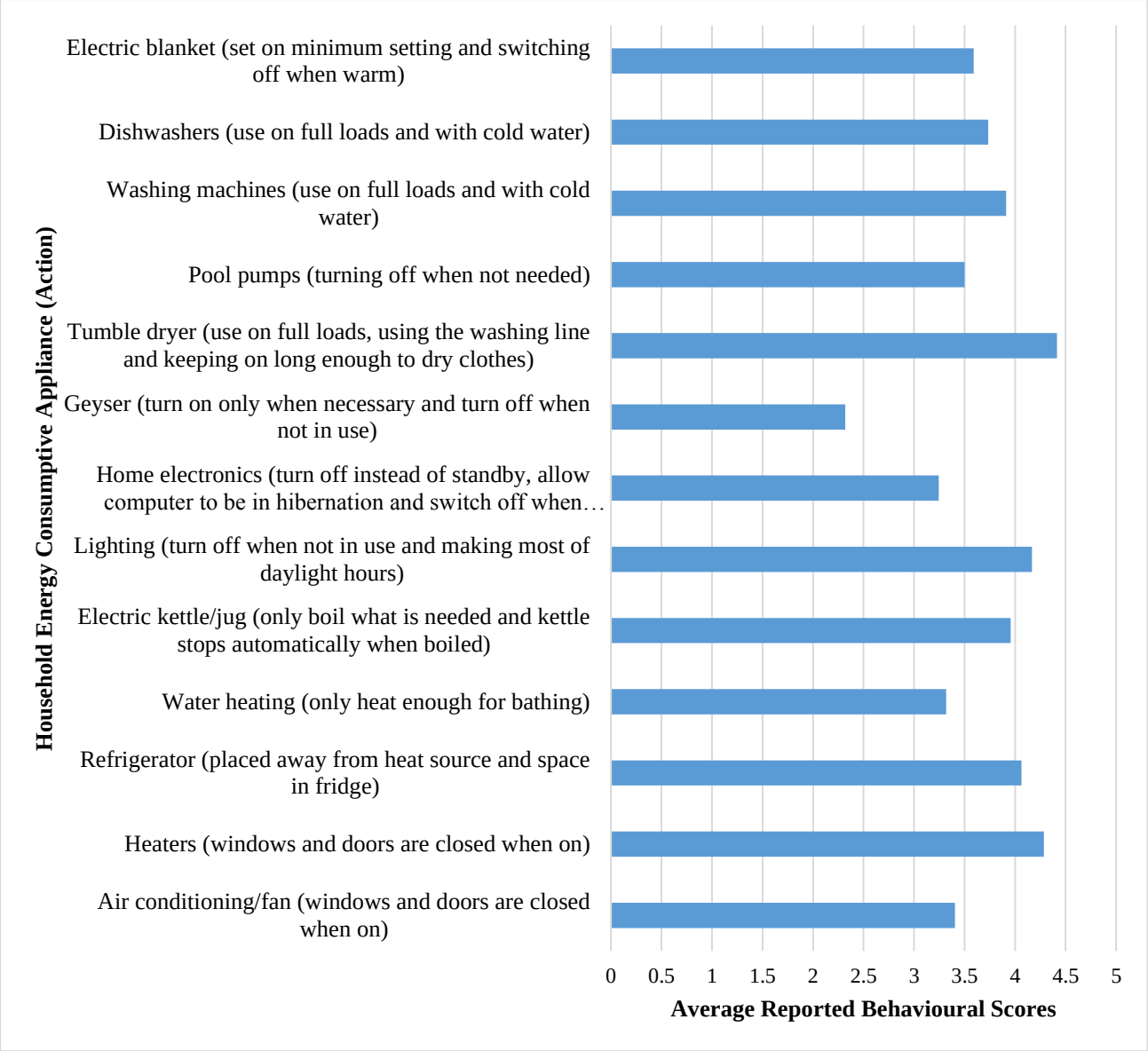

Figure 2.3: *Average reported behaviour scores for household energy consumptive appliances*

Figure 2.3 and Table 2.2 show the level of PEB through the use of a self-reported PEB scale. Positive PEB is reflected in higher scores, while negative PEB is reflected in lower scores. On average, the most sustainably used household appliances (or highest level of reported PEB) was the tumble dryer (4.4), heaters (4.3), lighting (4.2), and the refrigerator (4) (Figure 2.3). These appliances were 'usually' used in a way that conserved electricity, such as using an

outside washing line to dry clothes, keeping windows and doors closed when the heater is switched on, and turning off lights that are not in use. However, the geyser (2.3), household electronics (3.2), and water heating (3.3) showed low average behavioural scores, illustrating that they were not utilised in a pro-environmental manner (Figure 2.3). For instance, nearly half (46%) of respondents 'rarely' turned off geysers when not in use, and household electronics (64%) and water heaters (66%) were only 'sometimes' used in a conserving manner (Table 2.2). Besides the geysers, all household energy consumptive appliances were in general found to be used in a pro-environmental way (behavioural score 3 and above). This indicates that the targeted households on average 'sometimes' (60%) engaged in PEB or used energy consumptive appliances sustainably. No household energy consumptive appliances on average were 'always' used in a sustainable manner.

Table 2.2: *Household's ownership of energy consumptive appliances and reported energy use behaviours*

Energy-saving action	**Percentage (%) of households with appliance**	**Average reported behavioural score**	**Modal response**	**Proportion (%) of respondents to modal response**
Air conditioning/fan *(windows and doors are closed when on)*	76	3.4	Sometimes	68
Heaters *(windows and doors are closed when on)*	89	4.3	Usually	86
Refrigerator *(placed away from heat source and space in fridge)*	100	4.1	Usually	82
Water heating *(only heat enough for bathing)*	44	3.3	Sometimes	66
Electric kettle/jug *(only boil what is needed and kettle stops automatically when boiled)*	99	3.9	Sometimes	78
Lighting *(turn off when not in use and making most of the daylight hours)*	100	4.2	Usually	84
Home electronics *(turn off instead of standby, allow the computer to be in hibernation and switch off when not in use)*	100	3.2	Sometimes	64

Geyser *(turn on only when necessary and turn off when not in use)*	98	2.3	Rarely	46
Tumble dryer *(use on full loads, using the washing line and keeping long enough to dry clothes)*	80.2	4.4	Usually	88
Pool pumps *(turning off when not needed)*	94.5	3.5	Sometimes	70
Washing machines *(use on full loads, using the washing line and keeping on long enough to dry clothes)*	99	3.9	Sometimes	78
Dishwashers *(use on full loads and with cold water)*	93	3.7	Sometimes	74
Electric blanket *(set on minimum setting and switching off when warm)*	58	3.6	Sometimes	72

2.4.3 Relationship between Reported Energy Use Behaviour and Situational Factors and Personal Values

The results of a Spearman Correlation analysis show that only 3 situational factors (age, number of dependents and household size) and two personal value factors (environmental quality and leisure time) yielded statistically significant relationships with reported energy use behaviour (Table 2.3).

Table 2.3: *Calculated Spearman's Rank Correlation analysis between reported behaviour and the various situational and personal value factors. * Denotes significant difference*

Variable	Valid N	Spearman R (rho)	P-value
Situational factors			
Age of respondent	91	0.238*	0.023*
Household size	91	-0.292*	0.011*
Number of dependents	91	-0.239*	0.022*
Sex of respondent	91	0.068	0.524
Number of rooms	91	-0.244	0.629
Personal values			
Environmental Quality: *having access to clean air, water and soil. Having and maintaining a good environmental quality*	91	0.308*	0.003

Leisure Time: *having enough time after work and household work and being able to spend this time satisfactorily*	91	0.295*	0.004
Aesthetic Beauty: *being able to enjoy the beauty of nature and culture*	91	0.187	0.076
Challenge / Excitement: *having challenges and experiencing pleasant and exciting things*	91	-0.021	0.839
Change: *having a varied life, experiencing many things as possible*	91	-0.009	0.931
Comfort: *having a comfortable and easy daily life*	91	0.126	0.233
Education: *having the chance to get a good education and to gain general knowledge*	91	0.163	0.123
Freedom: *freedom and control over the course of one's life, to be able to decide for yourself, what you do, when and how*	91	0.096	0.367
Health: *being in good health, access to adequate healthcare*	91	-0.007	0.944
Identity: *having sufficient self-respect and being able to develop one's own identity*	91	-0.005	0.963
Material Beauty: *having nice possessions in and around the house*	91	-0.051	0.633
Money / Income: *having enough money to buy and to do the thing necessary and pleasing*	91	0.039	0.712
Nature: *to enjoy natural landscapes, parks and forests. Assurance of the continued existence of plants and animals and maintaining biodiversity*	91	0.101	0.340
Family: *having an intimate relation, a stable family life and good family relationships*	91	0.188	0.075
Private: *having opportunities to be yourself, do your own things, a place of your own*	91	-0.108	0.307
Safety: *being safe at home and in the streets. Being able to avoid accidents and being protected against criminality*	91	0.087	0.410
Security: *feeling attended to and cared for by others*	91	0.049	0.646
Social Justice: *having equal opportunities and rights as others, being treated righteously*	91	0.034	0.749
Social Relations: *having good relationships with friends, colleagues, neighbours*	91	0.128	0.228
Spirituality / Religion: *being able to live a life with an emphasis on spirituality and/or with your own religious persuasion*	91	0.139	0.190
Social Status: *being appreciated and respected by others*	91	0.105	0.323
Work: *having or being able to find a job and being able to fulfil it as pleasantly as possible*	91	0.176	0.095

Age of respondent was found to have a statistically significant positive but weak relationship with reported behaviour (Table 2.3). The positive direction of the variable's relationship means that older individuals were more likely to engage in PEB. Household size and the number of

dependents both yielded a statistically significant but weak negative relationship with PEB (Table 2.3). Although the strength of this relationship was considered weak, the negative relationship suggests that as household size increases, household members are less likely to engage in PEB. The results also show that as the number of dependents within a household increases, the less likely a household would engage in PEB. Household income, gender and education level did not yield significant relationships with reported behaviour. Although socio-demographic information such as male and female participants were recorded in this study, it was beyond the scope of this research to analyse any correlations regarding energy consumptive behaviour between male and females and any subsequent gender roles related to energy consumption.

With regards to internal factors, environmental quality yielded a statistically significant but weak positive relationship with reported energy use behaviour. This result suggests that those who value environmental quality are most likely to engage in PEB. Leisure time showed a negative relationship with PEB, suggesting that individuals who considered leisure to be more important in their lifestyles were less likely to engage in PEB.

***Table 2.4**: Calculated Spearman's Rank Correlation analysis between reported behaviour and aggregated personal value factors. * Denotes significant difference.*

Variable	Valid N	Spearman R (rho)	P-value
Universalism: *Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature*	91	0.2777199	0.008*
Stimulation: *Excitement, novelty, and challenge in life*	91	0.001813	0.986
Hedonism: *Pleasure and sensuous gratification for oneself*	91	0.248468	0.018*
Achievement: *Personal success through demonstrating competence according to social standards*	91	0.209559	0.046*
Self Direction: *Independent thought and action; choosing, creating, exploring*	91	-0.013358	0.900
Security: *Safety, harmony, and stability of society, of relationships, and of self*	91	0.131616	0.214
Power: *Social status and prestige, control or dominance over people and resources*	91	0.077709	0.464

Benevolence: *Preserving and enhancing the welfare of those with whom one is in frequent personal contact (the 'in-group')*	91	0.138500	0.190

When analysing the reported behaviour against Schwartz's aggregated model (1994) of personal values, three groups of personal factors were found to be significantly and positively related to PEB. Significant positive correlations were found between reported behaviours and factors related to Universalism (self-transcendence or altruism, measured by statements about social justice, environmental quality, aesthetics and loving nature); Hedonism (leisure time/comfort); and Achievement (Education). Stimulation (change and challenge factors) yielded a positive relationship with reported behaviour but this was not statistically significant. Other values such as Self Direction, Security, Power and Benevolence did not yield any significant results.

2.5 Discussion

The study aimed to examine household reported energy use behaviour and the links between pro-environmental behaviour, personal (internal) value factors and situational (external) factors. In summary, the results suggest that households that are smaller, have fewer dependents and older members are more likely to engage in PEB. Energy use behaviours in the household were also found to vary depending on the type of energy used. For example, 88% of respondents 'sometimes' used the tumble dryer pro-environmentally, while 66% of respondents 'sometimes' used water heating pro-environmentally.

In addition, households who value environmental quality are more likely to engage in PEB, while those who value leisure time are less likely to engage in PEB. In the same vein, positive relationships were found on a more aggregated level for respondents who valued Universalism (which relates to altruistic values such as environmental quality), Hedonism and Achievement. Respondents who held these values indicated a higher probability of engaging in PEB.

2.5.1 Reported Energy Use Behaviour

The results from households' reported energy use behaviours show that all households consisted of numerous energy consumptive appliances. The results generally reveal that while some households engaged in PEB for certain energy consumptive actions, others did not always

do so. On average, the tumble dryer, heaters, lighting and refrigerator all had high pro-environmental scores (4 or 80% and above). These appliances were 'usually' used in a way that conserved electricity, such as using an outside washing line to dry clothes, keeping windows and doors closed when the heater is switched on, and turning off lights that are not in use. However, the geyser, household electronics, and water heating were reported to have lower average scores, illustrating they were not utilised in pro-environmental ways. For instance, nearly half of respondents 'rarely' turned off geysers when not in use, and household electronics and water heaters were only 'sometimes' used in a conserving manner. Besides the geysers, all household energy consumptive appliances were on average only 'sometimes' used sustainably.

Therefore, because on average no household energy consumptive appliances were found to 'always' be used in a sustainable manner, it implies that regardless of the level of pro-environmental engagements, energy was wasted in the household or was not consistently used conservatively. For example, geysers being used rarely efficiently and home electronics and heaters sometimes being used in a conserving manner. Even though the higher and more positive scores of the tumble dryer, heaters, lighting and refrigerator being usually (over 80%) used in a sustainable way, none of these results reflected 100% sustainable use. This illustrates further scope for energy-saving interventions.

The more frequent reported pro-environmental behaviours regarding the tumble dryer, lighting and heaters were unsurprising as they require little effort. This is in line with findings that people often engage in PEB when it is easy to do so in terms of effort and time (Steg and Vlek, 2009; Kua and Wong, 2012; He and Kua, 2013; Mtutu and Thondhlana, 2016). Also, with the questionnaires being administered and completed in the hot summer month of January it could be expected that many households would use washing lines to dry their clothes or linen etc., instead of a tumble dryer and use heaters sparingly. The finding that geysers and water heaters were actions showing the least PEB, could be explained by convenience issues of having to wait for the water to heat up and measuring specific amounts of water for heating as shown and discussed by Steg and Vlek (2009), Kollmuss and Agyeman (2010) Kua and Wong (2012), He and Kua (2013), Mtutu and Thondhlana (2016), and Bulunga and Thondhlana (2018).

Although not many studies have been conducted within a South African context regarding household energy use, Statistics South Africa (2013) conducted a study on behalf of the

Department of Energy, which investigated household energy use. This study is useful for comparative analysis, albeit lacking confirmation from other studies conducted in Johannesburg.

High-income households portraying an affluent living standard have a greater chance of owning electric geysers, washing machines and dishwashers (Statistics South Africa, 2013); all of which function by using electricity for cleaning, cooking and heating purposes. Less wealthy households might also have to cook, clean or heat water using kettles or stoves which function on electricity; however, they also use cheaper energy forms such as burning wood and coal or using paraffin (Statistics South Africa, 2013). This puts forward that due to the generally higher income levels of the study group, electricity would be their primary source of energy and as a consequence, the higher income households could consume larger amounts of electricity. According to Statistics South Africa (2013), higher income households have more opportunities to use electricity owing to the ease of access to electricity due to fewer restrictions such as financial limitations, and owing to higher income households accumulating more appliances that use electricity for cooking and heating such as dishwashers, geysers, electric blankets etc. Having more sources of energy consumption would make monitoring conservative energy consumption harder and increase consumption levels; thereby producing behaviours that are not conducive to energy conservation. Huebner et al. (2016) found that owning a separate freezer and a tumble dryer were related to higher electricity use, and the same was found for increasing number of televisions. Regarding the use of appliances, watching more hours of television per day, doing more laundry and dishwashing loads per week were also related to higher electricity consumption (Huebner et al. 2016). Thus substantiating higher negative pro-environmental behaviours for households with more energy consumptive appliances, as is common for higher income households. Wiesmann et al. (2011) and Bedir et al. (2013) also found higher energy consumption levels for households that owned more energy consumptive appliances. This is further supported by household income having shown to be adversely "linked to increased minor energy-saving behaviours (e.g. through diminishing marginal utility of income resulting in households becoming indifferent to switching appliances off at the wall or taking shorter showers" (Poruschi and Ambrey, 2016:335).

It is clear that reported energy use is variable. While some energy use actions show higher engagements with PEB, others do not. This reflects that households vary in the way that they

use energy (whether that be in a pro-environmental way or not) depending on the household appliance they use. This suggests that there is further scope for interventions regarding energy use activities that were not reported to be pro-environmental. These lessons can then be replicated and used to inform and promote PEBs in the household.

2.5.2 Relationship between Reported Energy Use Behaviour and Situational Factors and Personal Values

For situational factors, only age, household size and the number of dependents within the household were found to be significantly correlated with PEB. These findings are in line with previous studies (Brandon and Lewis, 1999; Poortinga et al. 2004; Abrahamse and Steg, 2011) reflecting energy use to be strongly explained by these demographic variables. This is further aligned with the VBN theory that assumes demographic variables act as opportunities and constraints for behaviour (Abrahamse and Steg, 2011).

The finding that as the age of an individual increases the likelihood of pro-environmental action also increases is consistent with literature such as Mtutu and Thondhlana (2016) who found older respondents to be more concerned about the environment and have a stronger inclination to PEB than the younger ones. Supporting this, Sanchez et al. (2016) also found that older individuals in Spain engaged more with pro-environmental consumption behaviour. This could be explained by older people tending to hold stronger values of responsibility (Morris and Venkatesh, 2000; Wey Smola and Sutton, 2002). To clarify, engaging in PEB may seem related to work activities. For example, PEB can be time-consuming, form part of daily routine, and become associated with a form of responsibility whether that be of a social nature, professionally or leading by example to younger people. Therefore, older people, while not necessarily having values that are pro-environmental, have personality traits that can contribute to PEB being implemented and practised. Though this was beyond the scope of this study's enquiry, it has been found that personality traits such as conscientiousness and agreeableness are likely to increase with age (Roberts et al. 2006). These characteristics are central to pro-environmental behaviour, for example reducing use, avoiding waste, and proper waste disposal, here the age-related discrepancies in these qualities support older people engaging in pro-environmental behaviours (Wiernik et al. 2016). Thus, it is argued for example within the workplace situation, that although older workers may be less eager to change their habits to benefit environmental sustainability, they may embody stronger natural inclinations to

undertake resource conservation behaviours that have a positive environmental impact (Wiernik et al. 2016). Relating this to household dynamics could mean that older household members may be more inclined to consistently switch off lights and unplug electronics that are not in use, be more mindful of consumption, or make use of outside washing lines instead of tumble dryers. These forms of PEB may not necessarily be environmentally inclined, they could be undertaken owing to financial motivations or habitual practice.

The finding that as household size increases, household members are less likely to engage in PEB is also consistent with previous pro-environmental studies (Abrahamse and Steg, 2009; Kua and Wong, 2012; Levy and Belaid, 2017). The reason for this inverse relationship could be due to the fact that as household size increases, so would the amount of energy consumption within the household due to the probability of more energy-intensive appliances, larger surface areas for cooling and heating, etc. Another perspective is that as household size increases, so does the difficulty in controlling the household's energy consumption. More rooms and appliances are typical of larger dwellings which would mean more areas and energy consumptive materials to monitor. This is consistent with Abrahamse and Steg (2009) and Kua and Wong (2012) who found that households that did not decrease their energy consumption were larger in size. In France, Levy and Belaid (2017) similarly found that the largest group of household energy consumers were those living in houses with multiple rooms and large living spaces. In another study of residential university students in Grahamstown, South Africa, "students who did not always switch off lights in shared places felt they had less control in these spaces than in their private rooms, claiming that other students countered their pro-environmental actions" (Bulunga and Thondhlana, 2018:784). These findings illustrate how shared living spaces can counter PEBs because of the inconsistent energy-saving behaviours per person within a living space.

The finding that as the number of dependents within a household increase, the less likely they will engage in PEB is consistent with expected results. The majority of the households that were approached for the study had children and/or grandparents living at home. Therefore, the household would have a greater number of dependents. More individuals within a household can cause the average household consumption levels to increase. The family life cycle analogy on household energy consumption concluded that the 'middle age with children' households was the highest energy consumers (Fitzsche, 1981). This conclusion was substantiated by the findings of Melo et al. (2018) who found PEB to differ with the presence of young children

particularly between the ages of 0 and 5 years old. Couples without children and with older children had higher PEB scores than couples with younger children or single-person households (Melo et al. 2018). Similar findings regarding energy use and the family life cycle were also confirmed by Levy and Belaid (2017). This supports the finding as children are dependent on their parents, and contribute to the amount of electricity consumed at home. Additionally, in a household that has dependents and therefore more household members consuming electricity, it would be harder to control and monitor the rate of electricity consumption and energy-saving practices for every member or dependent(s). Younger household members such as teenager and children, would generally tend to spend more time at home than older household members such as parents who may be out of the house during work hours. Thereby children may be consuming higher amounts of energy not because they are reluctant to engage in PEBs but because they are spending more time at home where energy consuming activities such as watching TV or using and charging electronic appliances energy may be unavoidable.

On the other hand, for personal values, only environmental quality and leisure time were found to be significantly related to PEB. These findings are in line with the VBN theory that personal values are related to a person's environmental concern. Other values such as values for freedom, health, security, privacy, social status etc., did not show significant relationships with PEB. The personal value held for environmental quality reflects self-transcendent values as a predictor of PEB, due to the assumption that people with a stronger concern for the environment tend to have a higher awareness of the environmental impact of their actions (Abrahamse and Steg, 2011). These results corroborate the findings of Mtutu and Thondhlana (2016) who found that participants' with high levels of concern for the environment were likely to engage in PEB. This could be owed to an improved awareness of the consequences of environmental degradation. However, the personal value for environmental quality can also be related to the personal value of self-transcendence (altruism). Theories of altruistic behaviour have been used to explain environmentalism or PEB. Heberlein (1972) initiated the use of such theories which presume that due to environmental quality being a public good, altruistic motives are required for an individual to significantly contribute to it (Stern, 2000). In this sense, justifying the finding that those who value environmental quality are more likely to engage in PEB. Therefore, fostering an improved value for the importance of environmental quality could be a possible solution to increase the frequency of pro-environmental behaviours.

Pro-environmental behaviours can contribute to raising the importance of environmental quality if people are able to understand and tangibly assess the impacts of their pro-environmental behaviours on the environment, such as lower consumption levels and wastage (Poortinga et al. 2004; Abrahamse et al. 2005; Zsoka et al. 2013; Mtutu and Thondhlana, 2016; Thondhlana and Kua, 2016). Therefore, by people being made aware of their impacts, it could in turn, have a reciprocal effect of raising the importance of environmental quality, thus increasing levels of pro-environmental behaviour. For example, understanding that inhaling polluted air and consuming dirty water can affect one's health could raise the levels of a person's concern for clean air and water. This in turn, could make a person more supportive of climate change policies and sources of renewable energy. This was confirmed by Hori et al. (2013) where positive correlations were found in two out of the five cities surveyed in Asia between global warming consciousness and energy-saving.

The correlation for leisure time supports the VBN theory that those who display values of self-interest (egoistic values) are less likely to engage in PEB. This is because valuing leisure time (i.e. having enough time after work and household work and being able to spend this time satisfactorily) reflects a central focus on the self (egoistic). Pro-environmental behaviours identified as more time-consuming have been shown to be less successful or have fewer engagements (Steg and Vlek, 2009; Kua and Wong, 2012; He and Kua, 2013; Mtutu and Thondhlana, 2016; Bulunga and Thondhlana, 2018). For example, turning off geysers and waiting for the water to heat up when warm water is needed instead of keeping the geyser on during all hours of the day, checking the house to make sure that all lights not in use are switched off, or regularly defrosting the refrigerator. This can even be extended to other PEBs not relating to household electricity such as recycling waste and water, using a bicycle or walking to a destination instead of using a car. These activities would in theory, subtract from an individual's leisure time. Therefore, if an individual places a high value on leisure time, they could choose leisure time activities over more time-consuming pro-environmental activities. This supports the Theory of Planned Behaviour (TPB) that PEBs are more likely to be performed when they are easier to do so.

Leisure time is defined as "having enough time after work and household work and being able to spend this time satisfactorily" (Poortinga et al. 2004:74). The finding suggests that the more a person values leisure time, the less likely they are to engage in PEB. Leisure could mean a variety of things for different people and households. For example, swimming in the pool or

watching television etc. However, these leisure activities usually consume energy. This allows for the assumption that households who value leisure time, and therefore partake in leisure activities that consume more energy, contribute to negative PEB. Therefore, leisure time relates to the personal value of self-enhancement by reflecting self-interest, a known strong negative predictor of PEB (Blok et al. 2015).

The findings regarding the aggregated values using the Schwartz model (1994) also showed significance. Values relating to Universalism, Hedonism and Achievement and reported energy use behaviour were all found to be significant. Households who values Universalism which is the understanding, appreciation, tolerance, and protection for the welfare of all people and for nature; were positively inclined towards pro-environmental behaviour. Universalism is an altruistic value, as is the value for environmental quality mentioned in the 22 QoL factors. This supports the theory that people who hold altruistic or self-transcendent values are more likely to engage in PEB. This theory was confirmed by Klockner (2013) who found that people who held self-transcendent values were more likely to engage in pro-environmental behaviour. De Groot and Steg (2007, 2008) and Nordlund and Garvill (2002) also found a higher probability of people engaging in PEB when they identify with values that are selfless, that is, self-transcendent, prosocial, altruistic or biospheric values.

On the other hand, Hedonism which is the pleasure and sensuous gratification for oneself is an egoistic and self-centred value. The finding of this aggregated value insinuates that the more people value Hedonism, the less likely they are to engage in PEB. This further supports the negative relationship found for households that valued leisure time within the 22 QoL factors as this is also an egoistic value (Poortinga et al. 2004). Schultz et al. (2005) also confirmed that self-enhancement or egoistic values discouraged PEB. The same was found in a study conducted in Brazil on environmental attitudes where environmental utilisation was found to be "positively correlated with self-enhancement orientations and negatively correlated with future and biospheric orientations" (Milfont and Gouveia, 2006: 72).

The aggregate value for Achievement which means valuing personal success through the demonstration of competence in line with social standards such as education was positively correlated with PEB. Therefore, those who value higher education could be more inclined to engage in PEB. This finding makes sense because the education levels of the households surveyed in this study were typically high with 63% of the respondents having received tertiary

education. Poortinga et al. (2004) also found that the Achievement value dimension was also positively related to environmental concern. Similar connections were found by Mtutu and Thondhlana (2016) where university staff members had a high level of environmental awareness and concern for the environment due to acquiring higher levels of education and income when compared to the university students. This is consistent with Schwartz (2012) who states that those more aware of the negative consequences of unsustainable behaviour are more likely to exhibit PEB.

Therefore, the findings regarding reported energy use behaviour are consistent with theories that environmentally relevant behaviours relating to self-enhancement (self-interest) are less popular and that environmentally relevant behaviour relating to self-transcendence (altruistic) are more popular when trying to foster PEB (Schwartz, 1994; Blok et al. 2015).

A possible explanation as to why the other value dimensions were not found to be significant or correlated to the reported energy use behaviours is that the participants did not understand the connection between the value factors and pro-environmental behaviour such as energy conservation (Kua and Wong, 2012). Therefore, even though someone might value social status or the environment, they may not understand what that has to do with switching off lights and geysers that are not in use, or other energy conservation behaviours (Kua and Wong, 2012).

Going forward, based on the results of these findings, when encouraging PEB in households, intervention programmes should take note of the values held within a specific demographic as it has been demonstrated in this study how values can influence energy use behaviours. Interventions could be more successful when aimed at households who hold more altruistic values, therefore leaving room to investigate possible strategies to improve cooperation with households who hold more egoistic values. One way could be to highlight to more egoistic-centred households, the connection between the 'self' and the 'other' such as the environment. For example, how the household would be inconvenienced if clean water and electricity (which are natural resources) were no longer available. Thus, improving the household understanding of the link between environmental quality and the impact that environmental quality can have on a household's quality of life. For example, a household that is not able to drink water from the tap and has to spend more money buying bottled water, or experiences load shedding and consequently is not able to use household electronics. If these concepts were not viewed as separate terms and were understood to be more interconnected, perhaps it could foster more

altruistic values in households and therefore more PEB. Bamberg and Moser (2007) confirmed in their research how PEB can be a mixture of self-interest (egoistic) and pro-social (altruistic) motives. In another example, a household survey conducted in Devon, England, residents who classified themselves as 'committed environmentalists' (and therefore holding altruistic values) tended to significantly sacrifice some level of comfort to save energy, compared to 'non-environmentalists' (Barr et al. 2005). Adding to this, demographic factors should also be noted as they were found in this research to relate to reported behaviour such as older people being more likely to engage in PEB, and as household size and number of dependents increase the likelihood of PEB being less.

Abrahamse and Steg (2009) similarly found that households with higher incomes and larger in size tended to use more energy. Additional studies have shown the influence of other demographic factors such as gender and level of education (Abrahamse and Steg, 2009; Kollmuss and Agyeman, 2010). Although the relationship between gender and energy consumptive behaviour was beyond the scope of this research, is the role of gender ought to be considered in greater detail in future studies, as women have shown to be positive change agents for PEB (Nahiduzzaman et al. 2018). It has been said that usually, women do not have as wide-ranging environmental knowledge compared to men instead they are more emotionally engaged, express higher concern for environmental destruction, trust less in technological solutions, and are further inclined to change (Kollmuss and Agyeman, 2010). The more extensive the education, the more encompassing the knowledge of environmental issues (Kollmuss and Agyeman, 2010; Mtutu and Thondhlana, 2016). Future interventions should pay more attention to the barriers that could prevent households that are larger in size and have more dependents in engaging in PEB. Perhaps energy-saving interventions should encourage the entire household to participate in energy-saving behaviours so that fewer behaviours would need to be monitored by one household member. Encouraging the entire household to participate in energy-saving behaviours could also foster greater accountability within the household by having more household members monitoring energy consumption. Energy - interventions should also aim to further encourage younger age groups in energy-saving behaviours. Older household members could assist in explaining the benefits of and how to practice PEB to younger household members such as checking the house for lights that could be switched off, using the outside washing line instead of the tumble dryer etc.

2.6 Conclusion

The results from this study highlight that both situational factors and personal values can predict pro-environmental energy use behaviour in households. This advocates the insights provided by behavioural models and theories such as the Value-Belief-Norm (VBN) theory. However, due to the significant finding of demographic factors influencing PEB in this study, it can be argued that behavioural theories are insufficient in predicting PEB alone. Further, due to the various correlations found between value dimensions and reported behaviours, it is suggested that future energy-saving interventions should target households that hold altruistic values (positive predictors of PEB), and that further interventions and research be given to households that hold egoistic values (negative predictors of PEB). For example, how could higher suburban income households be encouraged to value environmental quality, and how could PEBs be included within a household's understanding and undertaking of leisure time activities? When encouraging altruistic value dimensions in households, it could be useful in assisting households in understanding the connections between various value dimensions and PEBs, thereby improving levels of awareness of consequences and generating a need and desire to practice energy conservation.

The reported behaviours from this study suggest that future policy mechanisms aimed at household energy conservation should be designed towards simplistic pro-environmental activities like switching lights on and off, making the most of South Africa's sunny weather when drying clothes on a washing line instead of using a tumble dryer, and switching off heaters when rooms are not occupied. Further, the PEBs that were not reportedly popular (such as the PEBs relating to geysers, household electronics and water heating, necessitate greater intervention) require further research to explore possible methods that could make these areas of household energy consumption more convenient to engage in pro-environmentally. Owing to a high proportion of households who own refrigerators and home electronics like washing machines and electric kettles; it is further recommended that energy-saving interventions should be geared towards these energy consumptive appliances. Seeing that these areas of energy use are found to be the most prominent in higher income households, it is possible that higher levels of energy reduction could be achieved if preference is given to these areas of consistent energy use.

A further step to foster energy conservation behaviours could be to encourage the entire household to participate in practicing energy-savings. More household members monitoring their consumption levels could lead to greater accountability and assist larger households in saving energy (as household size and number of dependents were found to be negatively correlated to PEB).

CHAPTER 3: THE EFFECTS OF INTERVENTIONS ON HOUSEHOLD ENERGY CONSUMPTION IN EDENVALE, JOHANNESBURG, SOUTH AFRICA

3.1 Introduction

Globally, the residential sector consumes a substantial proportion of energy, up to one-third of all end-use energy (Isaac and van Vuuren, 2009), with obvious environmental and economic costs (Abrahamse et al. 2005, 2007; He and Kua, 2013). Especially in urban contexts, urbanisation has meant that there is an ever growing energy demand (Martinsson et al. 2011; Poruschi and Ambrey, 2016). National authorities have traditionally responded to the growing energy demand by building infrastructure like power generation plants (Inglesi, 2010). The rate of electricity consumption seems unlikely to change due to the global increase of energy demand (Wolde-Rufael, 2006) which has particularly been found in developing countries (Pachauri and Spreng, 2002; Winkler, 2005; Mahadevan and Asafu- Adjaye, 2007; Asif and Muneer, 2007). Traditional approaches to solving the growing energy crisis like building more infrastructure (Pollet et al. 2015), remain prevalent. There is growing realisation that technical approaches to solving growing energy demand are inefficient and increasingly becoming an expensive option for urban authorities due to the financial resources required to invest in huge infrastructure development and the expensive designs that need to be implemented for environmental considerations, as found in the UK by Bradley et al. (2013) and Ofgem (2015). Another solution has been to shift to renewable, cleaner and more sustainable energy sources such as solar and wind-generated electricity, but the initial costs required for these energy sources mean many households, especially in the developing, world may not be able to afford renewable energy sources (Banks and Schaffler, 2006; Deichmann et al. 2011) without some form of assistance, like government subsidies.

In response to this, demand-side management programmes like behaviour change interventions are gaining traction worldwide as alternative approaches to curb growing energy demand and also to minimise environmental costs and the financial burden associated with increased energy consumption (Abrahamse and Steg, 2011; Kua and Wong 2012; Mtutu and Thondhlana, 2016; Thondhlana and Kua, 2016; Levy and Belaid, 2017). With approximately 20% of total energy-related CO_2 emissions accounted for by households (Biesiot and Noorman, 1999), households are an important target group for energy conservation. However, the energy-consumptive

characteristics of the residential sector are complex and inter-related (Swan and Ugursal, 2009). Consequently, household-based interventions to conserve energy can have the same complex and inter-related characteristics when trying to design effective intervention strategies. Therefore, to promote energy reduction in households it is important to examine the determinants of household energy use and energy conservation (Abrahamse and Steg, 2009).

3.2 Behaviour Change Interventions: Their Effects on Energy Use

Various strategies have been developed to steer behaviour towards pro-environmental energy use. These strategies have been developed depending on the findings of previous research that illustrate or predict why and how people behave pro-environmentally. In 2006, a study found that the majority of the 73% of Swedish households chose to undertake non-investment measures to conserve energy (Eurobarometer, 2007). In addition, evidence from surveys in the UK (Barr et al. 2005) and the US (Forstater et al. 2007) suggests that greater participation in non-investment measures rather than investment measures (infrequent or one-time measures) to reduce energy use (Nair et al. 2010) took place. More recent studies concerning energy-saving also support the use of low-cost interventions (Pothitou et al. 2016; Bulunga and Thondhlana, 2018).

Those who partake in non-investment measures may do so because the rewards are more perceptible (Kempton et al. 1985; Nair et al. 2010). Non-investment measures are considered attractive because they have no investment-related risks (cost-effective) and because they are easy habits to form with consistent practice (Nair et al. 2010). Kua and Wong (2012) and Mtutu and Thondhlana (2016) have also provided evidence from studies that prove how behaviour change actions that are easy to complete and inexpensive to implement are likely to encourage pro-environmental behaviour. Perhaps South African households would also consider non-investment energy-saving measures that are easy and cost-effective in light of the country having slipped into a technical recession after its gross domestic product (GDP) fell 0.7% during the first quarter of 2017 (Rossouw, 2017).

Interestingly, Tait and Winkler (2012) have suggested that in South Africa, if income levels were to rise so would electricity demand and that greater energy efficiency can be achieved through the use of efficient technologies such as solar water heaters, efficient lighting and appliances, thermal insulation and the expansion of the solar off-grid programme. However,

these strategies would require considerable capital investments and by default may make these strategies unappealing even though they have substantial sustainable value for reducing electricity consumption in the long-term. Further, while a change in more sustainable technologies is an improvement, it does not address wasteful behaviour (Tait and Winkler, 2012). Therefore, even though people might use more environmentally friendly technologies, these technologies would still foster unsustainable practices because they allow for the same behaviour to continue. In contrast to Tait and Winkler (2012), Ziramba (2008) found that in South Africa price increase alone would not dampen residential electricity consumption. This highlights the need for actual behaviour change, and not just financial or technological solutions. Regardless of this, establishing energy reduction solutions that are cost-effective, mass-scalable and applicable to broad sections of the community is of major importance at local, national and international levels (Ziramba, 2008; Statistics South Africa, 2013).

3.2.1 Forms of Household Energy Conservation Interventions

Household awareness of energy problems and knowledge of how to reduce these problems can be combated through the provision of information (Geller, 1981; Purcell and Magette, 2010; Kua and Wong, 2012, He and Kua, 2013; Pothitou et al. 2016). A vast amount of energy-saving experiments have been undertaken using various information sharing strategies to reduce energy use (Vining et al. 2002; Abrahamse et al. 2005; Fischer, 2008). These strategies have been in various forms such as discussions, pamphlets, stickers, media platforms, television, etc. Successful intervention strategies have been recorded in Singapore by He and Kua (2013) where 61% of households who were subjected to tailored information (counselling, stickers, and pamphlets) and feedback on energy-saving recorded actual reduction in energy consumption. Aydin et al. (2018) analysed the effect of information provision on households in the Netherlands and found that information provision reduced electricity demand by 20%. Kua and Wong (2012) also found that providing tailored information and feedback to households in Singapore produced on average a 2% reduction in energy consumption in 37 of the 62 households surveyed.

Positive results when utilising information strategies have been documented further back with Dennis et al. (1990) having reported significant energy-savings by providing antecedent information on how to conserve energy; they claimed a 60 % reduction in excessive lighting use by putting signs near light switches. However, within a group setting, Hayes and Cone

(1981) found that information alone had a temporary effect in reducing electricity consumption. At first, when the information was circulated in one unit of a student-housing complex, there was a 30% reduction in electricity usage, but in the following week, the savings had fallen to 9%. This could be due to energy reductions not being able to consistently decrease by the same percentage as time persists. For example, a person may have the most significant reductions in the first week, because in the first week before trying to save energy, wasteful energy consumption would be at its highest. However, it would be harder to consistently reduce energy consumption from the initial phase because households require a minimum energy supply to perform daily activities such as cooking, heating, cooling, charging electronics etc. Therefore initial reductions would be most significant during the first week when the scope for energy-savings is at its widest, and consequently in following weeks that scope would be less and less. A second possible reason is that motivations for reducing energy reductions could also have dwindled. Therefore, less commitment to energy-savings could cause a decrease in energy-saving levels over the intervening time period.

Media campaigns such as booklets, pamphlets, newspapers, brochures, stickers etc. have shown to increase energy-savings owing to the generation of awareness and providing instructions on PEB (Ajzen, 1985; Abrahamse et al. 2005; He and Kua, 2013). Support for media campaigns has been documented since the 90s where Staats et al. (1996) appraised a media campaign of the Dutch government which intended to communicate the nature and causes of global warming, and possible solutions. Even earlier, Hutton and McNeill (1981) assessed the Low-Cost/ No Cost energy conservation programme of the US Department of Energy. A booklet of energy-saving tips was sent to 4.5 million households. Households who had received the booklet reported implementing the energy-saving tips more often than households who had not. McMakin et al. (2002) conducted a survey study at Fort Lewis and MCAS Yuma residents in the USA to evaluate campaign effectiveness in terms of awareness and behaviour change around energy use. The results showed that the campaigns were moderately effective in promoting behaviour change. At Fort Lewis in the USA, 92% of respondents said they had started practising one or more new actions to improve energy efficiency. At MCAS Yuma, up to 94% of respondents said they had already been practising one or more of the targeted behaviours before the campaign began (McMakin et al. 2002). The above literature review highlights the importance of information provision in raising awareness about the environment and in promoting PEB. It is therefore hypothesised in this study that

information provision (on energy-saving tips) will yield actual reductions in energy consumption among households.

Another type of intervention is incentives. Incentives tend to incite action or greater effort, as a reward offered for increased productivity or various actions (Kollmuss and Agyeman, 2002). The effectiveness of an incentive depends on factors within the personal and social domain. Intervention strategies that bring about financial, material, technological and improved educational benefits are said to be more successful in the long and short-term (De Young, 2000; Stern, 2000; Lin et al. 2010; Huo, 2015). Pitts and Wittenbach (1981) looked at rewards by evaluating the effect of tax credits on consumers' decisions to insulate their homes. It was found that once the tax credit had been in effect for two years, no impact was recorded on the decision of whether or not to install insulation. This finding notes that incentives may not always be an effective intervention for pro-environmental behaviour change, at least with incentives being the only intervention implemented. This could mean that incentives could be used as an intervention in conjunction with other intervention strategies. In a study conducted in the United States, Asensio and Delmas (2015) found 8% of energy-savings to be encouraged by incentives associated with the environment and one's health. Asensio and Delmas (2015) further found these interventions to be successful (19% energy-savings) for families with children. An earlier study which was also conducted in the United States, used methods of monetary payments (which increased according to the amount saved), energy information, or daily feedback on consumption (Hayes and Cone, 1981). The findings showed instant and enduring decreases in consumption of up to 33% (Hayes and Cone, 1981).

Within the context of this research, although incentives were not formally noted as an energy-saving intervention such as the information interventions, they are noted as an indirect intervention through the monetary savings that would result in PEB change. Therefore, by consuming less energy the participants would lower their electricity bills thus allowing for greater monetary savings. While such an incentive may not stem from a desire to behave pro-environmentally for sustainability reasons, it highlights how energy-saving interventions may still be attractive to households that are not interested in consuming less energy purely for environmental reasons.

Using feedback on energy-saving performance has also proven to be a useful intervention for encouraging energy-savings. Abrahamse et al. (2005) found that when households were

provided with frequent feedback, it was an effective intervention for reducing energy consumption. Steg (2008) also notes feedback to be an important tool for educating people about energy use and wastage. Faruqui et al. (2010) further found that providing feedback on energy consumption resulted in consumers making more efficient use of energy by saving on average 7% of energy. However, while feedback is considered a valuable learning tool, it should be used in context because outcomes from feedback can vary according to circumstances, but energy-savings may be improved when feedback is used simultaneously with advice and information (Darby, 2006). In this way, further energy-saving advice and information should also be clear and simple for the energy user to implement as this is critical in encouraging PEB (Abrahamse and Steg, 2009; Delmas et al. 2013).

Although interventions can yield reduction in consumption and thus promote PEB, their effectiveness is, broadly speaking, shaped by a complex suite of socio-demographic (Barr, 2007; Abrahamse and Steg, 2009; Anderson et al. 2013) and personal (internal) factors (Stern, 2000; Blok et al. 2015). In other words, similar interventions can yield varied outcomes in different households, as shaped by various internal and external factors (See Chapter 2, Section 2.2.1). With regards to socio-demographic factors, it has been found that their influence on energy-saving is varied; for example, Frederiks et al. (2015) found small or statistically insignificant support for age and gender differences in determining household energy consumption. Yet, education was typically found to be related to more knowledge, awareness and concern for environmental issues. In the same study, household income tended to be positively related to residential energy consumption (Frederiks et al. 2015). In addition, household size was found to be positively associated with energy consumption; as was dwelling size, for example floor space and the number of rooms (Frederiks et al. 2015. This would most likely be due to the higher average energy consumption level in a household that has more individuals consuming energy, and the larger surface area that would require more energy to heat and cool. Barr et al. (2005) found age, homeownership and household income to be important predictors of energy behaviour. Martinsson et al. (2011) found that generally, people with higher incomes do not save electricity because the economic incentives are not persuasive enough. Melo et al. (2018) also found higher consumption levels and lower PEB scores for individuals and households with higher income levels. In contrast, Thondhlana and Kua (2016) found that energy conservation was not determined by socio-demographic factors in low-income South African households. Further, Poruschi and Ambrey (2016) found that residents in densely urbanised areas are said to be more progressive and environmentally conscious

(Poruschi and Ambrey, 2016). This highlights the need for further investigation into the relationship between energy-savings and higher income households within a South African suburban context as there are varied outcomes relating to the relationship between socio-demographic factors such as income, household location and energy-savings. It also speaks to the multitude of possible determinants of PEB within a household context.

A possible way that researchers can make sense of (and predict) various pro-environmental behaviours is by using behavioural theories and frameworks formed in response to common behavioural findings.

3.2.2 The Theory of Planned Behaviour

Concerning the determination of the external and internal factors that influence pro-environmental behaviour (PEB), and therefore the effectiveness of interventions, the Theory of Planned Behaviour (TPB) (Ajzen, 1991) is often used as a starting point (Figure 3.1). The TPB in short, states that a person's attitude towards behaviour, subjective norms and perceived behaviour control together create a person's intention to act (Azjen, 1980). In other words, intention could be positively or negatively inclined towards pro-environmental behaviour. Therefore, this behavioural theory could be considered useful in providing a framework for exploring factors that can predict whether or not a person may be motivated to engage in PEB and the reasons for these motivations or lack thereof.

The TPB has been argued to be better suited to understanding consumer energy efficiency behaviour, especially in a residential context due to the links it identifies between beliefs and behaviour (Sarkis, 2017). The TPB argues the 'intention to act' as the most prominent predictor of behaviour. The TPB states that three factors are responsible for influencing a person's intention to act. These are attitudes towards a behaviour, subjective norms and perceived behavioural control. These three factors all relate to one another; for instance, the attitude of a behaviour determines a person's behaviour, which is motivated by beliefs and assessments of it (McDonald, 2014). This attitude can then lead to an intention to act. But what exactly do attitudinal behaviour, subjective norms and perceived behavioural control consist of?

A person's attitude towards behaviour is the positive or negative evaluation of the behaviour and its expected outcomes (Ajzen and Fishbein, 1980; Kollmuss and Agyeman, 2002).

Subjective norms are connected to social pressures exerted on an individual due to perceptions of what others think they should do and their propensity to conform to these (Gronhoj and Thorgersen, 2012; Al-Mamary et al. 2016); for example, a person may practice recycling or purchase solar panels because the wider community supports these actions and so participate in recycling and purchasing of solar panels as well. Also, community members may ask or persuade an individual to contribute to sustainable living by practising PEBs. Such things could make a person feel socially pressured to engage in PEB. This is supported by Mtutu and Thondhlana (2016) who found that people will likely engage in PEBs if they see that other people are actively involved in them. Lastly, perceived behavioural control is the "perceived ease or difficulty with which the individual will be able to perform or carry out the behaviour, and is quite similar to ideas of self-efficacy" (Armitage and Connor, 200:479). This factor is related to responsibility - those who feel that they cannot influence a situation or should not have to take responsibility for environmental issues are less likely to act in a pro-environmental way while the opposite is true. Further, if an action is perceived to be difficult or inconvenient to undertake, a person may be less willing to engage in the action (Blok et al. 2015). Robust links have been found between behaviour and the attitudes towards the behaviour and perceived behavioural control (e.g. Wall et al. 2007; Ohnmacht et al. 2017). Whitmarsh and O'Neill (2010) found background and attitudinal variables to be significant predictors of PEB. Similarly, Klockner (2013) found the most robust determinant of environmental behaviour to be intentions followed by habit strength, while perceived behavioural control had a weaker impact on behaviour. Mannetti et al. (2004) found perceived behavioural control to be the most important predictor of the intention to recycle and engage in PEB. Klockner and Oppedal (2011) reported similar results for PEB regarding recycling. Frederiks et al. (2015) found that energy-saving measures that did not compromise personal comfort had a powerful influence on household savings. Bedir et al. (2013) also found comfort dimensions to be related to household electricity usage. Based on the findings from Blok et al. (2015), pro-environmental interventions are encouraged to focus on interventions which increase behavioural control aspects.

It is suggested that TPB can predict about 20-30% of the variance in behaviour owing to interventions, and a greater proportion of intention (Armitage and Connor, 2001; Palmeira et al. 2007; Wilson and Dowlatabadi, 2007; Morris et al. 2012). There is some criticism, however, that the TPB is limited because it is not considered useful for planning and designing interventions that generate behaviour change (Hardeman et al. 2002; Taylor et al. 2007; Webb

et al. 2010). This means that if energy-saving interventions aim to be successful, they will need to be diverse in combining and taking into account personal and situational factors. Therefore, there should be consideration of the surrounding and influencing environment of where PEB would take place, as well as the varying personal values factors of the individual that would influence PEB change.

Similar to the VBN theory (Chapter 1, Section 2), altruistic beliefs have been included into the TPB because altruistic concerns are said to activate the beliefs about a person's responsibility, and the consequences of their actions, and their norms that would be activated; which would then affect their behaviour (McDonald, 2014). Thus, drawing on a person's individual responsibility to behave in a socially, and therefore environmentally responsible way. Further, unlike the VBN theory, the TPB does not consist of a psychological construct which directly supports morally grounded environmental action for the public good (Sarkis, 2017). The VBN theory adds to Azjen's causal chain by showing that environmental beliefs are interceded by personal values (e.g. altruistic values, egoistic values (Oreg and Katz-Gerro, 2006). De Groot and Steg (2008) support this by noting that stable PEB can be promoted when people act in line with altruistic and biospheric values. Pro-environmental attitudes were found by Meinhold and Malkus (2005) to significantly predict PEB. Adding to this, Barr and Gilg (2006) revealed how environmentalists evidently exhibit a positive, confident and responsible attitude toward environmental protection. However, Whitmarsh (2009) noted on a study conducted in the UK that of the 40% of the English public who claimed to regularly cut down on electricity 81% did so to save money, while only 17% reported cutting down for environmental reasons. The UK study highlighted that the determinants of pro-environmental intent and environmental impact should be understood separately (Whitmarsh, 2009). Therefore, although there is evidence of links between PEB and pro-environmental values and attitudes, there has also been found evidence of pro-environmental values and attitudes not translating to positive environmental action and impacts (Kollmuss and Agyeman, 2002).

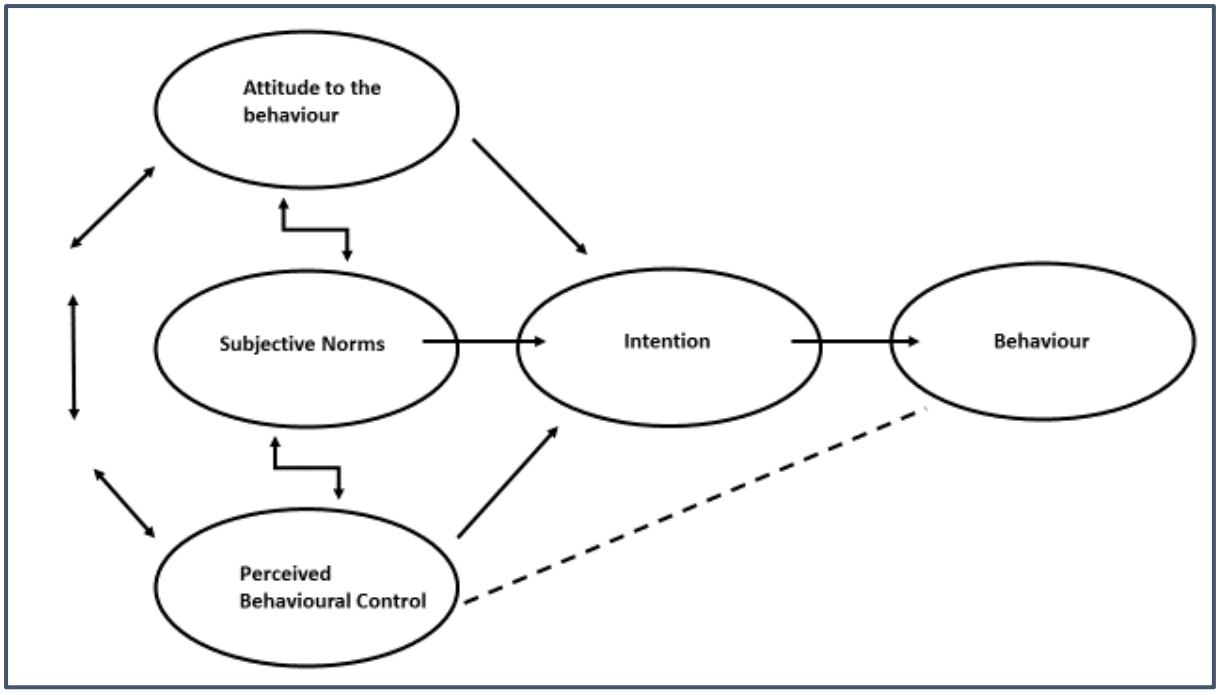

***Figure 3.1**: Theory of Planned Behaviour (Azjen, 1980).*

Therefore, although it may seem reasonable to assume that consumers who are interested in decreasing pollution and report anti-pollution behaviours would also limit their energy consumption; it may not always be so (Heslop et al. 1981). As was confirmed by Bulunga and Thondhlana (2018:786), "the willingness to engage in pro-environmental behaviour does not always translate into pro-environmental actions". For many years it has been recorded how social and ecological consciousness has not always been found to be completely connected, and similar demographic and personality variables do not necessarily correlate to both (Anderson et al. 1972; Heslop et al. 1981; Kennedy et al. 2009; Heberlein, 2012). Tucker and Speirs (2003) concur with this argument that should people value environmental quality over financial implications, their environmental values need to be exceedingly important before they promote the motivation to behave. However, other dynamics outside of values and situational factors such as household norms and habit have also shown their sway over PEB (Kollmuss and Agyeman, 2002; Abrahamse and Matthies, 2012)

There are however, other external factors not centred on the individual (Chapter 2, Section 2.2.1), which should also be considered. These external factors can be identified as conditions required and infrastructure available that allows people to engage in PEB (Blok et al. 2015). For example, recycling facilities (Mtutu and Thondhlana, 2016) and environmentally friendly technology (Sorqvist et al. 2015) can promote PEB. The easier it is for one to perform a pro-

environmental action, the more likely it is that one will perform the action (Blok et al. 2015). Thus, it is possible for people to have the motivation or desire to behave pro-environmentally, but do not do so in practice due to a lack of supporting infrastructure, facilities or conditions. These external factors that constrain PEB regardless of attitude or intention to act pro-environmentally can also relate to lack of time, money and information. For example, regularly defrosting a refrigerator or switching off a geyser during certain times of the day may be considered too time-consuming for an individual. Purchasing less energy consumptive appliances could be financially burdensome for some individuals or households, or individuals may not be aware of the consequences (and mitigation measures) for over-consumptive lifestyles such as resource depletion. Despite the complexity of these factors in explaining PEB, they provide insights into what constraints or promotes PEB. Based on the literature, it is expected that a combination of energy-saving interventions promote pro-environmental behaviour as illustrated by the reduction in household energy consumption, though the level of energy reduction may vary between households due to various conditions experienced by the households.

A good understanding of why people participate or refrain from pro-environmental energy conservation practices will also aid in informing energy policies aimed at the residential sector. However, despite the global traction around encouraging PEB as a strategy for promoting sustainable energy use at the household level, there is comparatively less research enquiry on the effectiveness of interventions in reducing energy consumption in the developing world than the developed world (Davis and Durbach, 2010; Thondhlana and Kua, 2016). Consequently, the literature on the potential of household energy-saving via behaviour change interventions is still thin in the developing world. In light of this context, the main aim of this study is to examine the effectiveness of intervention measures aimed at promoting household energy conservation. Key questions include: (1) what are the effects of different intervention strategies on household energy consumption, (2) what factors influence reductions in household energy consumption and (3) what are implications of the findings on policy debates on and practical solutions household energy conservation for promoting sustainable energy use at household level in South Africa and beyond?

Therefore, the scholarly contribution of the study lies in that it focuses on the effectiveness of behaviour change interventions of high-income households in a developing country context. Potentially, the study contributes to our understanding of how and why behavioural

intervention strategies for encouraging pro-environmental energy use behaviour may be effective in reducing energy consumption within a different social context. As a result, this knowledge contribution could then potentially assist in developing African energy-saving policies that promote the sustainable use of energy resources and add to the body of literature supporting the use of knowledge in creating dynamic participation with energy issues.

3.3 Methodology

3.3.1 The Study Area and Participants

The study took place in Edenvale, a suburban area within Johannesburg, South Africa. Edenvale has a total population of about 49 292 people and 17 119 households. Nearly all homesteads in Edenvale (98.9%) are considered formal dwellings (STATS SA, 2011). According to STATS SA (2011), nearly all households (99.3%) in Edenvale have access to ESKOM supplied electricity. Ekurhuleni which is the district municipality of the study area is classified as an urban area displaying both informal settlements and elite urban residential suburbs (Stats SA, 2011). About 15% of the Ekurhuleni population is said to have higher education (Stats SA, 2011). The unemployment rate sits at 29% while 72% of the population is between the working ages of 15 and 64.

3.3.2 Data Collection

The household energy use intervention programme started in January 2017 to June 2017. One-hundred and twenty households were approached to participate in the study of which 91 responded positively (see Chapter 2 Section 2.3.2 for further details regarding how the participants were approached). The questionnaire was designed to capture household energy consumption data during the study period. Each household documented its monthly electricity consumption (kWh) and cost (ZAR) in a logbook from January 2017- June 2017. It is important to note that June, July and August are the winter months in South Africa, often associated with increased energy consumption due to increased heating. Therefore, a total of six (6) months' worth of data regarding electricity consumption and cost was collected. Data collection involved the following three (3) stages, explained in detail in the following section:

- Stage 1: During the first month (January) questionnaires were administered to capture household socio-demographic information and monthly energy consumption. Logbooks were also distributed to record energy use for the duration of the study or the

intervention period. In the logbooks, participant households logged monthly energy consumption. The 91 households were randomly divided into two (2) main groups, the Treatment group and the Control group. The Treatment group refers to the group of households that received a suite of energy-saving information. The Control group refers to the group of participant households that did not receive any energy-saving information as a basis for benchmarking against the intervention results (from the Treatment group). The Treatment and Control group were classified using a simple convenience sampling approach. When households were approached to explain the proposed research and encourage voluntary participation, one house was selected as the control and the following house would be selected as the treatment. Households were approached based on whether the households were located within an enclosed 'boomed-off' area. The Treatment and Control participants were given log books with a different colour coded sticker on it to distinguish between the two groups. Furthermore, the household numbers and street address were recorded in a separate log book recording next to each household (that chose to participate and with their permission) which households formed part of the Control group and which ones formed part of the Treatment group. This gave a 'one-for-one' style, and was repeated until 120 households were approached. In this way it allowed for roughly an even number of participants for the Control and Treatment groups. However, as is expected with voluntary research participants, many of the participants lost momentum and some opted out of the research half way through, or some did not consistently record there energy consumption (they skipped some months). These results were discarded from the rest of the energy consumption data. Thus, only complete data from 91 households was used for analyses.

- Stage 2: Following this, energy-saving interventions were distributed to households within the Treatment group. The Treatment group was given information on energy-saving to encourage energy-saving during the second month of the study (February) to test if the interventions would trigger a change in energy consumption behaviour. These interventions were in the form of information brochures, information and reminder stickers. These energy-saving tips were consistent with those developed by the South African public utility ESKOM (Demand Side Management, 2008). The brochures included information on turning off lights in empty rooms and making use of natural light, ensuring fully loaded tumble dryers and washing machines, filling kettles in

accordance with the amount of boiled water needed, cleaning out vacuum bags and refrigerators regularly, degreasing microwaves, using heat for ovens efficiently, leaving electronics on and unplugging appliances that are not in use, and closing windows and doors when fans and heaters are in use. The stickers that were provided had similar tips and recommendations provided in the brochure. However, the stickers served more as reminders than information documents. Monthly reminders were also given to both the Treatment and Control group to encourage consistent recording of monthly household energy consumptions. These reminders were printed on paper and distributed to the households similar to flyers. During the period of the study, households in the Treatment and Control groups were not informed of the differences in the interventions employed. At the end of the sixth month (June) and into the seventh month (July) the logbooks and other energy data were collected, captured and analysed.

- Stage 3: A final questionnaire of the usefulness of the intervention measures was administered to the Treatment group only. In this third stage of the survey (the sixth and seventh months) the final questionnaire was used to determine if the Treatment group read the energy-saving information, how often they read the information, if they shared the energy-saving information with their family members, and if they found the intervention programme to be usefulness with response options ranging from 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree. This questionnaire was meant to find out if the participants felt the energy-saving tips were useful, given that actions that are easy to do can promote PEB and those that are difficult to perform may constrain PEB.

3.3.3 Data Analysis

Following the approached used by Thondhlana and Kua (2016), after the interventions had been implemented, energy-savings were calculated by subtracting recorded actual energy consumption of the current month from the previous month energy-saving. In analysing the data, non-parametric tests were used because the energy consumption data failed Levene's test for normality. Mann Whitney U Tests were used to compare monthly household energy consumption between the Treatment and Control group during the treatment period. A multiple regression analysis was used to assess the influence of socio-demographic and external variables on household energy consumption. A correlation analysis was performed to

determine the relationship between energy reductions and the various explanatory variables (socio-demographic and personal factors). Descriptive statistics (frequency counts) were conducted to determine the proportion of respondents who read the leaflets, shared them with family members and thought that energy-saving intervention programme was useful.

Table 3.1: *Summary of data analysis methodologies*

Data Analysis Method	Reason for Method	Number of households)
Subtracted actual energy consumption of the current month from the previous month	Determine energy-savings over the treatment period	91
Mann Whitney U Tests	Compare monthly household energy consumption between the Treatment and Control group during the treatment period	91
Multiple regression analysis	Determine the influence of socio-demographic and external variables on household energy consumption	91
Correlation analysis	Determine the relationship between energy reductions and the various explanatory variables (socio-demographic and personal factors)	91
Descriptive statistics (frequency counts)	Determine from the Treatment group who read the leaflets, shared them with family members and thought that the energy-saving intervention programme was useful	45 (Treatment group)

3.3.4 Limitations

The limitations of this part of the research potentially lie in 1) the potential discrepancy between total reported energy consumption (kWh) and actual total energy consumption and 2) the potential yes-saying bias for socially desirable behaviours (Menton et al. 2010). In other words, participants may underreport their energy consumption levels on purpose to display pro-environmental behaviour change. The third limitation specific to this section of the study is that the study looked at energy consumption at the household level as a whole and not at the levels per household appliance. Therefore, although the study provides insight into household energy consumption levels, it does not specify exactly what areas of household energy use should be prioritised for intervention. However, despite the above-mentioned limitations, the study can provide helpful insights regarding household energy consumption levels and effects of information interventions on energy consumption.

3.4 Results

3.4.1 Socio-Demographics of the Sample

The socio-demographics of the sample are similar to those mentioned in Chapter 2, Section 2.4.1.

3.4.2 Household Energy Consumption Before and After the Energy-Saving Interventions

The average baseline (before interventions) electricity consumption for all households combined was 1467 kWh per month. When analysed by Treatment group the baseline consumption was 1478 kWh per month for the Control group and 1484kWh per month for the Treatment group (Table 3.2). Comparison by group shows that monthly energy consumption for the Control group (1460 kWh and 1496 kWh) was marginally different from the Treatment group (1475 kWh and 1493 kWh) in January and February before application of interventions and was not statistically significant (Table 3.2).

Table 3.2: *Average (± SD) monthly household energy consumption (in kWh) during the intervention period. * Denotes significant difference.*

Period	**Control (kWh) (1478 kWh baseline)**	**Treatment (kWh) (1484 kWh baseline)**	**Difference (in kWh) (Control –Treatment)**
January (baseline)	1460 ± 893	1475 ± 1339	-15
February (baseline)	1496 ± 914	1493 ± 1288	3
March	1485 ± 872 (+7)	1450 ± 1237 (-34)	35
April	1580 ± 891 (+102)	1468 ± 1192 (-16)	112
May	1670 ± 974 (+192)	1422 ± 1191 (-62)	248*
June	1827 ± 1022 (+349)	1498 ± 1168 (+14)	329*
Difference between January and June	367	23	314

Further analysis showed that on average the monthly energy consumption for households in the Control group was about 10% above baseline consumption compared to 2% below baseline for the Treatment group. This means that the Treatment group saved about 12% more energy than the Control group.

Comparison of January and June energy consumption shows the Treatment group recorded a smaller energy increase (23kWh) than the Control group (367 kWh).

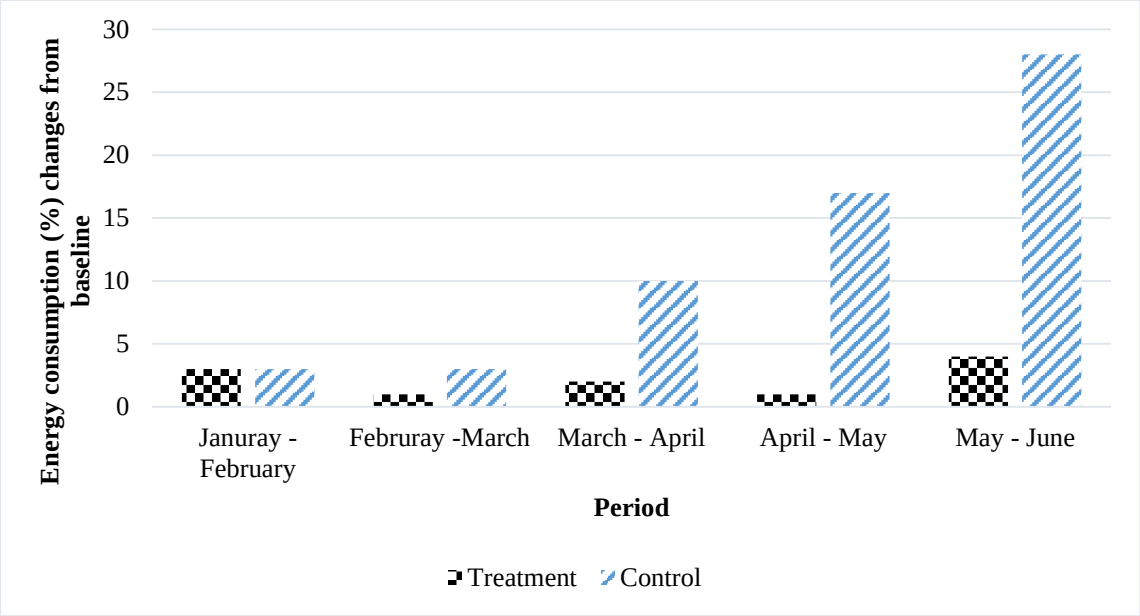

Figure 3.2: *Household energy consumption (kWh) changes from baseline between Control and Treatment groups*

After the application of interventions in the Treatment group at the end of February, it was observed that the differences in average energy consumption between the Control and Treatment groups increased from 35 kWh in March to 329 kWh in June (Table 3.2), though significant differences were only recorded in the months of May (248 kWh) ($Z = 2.552$; $p < 0.05$) and June (329 kWh) ($Z = 2.798$; $p < 0.05$).

In general, the results show a steady increase in energy consumption during the intervention period which is most likely a function of the change in seasons from warmer to colder periods (Figure 3.2). However, when analysed by group, the findings show that the Control group's energy consumption from baseline increased nearly 50 times from 7 kWh in March to 349 kWh in June, while the Treatment group recorded reductions in energy consumption from baselines in March, April and May (except for June) where energy consumption went above the baseline. The results seem to suggest that interventions yielded positive behavioural changes within the Treatment group.

3.4.3 The Relationship between Energy Reduction, Socio-Demographic Factors and Personal Value Factors

A correlation analysis was performed between the actual energy reduction and socio-demographic factors (Table 3.3). None of the socio-demographic factors considered yielded relationships with energy consumption reduction. Another correlation analysis was performed between the actual energy reduction and the reported personal value factors (QoL) (Tables 3.3 and 3.4). Similarly, no personal value factors yielded significant relationships with energy consumption.

Table 3.3: *Spearman's Rank Order Correlation results between energy reduction and socio-demographic variables.*

Variable	Valid N	Spearman R	t(N-2)	p-value
Age of respondent	45	-0.005277	-0.034607	0.972554
Sex of respondent	45	0.092975	0.612327	0.543546
Household size	45	-0.040743	-0.267393	0.790445
Number of rooms in house	45	0.033335	0.218714	0.827908
Number of dependents	45	0.096040	0.632701	0.530279

Table 3.4: *Spearman's Rank Order Correlation results between energy reduction and personal value factors*

Variable	Valid N	Spearman R	t(N-2)	p-value
Aesthetic beauty	45	0.001948	0.01278	0.989865
Environmental quality	45	0.048446	0.31806	0.751981
Social justice	45	0.233391	1.57392	0.122837
Nature	45	0.020917	0.13719	0.891522
Challenge/excitement	45	-0.146884	-0.97374	0.335630
Change	45	-0.020217	-0.13260	0.895132
Comfort	45	-0.218465	-1.46803	0.149374
Leisure time	45	-0.192281	-1.28485	0.205724
Education	45	-0.056472	-0.37091	0.712529
Work	45	-0.195175	-1.30494	0.198853
Freedom	45	0.135937	0.89975	0.373265
Private	45	0.221801	1.49160	0.143105

Health	45	0.134066	0.88714	0.379939
Identity	45	0.036859	0.24186	0.810037
Family	45	0.098878	0.65158	0.518141
Safety	45	0.136340	0.90247	0.371837
Security	45	0.267560	1.82090	0.075585
Social relations	45	-0.018082	-0.11859	0.906153
Material beauty	45	-0.234141	-1.57927	0.121604
Money/income	45	-0.049094	-0.32232	0.748773
Social status	45	-0.195122	-1.30458	0.198976

Table 3.5: *Spearman's Rank Order Correlation results between energy reduction and aggregated personal value factors.*

Variable	Valid N	Spearman R	t(N-2)	p-value
Universalism	45	0.079721	0.52444	0.602669
Stimulation	45	-0.074260	-0.48830	0.627815
Hedonism	45	-0.290971	-1.99432	0.052482
Achievement	45	-0.167408	-1.11348	0.271688
Self-Direction	45	0.204787	1.37196	0.177193
Security	45	0.145246	0.96265	0.341106
Power	45	-0.209485	-1.40486	0.167247
Benevolence	45	0.005925	0.03885	0.969189

3.4.4 Perception of Energy-Saving Interventions

Questionnaires were administered to households in the Treatment group to gauge their perception of the energy-saving interventions (Annexure 3).

Table 3.6: *Perception of interventions of the Treatment group. Results show a relatively positive response to the interventions. The responses were scored according to 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree*

Perception Questions	Score	Score as Percentage (%)
All your family members know they are part of this research	3.9	77

The leaflets provide useful information about energy reduction	3.4	69
The information is easy to access therefore the recommended measures are practised	3.4	67
You have changed your behaviours towards a more energy efficient way	3.3	66
Why do you practice the recommended measures? I am concerned about the environmental problem	3.5	70
You practice the recommended measures so that you can save money	3.5	70
Encouragement makes me perform the recommended measures	3.3	65
Because the energy reduction information is from trusted persons or organisations, the recommended measures are performed	3.2	63
A sense of satisfaction is obtained after practising the recommended measures	3.2	63
If the measures are easy to perform, they are more likely to perform; if they are difficult, they are unlikely to perform	3.5	69
Rate the programme	3.5	70

Survey results on the usefulness of the intervention programme show that 77% of the participants shared saving information with their family members (Table 3.6). Just about two-thirds of the respondents felt that the leaflets were useful in explaining energy-saving tips (69%) and the tips were easy to access (67%) – suggesting that a sizeable proportion felt otherwise. About 69% of those in the Treatment group felt the easier the interventions are to perform the more likely they are to engage in the energy-saving interventions, and the less likely if the interventions are difficult to perform. Out of all the participants, only 66% indicated they had actually changed their behaviours due to the energy-saving measures. The least

positive responses at 63% were those that agreed with the statements that energy reduction took place because the information provided is from a trusted source, and due to a sense of satisfaction after practising the energy-saving interventions. However, overall, the programme was rated positively with a score of 3.5 by 70% of respondents.

3.5 Discussion

3.5.1 The Effectiveness of Energy-Saving Intervention Strategies

In light of energy reductions in the Treatment group, the average monthly energy consumption levels were still considered high for both the Control and Treatment group. The high average electricity consumption could be attributed to general characteristics of higher income lifestyles. This is worth noting seeing as the average house size found in this study was quite large with an average of 9 rooms per household.

From the previous research conducted by Statistics South Africa (2013), it was evident that greater levels of electricity consumption are prevalent in households with higher income levels. This could be attributed to Gauteng consisting of two major cities: Johannesburg and Pretoria. Such features are consistent with Poruschi and Ambrey (2016: 1) who found that "there are characteristics unique to living in a city linked to higher levels of direct residential energy consumption". Unfortunately, Poruschi and Ambrey (2016) also found that residential households in cities are less likely to participate in energy-saving behaviours. Nonetheless, findings from this research contradicted this as the Treatment group responded well to the energy-saving interventions in spite of living in a city area.

However, regardless of the monthly increases for both groups, the results reflect that the energy-saving interventions proved to be a success with the Treatment group saving 12% more energy than the Control group when considering consumption before interventions in January 2017 and consumption at the end of the intervention programme (June 2017). This lends support to the fact that energy-saving interventions such as information provision and self-monitoring (via recording monthly energy consumption) yield energy-saving behaviours. These results support similar findings from Ajzen (1985); Dennis et al. (1990); Vining et al. (2002); Abrahamse et al. (2005); Fischer, (2008); Kua and Wong (2012) and He and Kua (2013) who all recorded increased energy-savings from information interventions. A relatively recent study by Thondhlana and Kua (2016) in low-income households in South Africa found

that interventions resulted in energy consumption reduction. Palm (2010) also supports these findings, stating that the potential to reduce 30% of energy consumption by using information tools. These reductions are likely due to the households (Treatment group) being provided with information on how to save electricity, therefore broadening energy-saving awareness and knowledge, and due to the monthly reminders that were sent out to log electricity consumption which led to self-monitoring of monthly consumption levels. However, it should be noted that these positive results came from only 6 months' worth of data collection. It could not be determined if these positive energy-savings continued after the study period. Therefore, there is a need for research that conveys the longevity effects of the interventions to confirm that these positive behaviour changes were in fact permanent changes. Nahiduzzaman et al. (2018) note that studying longevity effects for energy-savings is currently a knowledge gap and should be included in future discussions. Especially since as noted in Chapter 1 Section 1.2, the relatively cheap source of coal that is the primary source of electricity in South Africa, may make long-term financial incentives towards energy-savings seem negligible (Bradley et al. 2016).

The self-monitoring (recording of monthly consumption) provided feedback for households to compare their consumption levels throughout the study period. Effects of feedback regarding energy consumption have proven success in reducing household consumption levels. Darby (2006) established 20% reductions in consumption levels due to improved feedback. Comparisons can foster intentions for energy-savings, for instance, feelings of competition and ambition (Fischer, 2008). They can also help assess if consumption within a certain period or of a certain household is below or above average, thereby making consumers take note of their consumption and alerting them to a potential problem and initiating the pursuit for reasons and redress (Fischer, 2008). However, self-monitoring and its indirect effects of comparisons were conducted by both the Treatment and the Control group. In light of this, the Treatment group consumes significantly less energy than the Control group. The significant energy consumption differences however, could be a result of the 'combination' of the information provision and self-monitoring, comparative feedback. Thondhlana and Kua (2016) found that a combination of measures rather than a single measure approach to energy-saving could yield maximum results. This is also in line with a study by Heiskanen et al. (2013) and the findings of Abrahamse et al. (2005) that found combining energy reducing interventions to be more effective than just using one type of intervention.

The effectiveness of the energy-saving interventions in the Treatment group is also supported by a substantial proportion of respondents who said they felt the interventions provided useful information. From the responses of the perceptions study, it can be said that interventions that include the entire household members, provide useful information, encourage sustainability (both environmentally and economically), and are easy to perform are likely to encourage energy-savings. This supports the TPB model which supports perceived behavioural control (ease with which a person can carry out a behaviour) as a significant determinant of behaviour (Azjen, 1988). This supports the research findings because when a household is better equipped to carry out PEB such as having the correct information and household member support, it would be easier for that household to practice energy conservation. Abrahamse et al. (2005) and Delmas et al. (2013) both confirmed that when useful information is provided about potential energy-savings it promotes PEB. When information is useful to the energy user it may assist in the positive and negative evaluation of saving energy by providing a greater understanding of the impacts of energy-savings or an energy-saving intervention, which may shape an individual's attitude either positively or negatively towards PEB (Abrahamse et al. 2005; Delmas et al. 2013; Zsoka et al. 2013; Fornara et al. 2016). This supports the TPB model which attributes attitudes (the positive and/or negative evaluation of the behaviour) in determining behaviour (Azjen, 1988). Providing useful information can assist in households forming more positive attitudes towards energy-savings measures and behaviours, thereby encouraging PEB. Fujimi et al. (2016) found that in Japan, habitual energy-saving measures that do not require frequent efforts or involve high levels of discomfort such as reducing the brightness of lights and lowering refrigerators' cooling intensity can be effective and persistent.

However, not all respondents reported having changed their behaviour because of information provision. This is consistent with literature from Kua and Wong (2012), Mtutu and Thondhlana (2016) and Thondhlana and Kua, (2016) who noted energy consumption differences within study groups, however not all participants reduced their consumption levels. The finding that interventions that encourage environmental and economic sustainability would be more effective also confirms the VBN theory which highlights how a person's value towards environmental quality is a positive predictor of PEB (Poortinga et al. 2004). In other words, if a proposed intervention is aligned to a household's value (which in this case would be environmental and economic sustainability) it has a greater chance of being accepted.

3.5.2 Relationship between Energy Reductions and Socio-Demographic Factors

No significant relationships were found between socio-demographic factors and electricity reduction. Although much research has confirmed energy reductions and/or increases with values and socio-demographic factors (Purcell and Magette, 2010; Kua and Wong, 2012; He and Kua, 2013), discrepancies between energy behaviours, values and socio-demographics have also been found within research (Abrahamse and Steg, 2009; Musango, 2014; Huebner et al. 2015; Blok et al. 2015; Mtutu and Thondhlana, 2016).

Musango (2014) found in some instances the use of electricity to be indifferent to the level of income, population group or even education. Diamantopoulos et al. (2003) found that socio-demographic variables could not accurately account for the behavioural domain regarding PEB relating to recycling and purchasing green products. Abrahamse and Steg (2009) did not find any correlations between household energy reductions and socio-demographic factors. Huebner et al. (2015) admitted limitations regarding the amount of variability in domestic energy consumption that they could provide explanations for. In spite of using all variables measuring a variety of predictor types, they could only explain just under half of the variability in domestic energy consumption, and household building variables (e.g. glazing) dominated the explanation of domestic energy consumption over socio-demographic variables (Huebner et al. 2015). Mtutu and Thondhlana (2016) also found the majority of the personal value and situational factors (socio-demographics) were not positively related to PEB and the scarce factors that did yield significant correlations displayed weak relationships. Further, Blok et al. (2015) found that personal norms, environmental awareness and self-transcendent values did not have a significant positive relation with PEB.

A possible explanation for the lack of significant correlations found could be that the personal values and socio-demographic factors measured in this study were not comprehensive enough and other personal values and socio-demographic factors need to be considered. For example, other socio-demographic factors such as occupation, marital status, religion and personal value factors concerning lifestyle, consumption, emotional stability, agreeableness and conformity. Another explanation is that although a household may identify with a personal value factor, the household may not understand the connection of that value factor to energy-savings (Kua and Wong, 2012). A further explanation could be that the intervention strategies provided to the Treatment group were influential enough not to be impacted by the personal values or socio-demographics of the Treatment group. In other words, the intervention strategies provided to

the Treatment group transcended personal value factors and socio-demographic factors. This could prove beneficial in motivating for the broad applicability of information provision regardless of the values of socio-demographics pertinent to South African households.

Energy reduction practices may also have been enforced throughout the study by fostering energy-saving habits. These habits could form regardless of socio-demographic factors or personal values, but rather by having an 'energy champion' in the household constantly reminding and encouraging other household members to practice energy conservation (Klockner et al. 2003; Steg and Vlek, 2009). This energy champion could have instilled household energy-saving habits through the monthly reminders that were distributed and the stickers that were given out with the purpose of encouraging PEB by reducing electricity consumption. These habits could then have filtered down to other household members. Gronhoj and Thorgersen (2009) explain this with their findings of positive correlations between parents and their children who conserve electricity and have pro-environmental values. In other words, if parents were found to practice energy conservation and have pro-environmental values so did their children. Therefore, if a parent (who is a typical head of the household), formed pro-environmental habits, it is likely that other household members (i.e. children) also did. Although this cannot explicitly be found in the data of this research, significant energy reductions were found and therefore it is a possibility that positive PEBs were adopted by more than one household member.

Abrahamse and Matthies (2012) explain the formation of habits with 'prompting'. Prompts can be assumed to overrule the automatic elicitation of a problematic behaviour through a short written message or sign which draws attention to a specific behaviour in a given situation (Abrahamse and Matthies, 2012). By consistent prompting from the energy-saving interventions provided, the household could have formed energy-saving habits. Austin et al. (1993) used prompts to encourage recycling and proper disposal of trash, of which resulted in the improved correct disposal of both recyclables and trash by 54% and 29%.

Although more in-depth details of the household's lifestyles were not investigated in the study, Sukarno et al. (2017) provide further evidence of how lifestyle factors influence levels of energy consumption. Sukarno et al. (2017) found that in Indonesian households, cooking activities consumed the most energy due to the number of electric appliances used, and households with retired dwellers and housewives generally consumed more electricity due to

long hours spent at home. These types of aspects regarding household lifestyle and its subsequent influence on energy consumption can be studied further to further understand the energy consumption-lifestyle dynamic and provide appropriate policies for fostering more sustainable energy use. Wang et al.'s (2011) study of Beijing residential electricity consumption resulted in the recommendation that policymakers give further attention to the rising electricity consumption of residents living in larger dwellings and recommended tiered pricing for household electricity. In this way, households who pay a higher marginal cost of electricity due to their large dwellings would then have to give more attention to their daily electricity consumption (Wang et al. 2011). This could be an example of fostering financial incentives into electricity savings. However other incentives, such as simplicity, have proven effective. Adding to this, Nakamura (2016:683) advocated to government the importance of "promoting electricity savings and educating the public on reasons to save electricity in order to encourage energy-saving behaviour. Even if people are not willing to save electricity, the understanding of the importance of energy-saving can work to some extent to elicit their cooperation for electricity saving".

Therefore, it may be beneficial for policymakers (when targeting certain population groups) to ascertain the distinctive household profile because diverse consumer groups and households have different characteristics, requirements, and living conditions (Frederiks et al. 2015). Comprehending the distinct profiles of energy consumers will improve the ability of policymakers to identify and target prospects for effective behaviour change, along with the messages and motivational strategies that have a higher chance of sustaining that change in the targeted population. (Frederiks et al. 2015). Therefore, still allowing energy-saving measures to be vastly applicable, but vastly applicable to households of the same socioeconomic status or income level. However, even if separate households display the same socioeconomic status, there might still be barriers preventing them from engaging in pro-environmental energy-saving behaviour. There may even be no barriers but a lack of desire to engage in PEB.

3.5.3 Relationship between Energy Reductions and Personal Factors

No correlations were found between the energy reductions and the reported personal value factors of the household. Kua and Wong (2012) suggest that this could be because the designed interventions may not relate to respondents' values to the environmental context of the study. For example, even though a respondent may consider a QoL factor to be important, the

respondent may not be able to understand how saving energy at home can contribute to a QoL factor. Therefore, even though a household member may value a sense of security or leisure time, they may not understand how that relates to practising energy-saving or pro-environmental behaviour at home. Gatersleben et al. (2014) also provide an explanation regarding how attitudes or feelings towards PEB may not always be related to other behaviours. For example, "people who have a positive attitude towards recycling are more likely to recycle, but this does not mean they also cycle to work or use ecological washing powder" (Gatersleben et al. 2014:375). Here it becomes evident that a person's attitudes or values are not always aligned to or can completely explain their actual behaviour.

The results from the perception questionnaire of the interventions by the Treatment group however, provide some connections to the energy-saving results. The results from the perceptions suggest that interventions should be simple to implement. Basically, those who value leisure time, i.e. "having enough time after work and household work and being able to spend this time satisfactorily" (Poortinga et al. 2004:74) are less likely to practice energy conservation. This is also affirmed by Schwartz model (1994) that values of self-enhancement which relates to leisure time, are negative predictors of pro-environmental behaviour. It is also in line with the Theory of Planned Behaviour (TPB) (Azjen, 1991) that the influence of perceived behavioural control (the ease or difficulty of practising PEB) can determine pro-environmental action. Therefore, it can be argued that when energy-saving interventions are less time-consuming and easier (i.e. allow for more leisure time and perceived behavioural control) they could be better implemented, as was confirmed by the respondents' perceptions on how they felt (or perceived) about information provided (just over a third of the participants thought the information was not easy to access). Such recommendations have also been confirmed by the findings of Palm (2010), Kua and Wong (2012), Mtutu and Thondhlana (2016), Thondhlana and Kua (2016), and Bulunga and Thondhlana (2018) to name a few.

The positive correlation between valuing environmental quality and reported pro-environmental energy use behaviour should also be mentioned as the Treatment group noted that they made use of the energy-saving interventions out of environmental concern. Concern for the environment is an altruistic value (Stern, 2000). This is also in line with the VBN theory that those who have altruistic (self-transcendent) values are more likely to engage in PEB. Altruistic beliefs draw on a person's responsibility to behave in a certain (PEB) way. Therefore, it makes sense that respondents in the Treatment group reported they practised the energy-

savings tips out of concern for the environment. From this, it can be suggested that energy reduction techniques that relate to people's concern for the environment would have a more probable chance of being implemented (Palm, 2010; Pothitou et al. 2016).

Respondents from the perception questionnaire also stated that they practice energy-savings in order to save money. This could relate to one of the 22 QoL factors of the personal value of money/income, i.e. "having enough money to buy and to do the things that are necessary and pleasing" (Poortinga et al. 2004:74). Therefore, it is possible that those who claimed to practice the energy-savings tips to save money, value money and/or income. Paying less on electricity bills would mean a higher disposable income.

3.6 Conclusion and Recommendations

The findings from this study have shown that interventions centred on information provision, consistent reminders and feedback can promote energy conservation at the household level in a developing country context. However, the limitations of this study should be noted that the findings reflect a specific group: well-off households, and that recorded energy consumption information may not be generalised for all income classes, especially the poor. The main findings of the research reflect that information specifically tailored to energy consumption for high income households could further improve success of energy-saving interventions. However, further research into lifestyle energy consumption could improve energy consumption and saving information through the enhanced potential understanding and prediction of PEB. All family members should be made aware of energy consumption interventions to encourage entire households to participate instead of their being one 'energy champion'. Adding to this, interventions should be targeted at those who value environmental quality and altruistic values as these values were positively related with PEB. The financial benefits of energy-savings should also be highlighted for research participants to encourage energy-savings. Energy-saving practices should not be time consuming and easy to implement. Future research should attempt to gather information where households can see which appliances are consuming the largest quantities of electricity so that energy-saving measures can be targeted towards those appliances accordingly.

CHAPTER 4: SYNTHESIS OF FINDINGS AND POLICY IMPLICATIONS

Policy-makers continuously seek cost-effective and socially acceptable methods that encourage the public to adopt more environmentally friendly behaviours and lifestyles (Whitmarsh and O'Neill, 2010). The nature of this research implemented non-investment energy-saving interventions in households to encourage PEB. Non-investment interventions are traditionally habitual and low-cost measures such as switching off lights or appliances when not needed (Nair et al. 2010). In addition, the study examined energy use behaviours and the various internal (personal values) and external factors (socio-demographics) that influence PEB, using evidence from households in Edenvale, in Johannesburg of South Africa. This study should be considered as a first step towards understanding energy consumption and energy dynamics within high-income households. While this research provides evidence of the effectiveness of non-investment energy-saving measures, more studies focusing on energy consumption should be undertaken to further ground the findings of this research and validate any of the findings and recommendations discussed in this chapter. This final chapter aims to be a final synthesis of the research and puts forward a conceptual model based on the findings of the study.

4.1 Core Findings

The study focused on three main aspects. First, the reported energy use behaviour in households and the personal values and socio-demographic variables that influence reported energy use behaviours. Second, the effectiveness of intervention strategies for fostering pro-environmental behaviour and factors that influence the effectiveness of these interventions. Third, the implications of the research findings on future integrated energy policies aimed at promoting energy conservation in households.

4.1.1 Reported Energy Use Behaviour

Pro-environmental behaviour within the households was measured by electricity consumption levels and household energy behaviours or activities that require electricity. The highest or most common pro-environmental behaviours in the households were reported to be around the use of tumble dryers, switching off lights, heaters and refrigerators. These findings were explained using the TPB that states that PEB is more likely to occur when it is easier to do so.

Therefore, because PEB could be correlated to a person's convenience, it was not surprising that the opposite findings of pro-environmental behaviours requiring more effort and inconvenience were reported to be lower. For example, switching off geysers when not in use and using water heating devices sustainably.

The significant correlations that were found for the reported energy use behaviours and socio-demographics were age, household size and the number of dependents. The relationship of this significance was that as a person's age increases so does the likeliness of engaging in pro-environmental behaviours. This finding was consistent with previous literature and the typical values and habits held by older people (Morris and Venkatesh, 2000; Wey Smola and Sutton, 2002; Mtutu and Thondhlana, 2016).

The relationship of the second significant finding that as household size increased, the less likely a person was to engage in PEB is also consistent with the literature (Abrahamse and Steg, 2009; Kua and Wong, 2012; Levy and Belaid, 2017). Households larger in size could have more difficulty controlling energy use with more areas that could require heating and/or cooling, and more energy consumptive appliances to monitor. The finding relating to household size could also relate to the third finding that as the number of dependents within a household increases, the more unlikely they are to engage in PEB. A household that is larger in size would typically house more dependents. Therefore, it is not surprising that as the number of dependents in the household increased, the likelihood to engage in PEB decreased. This was also found to be consistent with the literature (Fitzsche, 1981; Levy and Belaid, 2017; Melo et al. 2018).

For personal values and reported behaviours, only two significant correlations were found, leisure time and environmental quality. In short, the more a person values leisure time, the less likely they were to engage in PEB, and the more a person values environmental quality, the more likely they are to engage in PEB. Both of these findings are consistent with the literature surveyed. These values were also consistent with Schwartz's model (1994). Leisure time relates to the personal value of self-enhancement, which is a negative predictor of PEB; and environmental quality is a value that relates to self-transcendence, a positive predictor of PEB (Schwartz, 1994; Blok et al. 2015).

Other significant correlations that were found and analysed according to the personal values of Schwartz model (1994) were those of Universalism defined as the "understanding, appreciation, tolerance, and protection for the welfare of all people and for nature" (Schwartz, 2012:7) relating to environmental quality, Hedonism defined as the "pleasure or sensuous gratification for oneself" (Schwartz, 2012:5) which relates to leisure time, and Achievement defined as "personal success through demonstrating competence according to social standards) which relates to education levels" (Schwartz, 2012:5). All of these values were significantly and positively related to PEB which is consistent with the literature. Although it is a positive step that some households put in an effort to use electricity in a more sustainable manner, no household reported to continuously use electricity sustainably. While the reasons for this could be numerous, it still implies room for further behaviour change and interventions.

4.1.2 Information Provision as an Energy-Saving Intervention

The study proved the information strategies to be successful. The Control group increased their monthly energy consumption from baseline over the study period by up to 10% while the Treatment group reduced their consumption by 2%. While it is noted that both groups did have an increase in consumption levels, and therefore may not seem to be deemed pro-environmental behaviour, the total energy consumption increases were expected due to the colder winter months during the study period. Higher energy levels were expected to be consumed in the colder months via water heating, lights being left on longer and use of electric blankets and heaters. Nevertheless, because the energy increase was less than half that of the Control group, the interventions were considered successful. This was in line with previous studies (Dennis et al. 1990; Vining et al. 2002; Abrahamse et al. 2005; Fischer, 2008; Kua and Wong, 2012; He and Kua, 2013; Pothitou et al. 2016).

Similar to the reported behaviours, personal values and socio-demographic factors were analysed to determine a correlation (if any) between those factors and the recorded energy reduction of the Treatment group. However, none of the personal values or socio-demographic factors yielded any significant results; which was an unexpected finding but consistent with literature that shows an "action-value-gap", or a disparity between peoples' reported environmental values and concerns, and their behaviours (Chai et al. 2015).

Regardless of the effects of the intervention strategies, a noteworthy finding of this study was the high average energy consumption levels recorded. This confirms that even though the energy interventions were shown to be effective and reduced energy consumption, more still needs to be done to further reduce household energy consumption. Taking into account that these high energy consumption levels are likely attributed to the lifestyles of the high-income households surveyed, it could be a step in the right direction to further investigate the characteristics or attributes of high-income households to better target and align energy-saving interventions. Energy use behaviours between Norwegian and Japanese households were examined and revealed that both households used energy in a culturally significant way (Wilhite et al. 1996). As a result, Wilhite et al. (1996) recommended that energy policies should take into account how different lifestyles factors affect energy consumption and savings. More recently, Melo et al. (2018) found a strong connection between PEB and a person's perception of the environment concerning their overall lifestyle.

People of a similar socioeconomic profile may have different values or beliefs, but they have roughly the same attributes or lifestyles within their homes. For example, not all higher income households may believe that climate change is a pressing issue, but they would typically all have a television, geyser, more than one bedroom, similar sized houses, etc. Therefore, energy conservation strategies could do well to target standard household appliances or commodities because they are common household features (Wang et al. 2011).

4.1.3 Perceptions towards Energy-Saving Measures in South African Households

The Treatment group was administered an additional questionnaire in order to gather their perceptions regarding how they viewed or felt toward the intervention strategies. As was expected, owing to the proven reduction in energy consumption levels from the Treatment group, the general perception towards the interventions was positive. However, while the majority of the Treatment group stated that they changed their behaviours due to the energy-saving measures, a significant portion did not. This allows room for further exploration behind a household's motivation in reducing energy consumption. A further conclusion that can be drawn from the perception survey is that the respondents were positively inclined towards the intervention strategy because it was useful, easy to access, and easy to perform. Such attributes should be noted for future proposed interventions.

4.2 Proposed Conceptual Model

In light of the above discussion, a conceptual model is put forward to explain the various determinants of PEB (Figure 4.1). The model has been formulated based on the nature and findings of this research, as well as other behaviour models from Blok et al. (2015) and Ohnmacht et al. (2017) both of which were previously informed by preceding models such as the Schwartz aggregate value model (1994), Azjen's TPB (1988) and Stern's (2000) VBN theory.

In short, the model proposes that various internal (personal values) and external (socio-demographics) factors initiate a person's intention to behave in a specific way. This intention then produces behaviours and actions. These behaviours and actions can either be positively or negatively inclined towards PEB. In the context of this study, this means that people would either use electricity more conservatively or less conservatively.

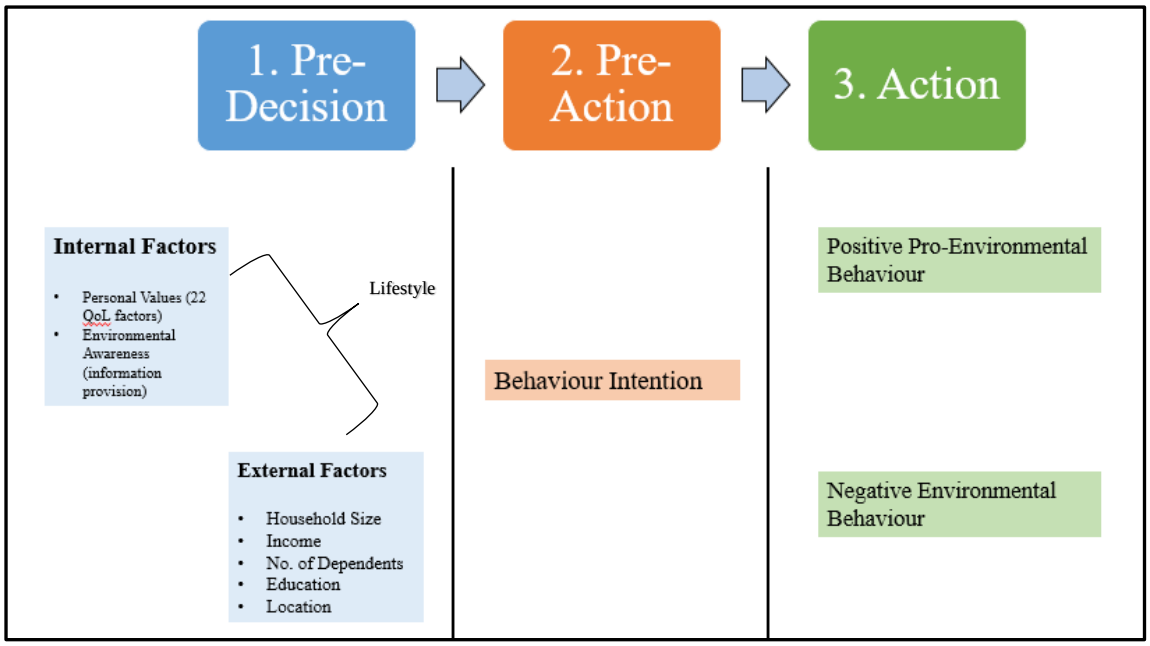

***Figure 4.1**: Proposed conceptual model for determinants of behaviour.*

The model (Figure 4.1) builds on aspects from the VBN theory, the TPB, the 22 QoL factors from Poortinga et al. (2004) and Schwartz model (1994). From the VBN theory, it draws on the impact of a person's value regarding PEB (Stern, 2000). From the TPB, it extracts the 'intention to act' as a predictor of behaviour (Azjen, 1980). Lastly, from Poortinga et al. (2004) and Schwartz's model (1994), it draws on the categories of human values. For example, values

relating to self-transcendence (positive environmental behaviour) and self-enhancement (negative environmental behaviour).

This model is useful as it incorporates internal and external determinants of behaviour, thereby highlighting the value of considering personal value factors in conjunction with socio-demographic factors and lifestyle (not in isolation) (Schultz et al. 1995; Clark et al. 2003; Gifford and Nilsson, 2014; Melo et al. 2018). It is also useful because it takes note of the important variable of "behaviour intention" in determining PEB. Many theories and frameworks while noting the existence of personal values and socio-demographic factors, do not account for *how* personal values and socio-demographic factors produce PEB. Behaviour intention thus provides an explanation as to why and/or how a personal value or socio-demographic factor could contribute to a person or household behaving pro-environmentally. Therefore, it contributes to the "knowledge-action-gap" (Kollmuss and Agyeman, 2002) because it highlights the need for an individual to have the intention to behave pro-environmentally or not (Azjen, 1980), instead of just holding a specific value or socio-demographic variable.

The model presented here also steps away from the 1970s linear characterised rational models of pro-environmental behaviour (Kollmuss and Agyeman, 2002; Latif et al. 2013), such reductionist approaches do not account for the complex interactions that shape pro-environmental action and the numerous levels these interactions take place on. This model, by noting the internal and external factors that shape behaviour intention and as a result, PEB is more comprehensive in explaining the determinants of behaviour.

So what do these findings mean for future integrated energy policy directions in South Africa and beyond?

4.3 Conclusions and Recommendations

Based on the findings of this study a few closing conclusions can be made:

1. Cost-effective and non-investment measures that are easy to implement and reduce household electricity consumption are effective instruments in reducing household energy consumption.

2. More research is required to determine the possible explanation(s) for the success of the interventions as no correlations were found between the reported socio-demographic and personal value factors and the decrease in household energy consumption.
3. Interventions designed to reduce energy consumption should be targeted in areas where pro-environmental energy use was least reported, for instance, areas of energy use such as water heating like the geyser.
4. Since high-income households consume high quantities of energy and the success of the interventions could not be confidently accounted for, a lifestyle approach to PEB may be more sustainable in the long-term and assist in understanding and predicting PEB.
5. Personal values and socio-demographic factors influence pro-environmental behaviour, and the behaviour models and theories discussed in this research have been useful in explaining why households may or may not behave pro-environmentally.

In light of these conclusions, the following recommendations are made for future household energy-related research:

- Firstly, this study examined the direct energy consumption of households via electricity consumption only. This was useful because it provided a less complicated method to measure consumption levels. However, it would be advisable for future household energy studies to also provide households with information about other sources of energy use such as gas. This could provide households with a more accurate and comprehensive account of their overall energy consumption levels.

- Secondly, measurements of electricity consumption for this study were only taken over a 6 month period. For a more accurate projection of household energy consumption and the effects of interventions, household energy consumption should be recorded over a longer period (1 year) for a long-term understanding of energy consumption levels and effects of interventions on behaviour, as a basis for establishing the persistent effect of the interventions and their longevity.

- Thirdly, energy-saving intervention strategies should be useful, easy to implement and easy to access. Convenience is especially stressed as noteworthy when considering energy behaviours. For example, the lowest pro-environmental engagements were found for energy behaviours that were inconvenient, such as switching off the geysers and waiting for heated water which can be considered time consuming. However, behaviour specifically regarding water heating was not the focus of this study and further research is required make robust conclusions on why these types of behaviour produced the least pro-environmental engagements.

- Fourth, although it was beyond the scope of this study, financial incentives should be further explored regarding promotion of energy-savings. Behaviour that had positive and negative engagements could be further explained by the financial implication of their use or non-use.

- Fifth, a combination of energy-saving interventions such as discussion groups and goal setting could improve the chance of people engaging in PEB (Abrahamse et al. 2007). This study only focused on information provision as an energy-saving intervention.

- Sixth, providing information regarding energy consumption levels for appliances could provide further details on household energy consumption. Information regarding which appliances are being used the most and least sustainably, could help in producing energy-saving interventions that are more tailored to household energy use.

- Seventh, the influence of lifestyles on PEB has only been briefly addressed in this study. Future research could be enhanced by investigating the effects of lifestyle factors and associated correlations to energy use behaviour and consumption levels.

The study reported on energy use behaviour for high-income households and the factors found to influence such behaviour. The study also detailed the success of information strategies as an intervention for reducing household energy consumption. Therefore, it is evident that addressing behaviour change can be a possible solution to reduce excessive energy consumption and reduce pressure on environmental resources. However, in order to address behaviour change first, a comprehensive understanding of personal values and socio-

demographic factors is necessary. The fact that personal values and socio-demographic factors were not found to be correlated with the reduction in energy consumption does not mean that values and socio-demographic factors do not influence pro-environmental behaviour. It is therefore advocated that the personal values and socio-demographic factors explored in this research be expanded on and include lifestyle factors to explain the lack of correlations found between these aspects and the reported reduction in energy consumption as these factors were argued to influence energy use behaviour. A new model inclusive of lifestyle factors is proposed in this study (Figure 4.1) however the specific attributes of high-income lifestyles that could cause high levels of energy consumption need to be further explored. This will allow for a better understanding and capability to predict potential barriers to and enablers of pro-environmental behaviour and as a result, interventions strategies that are designed based on evidence and behaviour-specific remedies.

Owing to the fact that households are places privy to changing environments due to a variety of different individuals, complex relationships, dynamics and behaviour; the challenges of ensuring the long-term sustainability of behavioural interventions are noted. However, because households have shown to consume large amounts of energy and behaviour change has been proven to be possible, interventions aimed at reducing household energy consumption are important areas of research in the pursuit of sustainable resource use and fostering more environmentally conscious individuals.

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ANNEXURES

ANNEXURE 1: ENERGY CONSUMPTION BEHAVIOUR

HOUSEHOLD NUMBER: _____ MONTH: _____ELECTRICITY BILL: _____

Aspect/Behaviour	**RESPONSE**				
Fans					
a. Possession: Yes/No. If yes, how many?					
1. Keep windows and doors closed when fan is switched on	Never	Rarely	Sometimes	Usually	Always
Heaters					
Possession: Yes/No. If yes, how many?					
2. Keep windows and doors closed when the heater is switched on	Never	Rarely	Sometimes	Usually	Always
Refrigerator					
b. Possession: Yes/No. If yes, how many?					
3. Refrigerator placed away from a heat source.(e.g. direct sunlight, cookers, oven	Very close, several heat sources	_	Close but with insulation	_	Far away
4. Allow some space all around the fridge	No	-	Small space	–	Enough space
5. Refrigerator is not overloaded	No space	–	Little space	–	Enough space
6. Cool down hot food before storing in fridge.	Never	Rarely	Sometimes	Usually	Always
7. Cover liquids stored in the refrigerator	Never	Rarely	Sometimes	Usually	Always
Water heater (for bathing)					
c. Possession: Yes/No.					
8. Heat enough water without too much unused	Never	Rarely	Sometimes	Usually	Always
9. For an instant type of heater, switch it on before shower and turn off after use.)	Never	Rarely	Sometimes	Usually	Always
Electric kettle/jug					
d. Possession: Yes/No					
10. Kettle stops automatically when water boils Yes or No	Never	Rarely	Sometimes	Usually	Always
11. Only boil the water you need?	Never	Rarely	Sometimes	Usually	Always
Lighting					
12. Make full use of daylight during the day time	Never	Rarely	Sometimes	Usually	Always
13. Turn lights off when nobody is in the room	Never	Rarely	Sometimes	Usually	Always
14. Use task lighting for activities requiring small amount of focus light. (e.g., reading lamps)	Never	Rarely	Sometimes	Usually	Always
Home electronics					
15. Turn off home appliances instead of leaving on standby	Never	Rarely	Sometimes	Usually	Always
16. Allow computer to be on hibernation mode after 10–15 min.	Never	Rarely	Sometimes	Usually	Always
17. Switch off the computer completely when not in use for more than 30 min	Never	Rarely	Sometimes	Usually	Always
18. Unplug chargers after use	Never	Rarely	Sometimes	Usually	Always
Geyser					
d. Possession: Yes/No					
19. Turn it on only when necessary. Turn it off if not in use overnight	Never	Rarely	Sometimes	Usually	Always
Clothes dryer					
e. Possession: Yes/No					
20. Dry laundry under natural sunlight whenever possible.	Never	Rarely	Sometimes	Usually	Always

ANNEXURE 2: PERSONAL VALUES

MONTH: _____

HOUSE NUMBER: _____ ELECTRICITY BILL: _____

Description	Unimportant	Slightly important	Important	Very important	Critical
1. Aesthetic beauty: being able to enjoy the beauty of nature and culture.	Unimportant	Slightly important	Important	Very important	Critical
2. Challenge/excitement: having challenges and experiencing pleasant and exciting things.	Unimportant	Slightly important	Important	Very important	Critical
3. Change: having a varied life, experiencing many things as possible.	Unimportant	Slightly important	Important	Very important	Critical
4. Comfort: having a comfortable and easy daily life.	Unimportant	Slightly important	Important	Very important	Critical
5. Education: having the chance to get a good education and to gain general knowledge.	Unimportant	Slightly important	Important	Very important	Critical
6. Environmental quality: having access to clean air, water and soil. Having and maintaining a good environmental quality.	Unimportant	Slightly important	Important	Very important	Critical
7. Freedom: freedom and control over the course of one's life, to be able to decide for yourself, what you do, when and how.	Unimportant	Slightly important	Important	Very important	Critical
8. Health: being in good health, access to adequate health care.	Unimportant	Slightly important	Important	Very important	Critical
9. Identity: having sufficient self-respect and being able to develop one's own identity.	Unimportant	Slightly important	Important	Very important	Critical
10. Leisure time: having enough time after work and household work and being able to spend this time satisfactorily.	Unimportant	Slightly important	Important	Very important	Critical
11. Material beauty: having nice possessions in and around the house.	Unimportant	Slightly important	Important	Very important	Critical
12. Money/income: having enough money to buy and to do the thing necessary and pleasing.	Unimportant	Slightly important	Important	Very important	Critical
13. Nature/biodiversity: to enjoy natural landscapes, parks and forests. Assurance of the continued existence of plants and animals and maintaining biodiversity.	Unimportant	Slightly important	Important	Very important	Critical
14. Partner/family: having an intimate relation, a stable family life and good family relationships.	Unimportant	Slightly important	Important	Very important	Critical
15. Private: having opportunities to be yourself, do your own things, a place of your own.	Unimportant	Slightly important	Important	Very important	Critical
16. Safety: being safe at home and in the streets. Being able to avoid accidents and being protected against criminality.	Unimportant	Slightly important	Important	Very important	Critical
17. Security: feeling attended to and cared for by others.	Unimportant	Slightly important	Important	Very important	Critical
18. Social justice: having equal opportunities and rights as others, being treated righteously.	Unimportant	Slightly important	Important	Very important	Critical
19. Social relations: having good relationships with friends, colleagues, neighbours.	Unimportant	Slightly important	Important	Very important	Critical
20. Spirituality/religion: being able to live a life with an emphasis on spirituality and/or with your own religious persuasion.	Unimportant	Slightly important	Important	Very important	Critical
21. Social status: being appreciated and respected by others.	Unimportant	Slightly important	Important	Very important	Critical
22. Work: having or being able to find a job and being able to fulfil it as pleasantly as possible.	Unimportant	Slightly important	Important	Very important	Critical

Rate the importance of the following aspects to your family: 1= Unimportant; 2= Slightly important; 3 = Important; 4 = Very important; 5 = Critical.

ANNEXURE 3: PERCEPTIONS OF INTERVENTION PROGRAMME EFFECTIVENESS (ONLY FOR TREATMENT GROUP)

PLACE: **DATE: _____**

HOUSE NUMBER: **ELECTRICITY BILL: _____**

1. All your family members know they are in such a programme	1	2	3	4	5
2. You have read the leaflets and stickers at least once.	Yes/No				
3. You pasted the stickers in your house	Yes/No				
4. You read the leaflets and stickers every time we gave you	1	2	3	4	5
5. Your family members read the leaflets and stickers as well	1	2	3	4	5
6. The leaflets provide you useful information about energy reduction	1	2	3	4	5
7. The discussion provides you useful information about energy reduction	1	2	3	4	5
8. We have provided you useful information about energy reduction	1	2	3	4	5
9. The information on how to save energy is easy to access so the recommended measures are practiced	1	2	3	4	5
10. You have spread the information from the discussion to other family members	1	2	3	4	5
11. You have changed your behaviours towards a more energy efficient way	1	2	3	4	5
12. The discussion let you understand the reasons of energy-related behaviour	1	2	3	4	5
13. Why do you practice the recommended measures? I am concerned about the environmental problem	1	2	3	4	5
14. You practice the recommended measures so that you can save money	1	2	3	4	5
15. Encouragement makes me perform the recommended measures	1	2	3	4	5
16. Because the energy reduction information is from trusted persons or organizations, the recommended measures are performed	1	2	3	4	5
17. A sense of satisfaction is obtained after practising the recommended measures	1	2	3	4	5
18. If the measures are easy to perform, they are more likely to perform; if they are difficult, they are unlikely to perform	1	2	3	4	5
19. Rate the programme	1	2	3	4	5

Do you agree with the following opinions?

1= Strongly disagree; 2= Disagree; 3= Neutral; 4 = Agree; 5 = Strongly agree.