Household energy use in South Africa: a systemic study of an individual intervention

by

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> *Then I applied myself to the understanding of wisdom, and also of madness and folly, but I learned that this, too, is a chasing after the wind. For with much wisdom comes much sorrow; the more knowledge, the more grief.*
>
> (Ecclesiastes 1:17-18)

Abstract

The world-wide problem of increasing greenhouse gas emissions has received considerable attention in recent decades. In South Africa, several factors necessitate residential energy efficiency research. These include the high levels of pollution caused by the generation of electricity with low quality coal, which is fairly readily available, the increasing consumer base since 1994, and electricity price increases of 20% per annum since 2008. This study investigates qualitative and quantitative aspects of energy efficiency strategies employed in 41 South African households from diverse socio-economic backgrounds, within the Pretoria region. Field work was conducted during 2010 and 2011. This research was conducted using a multi-phased combined experimental and ex post facto mixed methodology. Actual electricity consumption levels were recorded in all participating households, which were divided into two experimental groups, but only participants in the first experimental group participated in an interview and intervention to reduce electricity consumption. Measurements were followed by focus group sessions open to all participants. Thematic analysis was used to identify participants' main strategies for energy efficiency, and the effectiveness of these strategies was quantified. The qualitative and quantitative findings are discussed both separately from and in conjunction with one another. Feedback was shown to be a key factor in enabling behaviour change. Needs not only for information but for guidance in its interpretation are highlighted, particularly where literacy levels are lower. Erroneous beliefs about the functioning of appliances were identified and quantified. Winter was identified as the best time to introduce an intervention and improve energy savings due to the 'normal' steep increase during that time. Popular and effective strategies employed in households to reduce electricity consumption were also identified. This study culminates in a theoretical model, placing the micro, meso and exo implications of residential energy efficiency in a cyclical empowerment model of environmental concern, the need for information, behaviour change and the resulting need for feedback. Suggestions for policy development and future research are made focussing specifically on the role of females in designing energy efficiency measures, measuring quality of life and not just kWhs and emphasising the importance of real-time feedback on consumption.

Keywords

Environmental psychology, residential energy efficiency, systems theory, ecological approach, mixed methodology, pro-environmental behaviour change, attitude-behaviour gap, real-time feedback, environmental concern

Opsomming

Die wêreldwye probleem van 'n toename in kweekhuisgasemissies het die afgelope paar dekades baie aandag geniet. In Suid-Afrika is dit as gevolg van 'n aantal faktore noodsaaklik om navorsing oor energiedoeltreffendheid op die huishoudelike vlak te doen. Dit sluit in die hoë vlakke van besoedeling as gevolg van energie-opwekking met lae kwaliteit steenkool, wat geredelik beskikbaar is, die toenemende verbruikersbasis sedert 1994, en elektrisiteitsprysstygings teen 20% per jaar sedert 2008. Hierdie studie ondersoek kwalitatiewe en kwantitatiewe aspekte van energiedoeltreffendheidstrategieë wat in 41 Suid-Afrikaanse huishoudings uit diverse sosio-ekonomiese agtergronde gebruik word. 'n Multifase gekombineerde eksperimentele en ex post facto gemengde metodologie is aangewend. Werklike elektriteitsverbruikvlakke is aangeteken in al die deelnemende huishoudings, wat in twee eksperimentele groepe opgedeel is, maar slegs die deelnemers in die eerste eksperimentele groep het deelgeneem aan 'n onderhoud en intervensie om elektristeitsverbruik te verminder. Metings is gevolg deur fokusgroepsessies, wat oop was vir alle deelnemers. Tematiese ontleding is gebruik om deelnemers se hoofstrategieë vir energiedoeltreffendeheid te identifiseer, en die doeltreffendheid van hierdie strategieë is gekwantifiseer. Die kwalitatiewe en kwantitatiewe bevindings word beide afsonderlik en gesamentlik bespreek. Daar word getoon dat terugvoer 'n sleutelfaktor is om gedragsverandering moontlik te maak. Behoefte vir meer as net inligting oor energy doeltreffendheid, maar ook die begeleiding in interpretasie is beklemtoon veral waar mense se geletterdheidsvlakke laer is. Winter is geïdentifiseer as die beste tyd om intervensies te doen omdat die die 'normale' toename in energy gebruik verminder. Wanopvattings oor hoe huishoudelike toestelle werk is geïdentifiseer en gekwantifiseer. Gewilde en doeltreffende strategieë wat in huishoudings aangewend word om elektrisiteitsverbruik te verlaag, is ook geïdentifiseer. Die studie sluit af met 'n teoretiese model wat die mikro-, meso- en ekso-implikasies van residensiële energiedoeltreffendheid binne die sikliese bemagtigingsmodel van omgewingsbesorgdheid, 'n behoefte aan inligting, gedragverandering en 'n soeke na terugvoer plaas. Voorstelle vir beleidsontwikkeling en toekomstige navorsing word ook gemaak wat spesifiek fokus op die rolle van vroue in die ontwerp van enerdiedoeltreffende strategieë in die huishousing, die meet van kwaliteit van lewe as 'n aanduider van sukses (eerder as net kWhs) en die beklemtoning van in-tydse gebruiksterugvoer.

Sleutelwoorde

Omgewingsielkunde, residensiële energiedoeltreffendheid, sisteemteorie, ekologiese aanslag, gemenge metodologie, intervensie, eksperiment, omgewingsvriendelike gedragsverandering, houding-gedrag gaping, in-tydse terugvoer, omgewingsbesorgdheid

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If you put God outside and set him vis-à-vis his creation and if you have the idea that you are created in his image, you will logically and naturally see yourself as outside and against the things around you. And as you arrogate all mind to yourself, you will see the world around you as mindless and therefore not entitled to moral or ethical consideration. The environment will seem to be yours to exploit. Your survival unit will be you and your folks or conspecifics against the environment of other social units, other races and the brutes and vegetables.

If this is your estimate or your relation to nature and *you have an advanced technology*, your likelihood of survival will be that of a snowball in hell. You will die either of the toxic by-products of your own hate, or, simply, of over-population and overgrazing. The raw materials of the world are finite.

If I am right, the whole of our thinking about what we are and what other people are has got to be restructured. This is not funny, and I don't know how long we have to do it in. If we continue to operate on the premises that were fashionable in the pre-cybernetics era, and which were especially underlined and strengthened during the Industrial Revolution, which seemed to validate the Darwinian unit of survival, we may have twenty or thirty years before the logical reduction ad absurdum of our old positions destroys us. …The most important task today is, perhaps, to learn to think in the new way. Let me say that I don't know how to think that way.

The steps to realizing – to make habitual – the other way of thinking – so that one naturally thinks that way when one reaches out for a glass or cuts down a tree – that step is not an easy one.

(Bateson, 1972, p. 463)

Chapter 1:
Introduction

1.1 The context

The focus of this study is residential energy efficiency strategies and behaviours. In this introductory chapter, to provide a background to and rationale for this study, the global and South African context of climate change, the energy crisis and its macro-economic impact on pro-environmental behaviour in South Africa are discussed. This study was undertaken within the realm of environmental psychology, which is described briefly to show the role the individual plays in climate change, and the need to research this role. Some important aspects of previous research on residential energy efficiency behaviour are reviewed in this chapter to further justify this study and to develop the research questions. The chapter presents the research questions, followed by an overview of the theoretical framework and research methodology employed to answer these questions. Finally, the structure of this thesis is set out at the end of this chapter.

1.2 The global context of climate change and the South African reality

The world-wide problem of increasing greenhouse gas emissions has received much attention in the last few decades (Gardner & Stern, 2002). According to Gardner and Stern greenhouse gas emissions contribute to global climate change and are largely attributed to fossil fuel combustion (Gardner & Stern, 2002). By 2010, global energy-related CO_2 emissions reached an all-time high of 30.6 gigatonnes (OECD, 2012). Electricity generation in South Africa is largely dependent on low quality coal, with 85.1% of all electricity generated by coal-fired power stations (Eskom, 2014). Therefore in South Africa, the continued emissions of excessive greenhouse gasses pose a real risk to the health of people and to the environment. According to the American Psychological Association (APA), world-wide (and therefore also in South Africa), individuals and households are considered significant contributors of CO_2 emissions (APA, 2010). In South Africa, several aspects of the macro-economic environment necessitate an emphasis on households in particular. Large scale electrification programmes have successfully increased the number of households with access to electricity, from 50.9% in 1994 to 82.4% in 2010 (Eighty20, 2010). South African households now consume between 20% and 30% of energy in the country, and electricity generation relies largely on low quality coal, which is readily available locally, making South Africa one of the most energy-intensive countries in the world (Mohamed, 1997).

Since the first energy efficiency strategy in South Africa was published in 2004 by the Department of Minerals and Energy (DME), energy efficiency has gained a lot of social and political support and "has become recognised as one of the most cost effective ways of meeting the demands of sustainable development" (DME, 2008, p. 1). However, early in 2008, it became clear that South Africa was facing an energy crisis due to supply problems, which was to be addressed by load shedding during the winter months of 2008 (which refers to a situation in which the customers of electricity generation companies are not provided with electricity for specific periods due to a lack of supply) (Sangonet, 2008). This had a large economic impact, hampering the normal functioning of business in South Africa and leading to large losses for companies and individuals, and destabilizing the national electricity grid (Calldo, 2008). News, specifically during the latter part of 2009, about a failing electricity infrastructure, mismanagement at the national electricity supplier (Eskom) and proposed price increases had a large impact on people's awareness of electricity usage for most, if not all, people in South Africa (Ramayia, 2013).

Price increases contribute to the energy crisis in South Africa. Prior to 2008, the electricity price increased by around 8% annually. In the period from 2008 to 2012, however, average electricity increases of more than 20% per year were approved by the National Energy Regulator of South Africa (NERSA) (Ramayia, 2013), which provides an additional incentive to households to make more efficient use of electricity to counter rising costs.

A recent survey by the Department of Energy (DE) found that 85% of those who participated in the survey had access to electricity. Of these, 97% stated that they use this electricity for lighting, and 76% use electricity as their main source of energy for cooking purposes (DE, 2013). However, electricity is only one of various sources of energy used. Other sources include liquid paraffin gas (LPG), paraffin, candles, wood and coal, of which paraffin is the most popular alternative source of energy (DE, 2013). Only 44% reported using electricity to heat their living space; others elected to use other sources such as "wood or gas, or alternatively using blankets, warm clothing or nothing at all" (DE, 2013, p. 1).

In the same study, an overview of the strategies employed by South Africans to cope with the rising cost of electricity revealed that 41% try to use less electricity, predominantly by means of curtailment behaviour. Nevertheless, as many as 29% admitted that they usually use the same amount of electricity, and simply pay more. The remaining 26% in the study reported that they were obliged to use other sources of energy in order to cope with the rising electricity costs (DE, 2013), with largely similar percentages stating that they would continue employing these strategies.

In attempting to use less electricity, energy saving strategies that South Africans are aware of include "(i) switching off lights when leaving the house (75%), (ii) using energy-saving light bulbs (67%), (iii) switching off appliances at the wall when not in use (59%)" (DE, 2013, p. 3). In addition, the findings showed that "awareness of energy saving measures are lowest among blacks, among lower educated people, among people with low living standard, and people residing in Limpopo" (DE, 2013, p. 3). This implies that it is essential to include people from a range of socio-economic backgrounds in research. This will enable exploration and a better understanding of issues specific to their living circumstances, as has been done in the current study.

In summary, there are three main reasons for conducting a study on energy efficiency in households in South Africa, namely, first, the fact that pollution resulting from electricity generation in South Africa is particularly pronounced, second, that with an increasing household consumer base, Eskom is unable always to cater to an ever-increasing demand for electricity, and third, the rising price of electricity. Other factors, in some instances unique to South Africa and its macro-economic environment, also underline the importance of researching energy efficiency. These are discussed in the next section.

1.3 The macro-economic environment and energy use in South Africa

Although the South African macro-economic environment is not the focus of this study, it is necessary to understand the macro-level barriers for energy efficiency and pro-environmental behaviour in the South African context. According to the Academy of Science of South Africa (ASSAf), there are several obstacles to the effectiveness of climate change initiatives that are specific to the South African environment (ASSAf, 2011). Barriers particularly applicable to energy efficiency are discussed here.

According to the ASSAf (2011, p. 158), “South Africa has one of the most unequal societies in the world due to the historical legacy of apartheid and colonial segregation”. This inequality affects the ability of South African society to address climate change adequately in several ways:

- *Confusing sources and lack of information about climate change*:
  A considerable challenge in addressing climate change is providing not only accurate information, clarity and direction on the desired behaviour, but information that is relevant and applicable, and that can be understood by all citizens of South Africa, taking into consideration their level of literacy and cultural context;
- *Implementation deficit combined with a managerial, technicist approach to carbon reduction:*
  As the ASSAf (2011) points out, “[l]arge-scale legislative, policy and institutional reforms … since 1994” (p. 158) and a lack of staff capacity in the South African government to implement such reforms (Oelofse, Scott, Houghton, & Oelofse, 2009) has led to poor implementation. In effect, many good intentions in the regulatory framework are not implemented. Moreover, when attempts are made to use technical innovations to achieve change, individual value arguments and the application of locally derived and applicable solutions tend to be neglected (Randalls, 2010);
- *The polarization of the environment, development and poverty alleviation*:
  Economic growth and poverty eradication are both top priorities for the South African government. The clear drive for industrialization and development (with the aim of alleviating

poverty through job creation) and the pursuit of environmental sustainability are often set up as two poles, with the result that opportunities to find balanced solutions are often missed;

- *Neoliberal individualism*:
  Increased individualization can have a significant environmental impact. The ASSAf (2011) explains the implications of individualization for the environment as follows: "…more individualization…meaning fewer persons per household…[implies] more extended mobility patterns and higher expectations concerning fulfilment of individual lifestyle aspirations, all of which have frequently involved greater overall energy consumption" (ASSAf, 2011, p. 160). Thus this trend, in combination with the absence of a low carbon citizenship social norm, suggests a bleak future;
- *Absence of low carbon citizenship social norm*:
  The ASSAf (2011) notes that "there are no prevailing social norms in South Africa that encourage low carbon citizenship. The current social norm regarding pro-environmental behaviour is that it is elitist and anti-development" (p. 159). The ASSAF (2011) and Scott and Oelofse (2009) argue that the approach of addressing individual behaviour by providing more information, thus addressing an "information deficit" is too simplistic, and is therefore inadequate in order to address "awareness-raising in a multi-cultural society where the majority of the population has low levels of education and high levels of poverty" (ASSAF, 2011, p. 159). The absence of these norms has a distinct impact on the way in which energy efficiency can be pursued in a developing country.

The issues raised here characterise the South African situation that forms the context of this study, and are clearly different in several ways from the some of the issues more relevant to Europe and North American countries. National targets and policies on job creation and poverty eradication encourage improved industrialization in South Africa, and people's lifestyles will continue to change accordingly. Therefore, South Africa is not immune to the "harmful impact of the lifestyles pursued in industrialized societies on earth's ecosystems" (Bamberg, 2013, p. 151) currently observed in European and North American countries. Studies relating to changing the impact of these behaviours are also applicable in South Africa.

According to Bamberg (2013), not only behaviour change, but also applied environmental psychology, have become increasingly important in addressing issues that have an environmental impact (see also Abrahamse, Steg, Vlek, & Rothengatter, 2005; Dwyer, Leeming, Cobern, Porter, & Jackson, 1993; Schultz, Oskamp, & Mainieri, 1995). Weber (1997) points out that "[e]nergy consumption is the last part of a long chain of decisions and actions. Therefore, it is appropriate to discuss energy consumption within its social context" (p. 835). Inevitably, technology and society come together in energy consumption. It is therefore important to "focus on technical processes and at the same time emphasise the social context of energy consumption, taking human behaviour...into consideration" (Weber, 1997, p. 835). Hence, this study focuses on invidiuals in a residential setting, taking into consideration the social context of those individuals. This is the specific focus of the field of environmental psychology, which is discussed in more detail in the next section.

1.4 The focus on the individual in context – environmental psychology

This study falls in the discipline of psychology and, specifically, under the field of environmental psychology. Hellbrück and Fisher (1999) define environmental psychology in terms of its focus on "how material and energetic external conditions impact on experience and the behaviour, and how certain environments may be used, from material and energetic points of view, to produce desired effects on experience and behaviour" (p. 31). The interactions and relationships between humans and environment are not one-directional, as is demonstrated in another definition of environmental psychology recently proposed by De Young (2013), who sees it as a discipline concerned with the "relationship between environments and human affect" (n.p.).

Energy use is but one of a myriad focus areas of environmental psychology (which includes recycling, transportation, consumption and conservation behaviours). In view of the global focus on environmental issues, the search for efficient methods to enable sustainable use of our finite resources, and the energy crisis in South Africa, this study focuses on energy efficiency. The main reason for psychology's concern with energy efficiency lies in the changes that need to take place at a human level to increase the sustainability of even the best technology. In this regard, Yust, Guerin, and Coopet (2002) explain that "[e]nergy demand is rooted in the norms of comfort, cleanliness and convenience, which influence the ability of interventions to impact energy use by changing behaviour" (p. 188). Any attempt to decrease the demand for energy would have to address issues of comfort, cleanliness and convenience, otherwise no significant and lasting changes would be possible. This places energy efficiency squarely in the realm of psychology, since the sense of what is most convenient and comfortable may differ from one person to another. Moreover, what would motivate people to engage in conservation should be explored.

Gardner and Stern (2002) distinguish between energy efficiency and energy curtailment behaviour. Energy efficiency behaviours entail the once off attempt to change energy use over the longer term (such as installing a timer that regulates an appliance's use or buying an efficient fridge or freezer) while curtailment behaviours involve continued attempts to reduce electricity consumption. Oftentimes reduction in electricity consumption can be attributed to both of these efforts. Gardner and Stern (2002) mention, however, that although energy efficiency measures are successful in reducing energy consumption, energy curtailment behaviours are more often discussed in the academic literature. In this study, both energy curtailment and energy efficiency behaviour are considered to be means to reduce residential electricity consumption.

It might seem that studying individual behaviour would have little effect on a global problem, but it is important to take into account how the problem of climate change came about – through human behaviour and misunderstanding, and apathy about our impact on the earth (APA, 2010). According to the Global Action Plan (GAP), behaviour changes have already accounted for an average of around 40% savings in solid waste, 12% savings in electricity use and 20% savings in residential water use, in Europe and the UK (GAP, 2012). These are significant savings, and if such targets could be met across the board in South Africa, it would make a significant impact on the amount of electricity, water and other services needed in this country.

Niemeyer (2010) indicates that although a lot of research on energy efficiency has been done in the past, research methods in projects differ, social norms shift, energy prices change, and changes in awareness do take place. Therefore it is important to "continue to study why consumers do or do not take steps to change energy practices in their own homes" (p. 140). Technology, available resources and higher electricity costs may lead to a reduction in residential energy use, but, as Niemeyer explains, "consumer actions within their households can reduce or negate these potential savings" (p. 145) through their behaviour. Therefore it is important to study residential energy use as part of a holistic approach. Energy management, often represented by the energy generator, regulator or government, plays a distinct role in the approaches taken to achieve energy efficiency. Thus far, the role, experience and potential contribution to energy efficiency by households in South Africa are largely unexplored. In this research, distinctions are made between energy efficiency behaviours, energy curtailment behaviours (Garner & Stern, 2002) and energy practices (Niemeyer, 2010; Shove 2003) in section 6.2.5.2.

In attempting to understand environmentally significant behaviour, assessment and analysis of different populations are important, because some of the "highest impact behaviours are different in different populations and communities" (APA, 2010, p. 77). This serves as a strong motivator for this research based in South Africa, and the inclusion of people in households from different socio-economic and cultural backgrounds.

Environmental psychology includes conservation and social psychology, and seeks to "promote durable living on a finite planet. Environmental psychology develops and empirically validates practical intervention strategies" (De Young, 2013, par. 2). This concept has been applied in this research, in that the study implemented and tested an energy efficiency intervention amongst different groups of people in South Africa.

1.5 Previous research from an environmental psychology perspective on residential energy efficiency

Many studies have been conducted focusing on residential energy efficiency from an environmental psychology perspective, mainly in North America and Europe. They investigate many aspects of energy efficiency, the effectiveness of antecedent and consequent interventions, and, more recently, the need to make any type of intervention applicable to the social network of the participants in the study in order to increase the effectiveness of the suggested interventions;

for example, see Abrahamse et al. (2005), Dwyer et al. (1993), and Schultz et al. (1995) for meta analyses and overview discussions on these studies. In South Africa, some studies have examined energy efficiency from an environmental psychological perspective, looking mainly at small and medium enterprises (Van Eeden, Viviers, & Venter, 2003; Viviers, 2009), but no published study that qualitatively explored the energy efficiency strategies employed by households in South Africa could be found.

A recent study by the Department of Energy (2013) focused on energy-related behaviour and perceptions, quantifying perceptions and strategies employed in households. It provides much-needed background and planning indicators for management of energy consumption in South Africa; however, we still lack in-depth understanding of why people prefer some specific energy-saving actions to others. The current study hopes to address some of these issues by exploring and describing the strategies employed, rather than merely quantifying how many people implement a specific strategy.

South Africans' understanding of global climate change, their interpretation of the threats it poses, the perceived options for behaviour and the way they choose to react have not previously been extensively studied with a specific focus on electricity use. Abrahamse et al. (2005) call for in-depth qualitative studies of electricity use, suggesting that "evaluations of an intervention's effectiveness should be focussed on (changes in) behavioural determinants as well as (changes in) energy-related behaviours. Most studies reveal only to what extent interventions have been successful, without providing insight into the reasons why" (p. 283). Abrahamse et al. explain that interventions should be described in detail, with a clear indication of the content of the intervention and an exploration of why the changes occur. Abrahamse et al.'s concerns appear to be valid, as most of the studies reviewed in Chapter 3 of the current study report on the success or the failure of an intervention, without providing insight into the reasons for these successes or failures. In the current study, the researcher set out to reach an understanding of why certain behaviours occurred.

Geller et al. (2002) point out that an important first step in designing and implementing interventions is to diagnose the problem thoroughly: first, by identifying behaviours that contribute significantly to environmental problems, and second, by examining factors that make sustainable patterns attractive or unattractive, such as motivational factors (attitudes), opportunities and perceived abilities. Nye and Hargreaves (2010) have identified folk knowledge as a factor that contributes to the effectiveness of encouraged pro-environmental behaviour; they state that "'folk knowledge' [is] about what it means to live a green lifestyle, how to use surrounding systems in greener ways, and why it is desirable to do so" (p. 146). These notions are often dispelled or enforced within a person's close social system. In other words, beliefs are preserved and even promoted by means of normative beliefs via family and friends. The question of interest here is whether the same beliefs are found in different regions and social groupings. The research questions were developed in view of these issues, and are discussed in the next section.

1.6 Background to this study and research questions

Abrahamse et al. (2005) comment that the “pivotal question remains why energy use of households keeps rising” (p. 273). Following the load shedding in South Africa in 2008, and continued news of possible electricity infrastructure collapse in 2009, the researcher joined a South African NGO (the Nova Institute, founded in 1994) as a volunteer in an attempt to make a contribution from the field of psychology to the reduction of electricity use. “Nova” stands for “Navorsing en Ontwikkeling vir die Voorkoming van Armoede” (Nova Institute, 2008) [Research and Development for the Prevention of Poverty]. In association with a European engineering firm, Imtech, the Nova Institute ran a pre-feasibility study with the aim of exploring technologies and methods that could be employed in households across various cultures and socio-economic standing in South Africa, to improve energy efficiency in these households. During her time as a volunteer in this project, the researcher was intrigued by the psychological aspects of energy consumption and the perceived differences amongst cultural groups in South Africa. This interest led her to take a more in-depth look at the issue of residential energy efficiency in South Africa, in the form of a PhD study.

The South African energy crisis and resulting increased interest in energy efficiency (from an engineering point of view at least), the limiting macro-economic environment, the need to focus on individual households and the lack of a clear idea of South Africans’ perspectives on the psychological aspects of residential energy efficiency led to the development of three research questions.

The three questions this study aimed to answer are the following:

- What is the effect of a psychological intervention, using particularization, real-time feedback, goal setting and commitment-making, with an individual in a household on the household’s electricity usage?
- What energy conservation strategies (if any) are employed by households, as perceived by the individual (participant), and why?
- How do participants from different socio-economic backgrounds attempt to save electricity?

A further objective in this study was to develop a model of the process of behaviour change applied to energy efficiency in particular. This model would assist in the design of intervention and communication strategies, improving energy effiency and energy curtailment behaviour in South African households in particular.

The researcher, with technical support from the Nova Institute, set out to answer these questions. In the next section, an overview is given of the chosen methodology employed to answer these research questions and these choices are justified.

1.7 Theoretical framework

Systems theory is the chosen theoretical framework for this study because it focuses on the interconnectedness of the various factors that contribute to energy efficiency. The individual does not exist in a vacuum, the interconnectedness of the individual influence real world behaviour, including energy efficiency and curtailment behaviours in a household. The impact of change in the residential sector however, stretches further than the individual behaviour with the intervention possibly influencing others (in and outside of the household) both on a meso and exo-level as well. Systems theory is used to describe and understand when change is perceived as a difference in the system, and how this is translated into society extending beyond the household. The ecological approach was used to conceptualise the various levels of interaction and contextualise the findings of this research. This was done because the researcher recognises that an individual’s interaction with the environment cannot be contained within him/herself. A person’s thoughts and consequent behaviours are influenced by the person’s environment and vice versa. This requires researchers to study both the attitudes within an individual (between his or her attitude toward the environment, his or her perceived ability to make a difference and his or her perceptions of the societal norms regarding his or her behaviour) and the individual’s context.

Although this study focused on individuals, their perceptions of and attributions to their social network and its meanings are also explored in detail. Bronfenbrenner’s (1977) ecological framework was used to guide and conceptualise the different levels, namely the micro level (within the individual him/herself), the meso level (the immediate context of the individual such as family and friends) and the exo level (societal interaction such as schools and religious entities), placing them into the South African macro-level context that has already been discussed (see Section 2.2 for an in-depth description). The research questions are explored from an individual’s perspective, but also aim to describe the system in which individuals attempt to attain energy efficiency, and the conditions which improve the effectiveness of an intervention. This necessitated a mixed methods approach to consider energy efficiency from both a qualitative and a quantitative perspective. In the next section, an overview of the research methodology is given.

1.8 Methodological overview

A mixed methods approach employs both qualitative and quantitative data collection methods during the design, fieldwork and/or analysis in order to highlight more than one perspective of any phenomenon (Creswell & Plano Clark, 2011), in this case, broadly, household electricity consumption. The research design was a multi-phased embedded and combined experimental ex post facto research design. Using an experimental design allowed the researcher to observe and quantify the reaction to a particular intervention in two similar groups, while a qualitative enquiry shed light on the intervention and its impact on behaviour.

Due to the complexity of the research design, it is described throughout this thesis in four phases. Phase 1 was constituted of the recruitment of research participants and their allocation into experimental and Living Standards Measure (LSM) groups. Phase 2 consisted of two parts: Part 1 involved qualitative data collection by means of an in-depth interview; Part 2, consisted of quantitative data collection in the form of an experiment with an intervention, while monitoring actual electricity consumption data in each of the participating households. Phase 3 refers to the follow-up focus group sessions. Phase 4 relates to the analysis stage, since it consisted of a combined analysis of the results from Phases 2 and 3.

A total of 41 participants from varying socio-economic backgrounds (ranging from some rather poor to some very wealthy households, as determined using an LSM) took part in this study. These participants were randomly allocated to two experimental groups (Experimental Group 1, n=18, and Experimental Group 2, n=23). The qualitative data collected in Phase 2 (in-depth interviews) were collected only from Experimental Group 1, in order to understand the participants' initial views on climate change, any pro-environmental behaviour and energy efficiency in the context of the participants' social network. Quantitative data were concurrently collected from both experimental groups (complete data sets were obtained for 36 households). Quantitative data collection consisted of an inventory of electricity-consuming appliances in each household and the actual electricity consumption data for each household during a measurement period of three weeks. These measurements were followed by another qualitative data collection opportunity in the form of focus group sessions with volunteers from both experimental groups (the total number of participants in the four focus groups was n=16 even though all participants were invited).

This research design allowed the researcher to study how an intervention to improve energy efficiency influenced actual energy consumption, and how the socio-economic standing of a particular individual or group interacted with the intervention. This enabled the researcher to answer the research questions. In the next section, an overview of the structure of this thesis is given.

1.9 Overview of this study

The first chapter serves as an introduction, providing a background to and rationale for this study, along with a brief discussion of the global and South African context of climate change, the energy crisis and its macro-economic impact on pro-environmental behaviour. The research questions, an overview of the theoretical framework and the research methodology employed to answer these questions were also discussed.

In Chapter 2, the ecological and systems theoretical approaches used in this study are discussed. Chapter 2 clarifies the epistemology adopted by the researcher and provides a fuller justification for this study. The ecological approach and systems theory create the necessary framework in which several attitude-behaviour theories and social behaviour theories are discussed toward the end of Chapter 2. These theories are encapsulated in the empowerment spiral described by Mehlmann, McLaren, and Pumetun (2010), and serves as a basis for the development of the theoretical model proposed in Chapter 6.

Chapter 3 reviews literature on residential energy efficiency and pro-environmental behaviour change programmes. The focus is largely on reports from studies conducted in European countries and North America since the 1970s, but includes a summary of the South African government survey on energy-related behaviour completed in 2013 by the Department of Energy. More recent studies are also explored and described in detail.

In Chapter 4, the particulars of the mixed methodology employed to answer the research questions is described. For each of the four research phases, the instruments used and the procedures followed are explained. The last phase (Phase 4) involved a combined analysis. Chapter 4 concludes with a discussion of the ethical guidelines followed in this study, and the validity and reliability of the data during collection and analysis.

The research findings are presented in Chapter 5. Again, the four phases are used to guide the reader throughout the process. Finally, in Chapter 6, the findings of this study are discussed, culminating in a conceptual model of the contributing factors in behaviour change in energy efficiency. This model incorporates the ecological levels of the three overarching themes on energy efficiency, namely, first, environmental concern and energy efficiency, second, finding out about energy efficiency and, third, the behaviour and strategies employed by participants to improve their energy efficiency. At the end of Chapter 6, the limitations of this study are discussed, which includes discussion on the use of a volunteer sample, the individual as a unit of research in household energy efficiency and the size of the sample. Possible policy implications of this study are pointed out, and recommendations for future research are made.

1.10 Conclusion

The global context of climate change, the macro-economic environment and the accompanying energy crisis in South Africa create a need to research individuals' ideas about energy efficiency and consequent behaviour from a psychological perspective. Environmental psychology as an underlying discipline provides the necessary context for studying not only the individual, but also the individual in context. Previous studies in the realm of environmental psychology on energy efficiency have shown that there is a need to dig deeper and identify effective interventions, explore the reasons behind the successes and failures of such interventions and their impact. In order to address the identified gaps, three research questions were formulated for the current study. An overview of the methodology was presented, providing a justification for the use of a mixed method approach to answer these questions. Finally, an overview of the rest of this thesis was given, in a short chapter-by-chapter description, highlighting the four-phase approach used to collect, analyse and present the findings. In the next chapter, the theoretical framework within which this study was conducted is discussed in detail.

Chapter 2:
Theoretical Framework

2.1 Introduction

In Chapter 1, global climate change and the South African energy crisis were looked at in the context of the South African macro environment. The role of environmental psychology in this study was discussed, along with an overview and justification for this study and the chosen research approach. In this chapter, the theoretical framework of this study is discussed.

First, in Sections 2.2 to 2.4, the ecological and systems theoretical frameworks are explained, as well as the ontological and epistemological positions adopted by the researcher. The link between the ecological and systems theoretical approaches is described. The combination of these two approaches in this study is justified in Section 2.5 by describing the interconnectedness of these systems and perceptions pertaining to energy efficiency at each ecological level. Next, in Section 2.6, the attitude-behaviour theories often applied in behaviour changes studies are looked at. These include the theory of planned behaviour (Ajzen, 1991) and the value-belief-norms theory (Stern, 2000). Lastly, several social theories and their application in energy efficiency studies are discussed in Section 2.7. This discussion includes the empowerment spiral which is employed in Chapter 6 to ground the patterns identified in this study conceptually.

In the next section, the ecological and systems theoretical approaches used in the research are clarified.

2.2 The ecological and systems theory approaches

The aim of this section is to clarify the theoretical approach used in this study. It examines how the complex aspects that influence the use of electricity in households might be understood, and points out the need for a holistic approach to understanding the context and motivations of the individual members of a household in the context of the household itself and the broader society in which it is found. This discussion therefore focuses on the basic principles of the ecological approach and systems theory, exploring *what* we can know (ontology) and *how* we can know it (epistemology). This is followed by a justification for adopting this approach, an in-depth description of the ecological approach and systems theory.

2.3 Ontology

Ontology is defined in philosophy as the "study of existence" (Hergenhahn, 2001, p. 508), in which two central ontological questions are posed: What is the nature of human nature? What does it mean to be a particular individual? In this study, the question of what we can know is answered by adopting a constructivist view.

The constructivist view holds that "knowledge and reality do not have an objective or absolute value or, at the least, that we have no way of knowing this reality" (Murphy, 1997, p. 5). A researcher therefore cannot "know" a reality of objective or absolute value. Von Glasersfeld (1995) argues that reality "is made up of the network of things and relationships that we rely on in our living, and on which, we believe, others rely on, too" (p. 7), assuming that "knowledge, no matter how it is defined, is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience" (Von Glasersfeld, 1995, p. 1). What can be known is therefore determined by the study of the networks, relationships and beliefs highlighted for a researcher by the research participants.

A researcher cannot know what is not displayed or communicated by research participants. Murphy (1997) therefore emphasises that, as a result of people's interaction in and with the environment, they construct a reality based on their experiences, highlighting the viability of a model or theory, rather than aiming to show that it is "truth". Von Glasersfeld (1989) puts it as follows: "To the constructivist, concepts, models, theories, and so on are viable if they prove adequate in the contexts in which they were created" (p.7). Heylighen (1993) and others link this type of constructivism to cybernetic systems, in which information is fed back into the system in order to attain equilibrium. Therefore, the use of a systems theoretical framework in this study falls within the ambit of this constructivist school of thinking. The current study looks at how people make sense of their world by considering their behaviour and how they talk about environmental issues and energy efficiency in particular. In adopting this perspective, the study follows Keeney's (1983) view that "[t]here is no direct correspondence between an event occurring 'outside' of us and our inner experience of it. The world as each of us knows it is entirely constructed by ourselves" (p. 2).

2.4 Epistemology

Epistemology is primarily concerned with studying knowledge, coming to terms with what is known and what can be known, and how one can attain such knowledge (Mathiesen, 2007). Psychology "has always been involved in epistemology because one of its major concerns has been determining how humans gain information about themselves and their world" (Hergenhahn, 2001, p. 17). In essence, every researcher is an epistemologist, attempting to devise ways in which to determine which knowledge particular individuals hold on specific issues, and how research can come to "know" the beliefs of the research participants.

Epistemology, according to Vasilachis de Gialdino (2009), focuses on several questions:

> 1. how reality can be known,
> 2. the relationship between the knower and what is known,
> 3. the characteristics, the principles, the assumptions that guide the process of knowing and the achievement of findings, and
> 4. the possibility of that process being shared and repeated by others in order to assess the quality of the research and the reliability of those findings..(par. 8)

In this section, the impact of the researcher on this research is explored, followed by an assessment of the value of the outcome of this study in terms of an explanation of the researcher's epistemology. Bateson (1972) points out that "[m]yself is still to me an excessively concrete object" (p. 462), a comment which suggests that it is the researcher who is him- or herself conducting the research. Keeney (1983) rightly points out the importance of the "necessary connection of the observer with the observed, which leads to examining how the observer participates in the observed" (p. 80). Capra (1987) also warns that "the patterns scientists observe in nature are intimately connected with patterns of their minds; with their concepts, thought and values. Thus the scientific results they obtain…will be conditioned by their frame of mind" (p. 67). Hence, taking note of *who* the researcher is, and *how* she approached the research are important steps in understanding how the research project was constructed, conducted and analysed, thus enabling others to understand the process. The researcher cannot renounce or think outside of her belief systems, which include the belief that humans should have a humble approach toward the natural environment, recognising it for the gift of grace that it is, and that all humans should take responsibility for their actions. Respect to all humans and nature as a whole is also fundamentally important to the researcher, as she believes that it forms the basis for any exploration of people from different cultural groups and backgrounds. Such respect allowed the researcher to talk to participants in the study and come to understand their points of view, even where those views differed from those of the researcher.

Capra (1997) describes the relationship between the researcher and the researched as follows:

> Nature is seen as an interconnected web of relationships, in which the identification of specific patterns as objects depends on the human observer and the process of knowing. This web of relationships is described in terms of a corresponding network of concepts and models none of which is any more fundamental than the others. (p. 40)

Data are not simply collected – researchers interact with it even during the design and collection, long before analysis commences. In this section, the impact of the researcher on the research is therefore considered. During the data collection and analysis stages, a continuous attempt was made to stay true to the stated perceptions of the participants, with little interpretation during the first stage of analysis. The method of analysis is discussed in detail in Chapter 4, where the methodology is looked at, in order to involve the reader in the process of making sense of the data.

In this regard, Mathiesen (2007) comments, “[i]ndeed, given that our epistemic lives are increasingly dependent on complex social systems of investigation and dissemination of knowledge, not only is such epistemic investigation of social groups possible, it is essential” (p. 209). In order to respond to this call, the researcher needed to consider not only herself (as the researcher) or each research participant in isolation, but the world of interaction in which the researcher and research participant(s) alike make sense of their worlds.

Epistemology thus refers not only to the conceptualization of results, but also implies the need for a clear presentation of the research methodology and design (which is discussed in Chapter 4). In the next section, the ecological approach and systems theory are discussed and explained in order to highlight the ways in which the epistemology that the researcher adopted was translated into a working method for collecting and conceptualizing data gathered in this study.

2.5 Justification for using the ecological approach and systems theory

The ecological approach and systems theory were chosen as theoretical approaches for this study to add to the richness of the description and understanding of the data. Bateson (1972) describes research as follows: “[I]n scientific research you start from two beginnings, each of which has its own kind of authority; the observations cannot be denied, and the fundamentals must be fitted. You must achieve a sort of pincer's manoeuvre” (p. 15). He implies that using more than one data set (the two sides of the pair of pincers) enables a better grasp of an issue. Therefore looking at more than one data set dealing with the same phenomenon is likely to enhance understanding of the phenomenon under review. In this study, both quantitative and qualitative data on energy efficiency in the home were collected, enabling the researcher to gain rich insight into the phenomenon being researched, through multiple viewpoints.

Characteristics of the environments surrounding a household can change the entire system of energy use in the household. Energy consumption changes as the physical environment changes, and therefore all the aspects that may influence the process need to be studied as one system rather than as isolated variables (Guerin, Yust & Coopet, 2000). Such an approach can complicate a study immensely, but it is one of the contributions of this study to research in this field to attempt a more holistic approach that explores the main aspects of both what is happening (in terms of household electricity consumption) and why (people’s perceived norms and threats/risks) in a study including people from various socio-economic backgrounds in South Africa. The need to look at the wider environment of the individual therefore necessitated adopting an ecological perspective.

Whereas systems theory provides a way in which to understand and emphasise the interaction between systems, an ecological approach provides a framework in which these systems operate. This allows a researcher to focus on one level (such as the micro, meso, exo or macro system) at a time, whilst not neglecting the interaction between these levels. The interview guide and the data analysis process used in this study (see Sections 4.4.3, 4.5.1 and Appendix C for more detail) involved looking at the various levels in the lives of individuals (ecological approach) and the interaction between these levels using a systems theoretical approach. These approaches are discussed in more detail in the sections that follow below.

2.5.1 The ecological approach

Ecology, in the original Greek, referred to "the study of houses within which organisms live" (Levine & Perkins, 1997, p. 13). This field of study has evolved in recent years to include not only the physical housing of living organisms, but also the supporting systems that make a habitat liveable. This concept can also be applied to humans, and social ecology studies the living environment of people in particular. A formula invented by Kurt Lewin (1951), namely B=f(P,E), where behaviour (B) is the function of the interaction between personality (P) and the environment (E), forms the basis of the argument that there is a complex interaction between a person and his or her environment.

In environmental psychology, humans are examined in their natural environment (Guerin et al., 2000); this practice moves away from considering individuals in isolation, toward a broader view that takes the individual's context into consideration too. Uzzell and Moser (2009) support this shift, arguing that a "psychology that seeks to understand the people-environment relationships needs to move from a focus on individuals and groups to the social relations within which environmental behaviour is enacted and unsustainable ways of living are produced and reproduced" (p. 309). The principle underpinning the ecological perspective is that human beings are inseparable from the environment in which their behaviour occurs (Orford, 1992). Human behaviour should thus be studied under its "normal" circumstances, with the focus on each person in his or her environment. In the current study, data were therefore collected under real-world conditions to increase the reliability of the results. This study was thus guided by the ecological perspective advocated by Bronfenbrenner (1977) and the interrelatedness suggested by systems theory proposed by Bateson (1972).

Bronfenbrenner (1977) was a pioneering proponent of the ecological perspective. His basic premise is that a broader approach should be adopted in research, looking "not only [at] the immediate settings containing the developing person but also [at] the larger social contexts, both formal and informal, in which these settings are embedded" (p. 513). Every individual is in constant reciprocal interaction with different levels of his or her environment. Bronfenbrenner (1977) describes the environment as a "conceived topology" (p. 514) consisting of "a nested arrangement of structures, each contained within the next" (p. 514).

The environment in which a person acts includes multiple levels of influence. Bronfenbrenner (1977) describes these as the micro, meso, exo and macro systems. The micro system is the "complex of relations between the developing person and environment in an immediate setting containing that person" (p. 514), the meso system contains the interrelations of the main settings in which a developing person finds him- or herself at a particular point in his or her life. The exo system includes external networks that indirectly influence the individual. The macro system is slightly different from the other systems – Bronfenbrenner (1977) argues that the macro system refers "not to the specific contexts affecting the life of a particular person, but to general prototypes, existing in the culture or subculture that set the pattern for the structures and activities occurring at the concrete level" (p. 515).

The interaction between the individual, his or her direct environment and the pattern in which this occurs thus form part of the placing of people both in and among their environment. As Bronfenbrenner (1995) puts it, a human being acts as "an active agent in, and on, its environment" (p. 634). It is important to note at this point, where the psychological underpinnings are discussed, that an individual cannot be considered a solitary beacon of behaviour. As depicted in Figure 1, a person is influenced by myriad contexts such as his or her classroom, religious system, family or peers. These are described as the micro, meso, exo and macro levels of the ecological approach throughout this thesis.

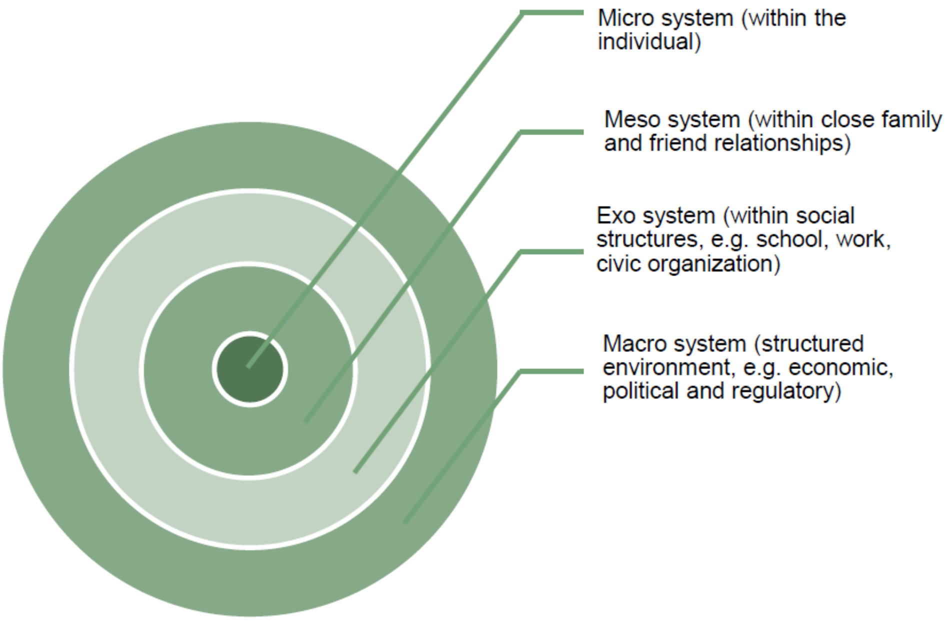

Figure 1 Bronfenbrenner's ecological levels as applied in this study

Weihl and Gladhart (1990) found that the occupant behaviour of residential properties is highly patterned, and is often determined by the routines, schedules and comfort requirements of individuals in the home. This suggests that the systems in which residents operate on a day-to-day basis have a direct impact on the way in which they use energy in the household. This finding suggests that a theoretical approach makes it possible to look at individuals, their attitudes and behaviour, as discussed in the previous section, taking into account the system in which these individuals operate.

Guerin et al. (2000) developed a human ecosystems theory, starting from the seminal work of Bronfenbrenner (1977) and Weihl and Gladhart (1990), which allows for the simultaneous study of natural, social and designed environments. Using this theory enabled the current study to examine the whole environment in which the individual participants operate.

People adapt to the things and issues they encounter according to the possibilities they are able to perceive (Toro, Trickett, Wall, & Salem, 1991). People tend to perceive both problems and applicable solutions as they interpret what they experience from the social context. The ecological environment includes social norms, social supportive structures, broad economic trends, neighbourhood attitudes, policies and cultural beliefs about problems and acceptable solutions (Visser, 2001), many of which were discussed in Section 1.3. Each of these influences people's daily decisions and behaviour, including those of the people who participated in this study.

2.5.1.1 Sociocultural influences

According to Toro et al. (1991), sociocultural influences require a researcher to explore how culture and social factors influence decisions an individual makes, in this case, about electricity use in the context of a household. This exploration involved considering the number of people in the household and the household's electricity bill, as well as factors affecting the selection of the household representative for participation in this study and the influence which that representative has as a spokesperson in the family.

In South Africa, it is impossible to avoid taking the political history of the country into consideration when studying geographically, socioeconomically and culturally different communities. Visser (2001) argues that apartheid has had formative effects on all communities in South Africa – this implies that it affected family structures, literacy levels, migration, work, and therefore also income, in both black families and white ones, so its effects are inevitably part of any system studied in South Africa. This is also true for the current research. This context was taken into consideration during the collection of data that allowed the researcher to understand participants' context, including their age, education levels and living standards. As suggested by Singer (1995), the context is discussed during the analysis and reporting stages (see Section 6.4).

2.5.1.2 Local influences

Local influences play an important role in the use of electricity. In this regard, Toro et al. (1991, p. 1210) note: "The norms, attitudes and concerns about the local effects of programs are as important as the development of the programs themselves." Local variations of these norms and attitudes were found in this study. Difficulties people experience include problems with municipal service delivery, mistrust in municipalities' ability to provide services, or the residents' own inability to pay for the electricity (which does not reduce their need for electricity in any way). It is therefore vital to understand the local influences in a community (Visser, 2001).

One problem encountered in the study was that there are many illegal connections, referred to as *izinyoka* (meaning "snakes" in isiZulu), to the electricity grid by people in a community (especially in the townships), which implies that a proportion of the community may not be paying the municipality for electricity at all. One could rightly ask what effect such practices had on the research, the community and the representativeness of those who participated in the study, since only paying participants were considered in this study, as *izinyoka* is a crime. In order to avoid the ethical implications of studying criminal activity and the likelihood of its confounding the study results, volunteer participants were asked to show the researcher their electricity bills or pre-paid meters during recruitment. This was done in order to ascertain that the participating households do pay the official electricity provider or municipality for the electricity they consume.

2.5.1.3 Person-environment fit and adaptation

According to Trickett, Kelly and Vincent (1985), thinking ecologically means seeing people, situations and events as resources for positive development, understanding context and managing and advancing community resources by means of intervention. Ideally this would lead to the creation of "networks between the intervention and the setting which are strong and durable enough to enable the intervention to endure over time" (Trickett et al., 1985, p. 301), emphasising the need to consider the fit between an individual and his or her environment.

Every individual in a community has the ability to interact with his or her environment in a unique way, leading to innovative and comfortable new ways of living within the constraints presented by a particular environment. Toro et al. (1991) suggest that the fit between a person and his or her environment could be unique for every individual, and that there are certain niches where balance between humans and their environment is achieved. In this study, for example, the variety of living standards required the researcher to understand that there is more than one approach to energy efficiency. It is important to explore each context on its own merits. The specific characteristics of each context and the perceptions of the residents who live there assist in gaining an in-depth understanding of the issues faced by the residents in that particular context. Household electricity consumption is therefore looked at in the context of the family structure, the size of the house, the number of appliances and the resources available to the members of the household to bring about energy efficiency in their homes.

The context in which an individual finds him- or herself creates meaning for the researcher, and provides a platform for interpretation of the data. Adopting a "historical and contextual approach to understanding the current state of social phenomena under consideration" (Toro et al., 1991, p. 1213) is very important in making changes for the future, such as the interventions attempted in this study. Hence, although democracy replaced apartheid in 1994, the legacy of apartheid even two decades later should not be underestimated. A multitude of influences play a role at any of the research sites, and environments continually develop in one direction or another for a reason. Taking the effects of history into consideration during the design and analysis of the study and including people from various socio-economic backgrounds enhanced the researcher's understanding of the possible interventions that could be implemented in community-driven programmes. Such an understanding may affect research and intervention questions, provide a context for decision-making and enhance a researcher's ability to assess the impact of action strategies devised for the specific group where the research is taking place (Visser, 2001).

Although an ecological perspective does provide insight into the way in which all aspects of an intricate living environment can be assessed, it does not necessarily provide a framework for describing the way in which the researcher herself made sense of the perceptions, the data collected and analysed, or interaction with members of different communities. A systems theoretical approach provided the researcher with an epistemology and a means for conceptualization, in other words, a framework for describing the researcher's thought process, her views and the way data were collected, analysed and described. Bateson (1979) uses the image of an epistemological framework of understanding in systems theory as moving away from single track, simplified and mechanical thoughts, to focusing on the "interactions of interactions" or "cybernetic patterns of interaction" (p. 79) (described below). In the next section, systems theory is discussed.

2.5.2 Systems theory

Historically, systems were subjected to studies in biology, chemistry and the physical sciences, reducing each system to its smallest parts. This became known as reductionism, defined by Hergenhahn (2001) as "the attempt to explain objects or events in one domain by using terminology, concepts, laws, or principles form another" (p. 53). Reductionism also became the norm in attempts to understand psychological illnesses, where it became common practice to reduce systems to their smaller parts and study these parts separately.

Bateson (1972), a prominent systems theorist in the 1970s, believed that the beginnings of a systems theoretical way of thinking lay in Lamarck's changing the logical direction of reasoning, by turning the "ladder of explanation upside down" (Bateson, 1972, p. 427), in other words, moving from deductive analysis to inductive analysis by building an understanding of the analysis outward from the observations until a hypothesis and theory are postulated. Lamarck's work encouraged the use of a "wide angle view of the world" (p. 428) looking at the whole rather than at parts in isolation. It is this approach, according to Bateson (1979), which can aid the world in working toward sustainability, considering the extended effects of our actions in the global context. Systems theory is thus a necessary part of the attempt in this study to make sense of electricity use on a broader scale and ultimately to make recommendations that are not only theoretically justifiable, but also practically applicable.

More recently, Uzzell and Moser (2009) have argued that environmental psychology requires a theoretical approach that assumes from the start the interconnectedness between people as well as their interaction with the environment, as “individuals are the sum of the relations to others and the environment” (p. 304). Therefore a systems theoretical approach is principally important for this study because of its consideration of the whole rather than of parts in isolation. Below, an overview of the system of systems theory is provided, followed by a discussion of.the entities of a system, the ability to self-regulate, the boundaries of a system, system autonomy, and positive entropy and equifinality.

2.5.2.1 The system of systems theory

Systems theory is intended to apply to single cells and to galaxies alike, implying systems and interacting parts that have natural interactions and natural ends. A system is, by definition, a set of interacting parts within a boundary (Germain, 1978) allowing various kinds of entity, including those explored in this study, to be defined as systems: an individual in a household, a household within the study group, the study group in its community, and so forth. Taking the system into consideration forces an assessment of the context and connectedness of the elements of the system under review.

Jordaan and Jordaan (1998) suggest some theoretical rules that aid description of a specific phenomenon being studied:

- context is paramount for the understanding of experience/behaviour/phenomena/problems;
- experiences/behaviour/phenomena and problems occur in more than one context;
- if experiences/behaviour/phenomena and problems occur in more than one context, there will be more than one way of describing these issues, all of them legitimate;
- there is a relationship between lesser contexts and larger contexts, based on the interdependence of the parts on the whole from which patterns emerge; and
- the interdependence of the lesser contexts and larger contexts and the patterns form a contextual spiral.

In the next section, the criteria of mind as described by Bateson (1972) are explored in more detail.

2.5.2.2 The criteria of mind in systems theory

The input, throughput and output of a living system refer to the information, decisions and action of the individual and larger systems (Bateson, 1972). Inputs are necessary in order to allow for throughput and output by one system, in turn allowing another system to make use of the output. This is a reciprocal process between systems at various levels, which implies that a change in a household could influence an individual, or vice versa (Germain, 1978). Bateson (1972) pinpointed six criteria of mind, otherwise known as a thinking system. These are briefly discussed in this section, followed by a more in-depth description of feedback loops, the maintenance of equilibrium and discovery and use of boundaries.

According to Bateson (1972), the mind is an aggregate of interacting components. These interacting components come together to form the system being studied. If these components are absent, no mind exists. Although it is impossible to identify all the contributing components of the system being studied in this study, the ecological framework assists in considering various levels of this system, namely the micro, meso, exo and macro levels of the system under review.

The first component of mind is the interaction between the components of the system. This implies, in the current study, the interaction between a person and his or her family members, the interaction within their communities and the regulatory environments in which these communities operate bring together the components of the system being studied via interaction, fulfilling the first criterion of mind.

Bateson (1979) argues that although differences occur continually, this is not always perceived or recognized. This ability to recognize or perceive differences constitutes the second criterion of mind. Interactions in a system only occur when perceptible differences register; therefore considering the differences pointed out by the research participants in this study highlights, for the researcher, the differences that make a difference in the systems being studied.

The third criterion of mind is that collateral energy has to be available in order to react on the perceived differences and activity interaction between the parts of the systems. Bateson (1979) claims that energy inherent in the system enables a reaction. In this study, the research participants and their household members alike were able to add to the changes in the system due to the collateral energy they embodied, the consequences of which are part of what is studied here.

Capra (1997) indicates that it is such additions of energy, also known as reactions to the perceived differences, that lead to the development of feedback loops. The feedback of a response into the system after perceiving a difference in the system is the fourth criterion of mind. Feedback loops are chains of determination and communication, forming the basis of learning in human systems, by reacting, changing and learning from incoming information. The feedback received from one system often sparks a perceivable difference in another system, leading to a cybernetic system of recurrent feedback loops, actions and reactions in every living system on earth. In this study, the information and intervention programme in which some of the research participants engaged allowed them to perceive a difference in respect of their desired electricity consumption, while in other cases, the differences remained imperceptible. In both instances, the messages that were fed back into the system of electricity consumption in the households effected some changes. These are discussed in detail in Chapter 6.

The fifth criterion of mind is the way in which a person interprets the world. Bateson is described by Capra (1997) as assuming “the existence of an independent world, consisting of objective features such as objects, events, and differences. This independently existing ‘outer’ reality is then ‘transformed’, or ‘encoded’ into an inner reality” (p. 299). This criterion emphasises interpretation of the differences perceived in the world, which may affect the type of reaction and input into the subsequent feedback loop, which may in turn affect the direction of change within the system. In this study, it is important to note that although many of the research participants received similar input from the researcher based on their actual electricity consumption, they may have interpreted it differently. The only method available to the researcher to understand how the participants interpreted the incoming messages was to look at the outgoing actions (the behaviour of the participants) or statements about boundaries (discussed in Section 2.5.2.3, below).

The sixth criterion refer to the importance, strength or “difference” perceived in the surroundings of a system determine the types of messages generated. These feedback loops or messages are perceived on a continual basis throughout the life of a system. Bateson (1979) notes that these messages about change sometimes contain messages about messages (meta-messages). Therefore messages of varying logical types may be generated and cause interaction between the components of a system or systems.

These criteria of mind are used in the conceptual discussion in Chapter 6, in order to guide the researcher in applying systems thinking in assessing the findings of this study. This highlights the interaction between different parts of the system, including both the households that participated in this study and those that did not, since they form part of the same thinking system, reacting toward one another and contributing to a system through the perceived differences and the consequent reactions.

In the two sections below, feedback loops, and the existence of boundaries in these systems are explored and discussed.

2.5.2.3 What is a feedback loop?

Feedback loops are continuous feedback rings whereby information on any given level of the n*th* perceptual system discussed above is fed back into the processing system. There are two types of feedback loops, as described by Bateson (1972), namely negative (homeostatic) feedback loops and self-amplifying loops.

A negative feedback loop is characterized by the balance in the system and the ability of the system to react to information, therefore keeping the system in balance, in other words, there is no change, and the system remains in homeostasis. A positive feedback loop is also called a self-amplifying feedback loop. A self-amplifying loop, the interaction between parts of a system or different systems is such that they are not kept stable, and have an amplifying effect on other parts of the system. A self-amplifying loop leads to instability within that and other systems, due to a lack of information, or information that seems contradictory to the expected outputs according to the throughput. When a system is not in equilibrium, changes are made in the applicable systems in order to establish a new equilibrium (Germain, 1978).

In an ideal world, all input, throughput and output would operate in equilibrium, ensuring that a constant feedback loop is maintained, with minimal influence on the operation of the system as a whole (Bateson, 1972). Feedback loops are a constant flow of information within or between systems (Capra, 1997). They are also called recursive systems (Singer, 1995). An example of a negative feedback loop (where equilibrium is maintained) is in residential electricity consumption: if feedback on electricity use is frequent enough, it may curb unintentional excessive use of electricity in a household by means of information input.

Feedback loops play an important role in individuals, households and communities alike, where feedback from one system has an impact on the larger system, or vice versa. The complexity of the phenomenon being researched increases when various systems are at work simultaneously. In the current study, higher order feedback loops are also briefly looked into during the final analysis and the conceptual discussion (Section 6.4) in order to describe the multi-layeredness of the research problem. Higher order feedback loops help to maintain equilibrium in each of the applicable systems (Keeney, 1983). A single feedback loop could ascertain equilibrium in a single system; however, higher order feedback is necessary in order to provide feedback about the feedback loop itself. Bateson (1972) describes this as a complex system of feedback and classification. A higher order feedback loop system is presented diagrammatically in Figure 2, which indicates how behaviour is influenced by rules of behaviour, in turn influenced by patterns of behaviour and the rules about the rules of behaviour.

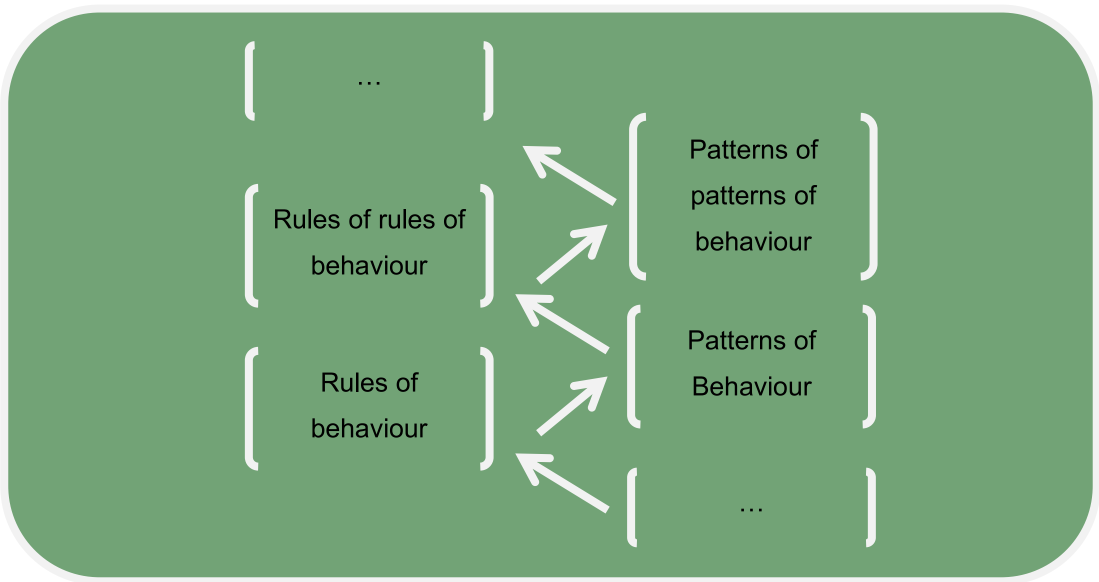

Figure 2 Higher order feedback systems

As indicated in Figure 2, in this study, individuals perform a behaviour focused on reducing electricity use, and rules govern that behaviour, but there are also rules about the rules (for example, the same rules do not apply in a cold spell, or when family is visiting) and patterns of behaviour that coincide with the weather and social events. The effect applies to both the individual and to other household members, and potentially to other people sharing a physical or social environment with the research participant.

Understanding these self-made rules (boundaries) in each household enabled the researcher to understand the system of electricity consumption better. These boundaries (discussed in more detail below) also assisted the researcher to understand what is considered part of the system of electricity in each household, what is not part of the system, and how participants' views of these systems differed.

2.5.2.4 A boundary

All systems have boundaries (Germain, 1978). Boundaries in living systems have to be permeable to some extent. Permeability has an impact on the equilibrium of the system as a whole (Bateson, 1979). Very permeable boundaries may allow other systems to affect the feedback in one system to such an extent that the system itself is unable to define its purpose or equilibrium. Similarly, if there is no interaction between the systems, due to very rigid boundaries, no interaction (and in essence, no learning) takes place and the system may die (Germain, 1978).

The extent of the boundary is somewhat arguable, since each system is itself part of another system. Living systems have to maintain an openness in order to develop and grow. Therefore it is not always possible to identify the boundary of a system. Instead, boundaries drawn by the participants themselves can be observed in order to understand the system of which they form part. This indicated to the researcher how learning took place in a household and enabled her to understand the learning and feedback systems in communication between a particular research participant and the household, civic organizations and the regulatory environment. In this study, it is suggested that the way in which a system identifies its boundaries is another way for the researcher of the system to delineate how the system under review is constructed (by the system itself), in other words, allowing the system to indicate its boundaries to the researcher. Similarities between the ways in which participants make sense of energy efficiency were investigated, as well as differences between participants with regard to electricity conservation and communication strategies before and after the intervention.

Boundaries are useful in ensuring negative entropy, or equilibrium, allowing the system to remain in equilibrium and avoiding a shutdown of a system due to disorganization, chaos, positive entropy or equifinality. Equifinality is described by Germain (1978) as the way in which a system reaches a natural point for termination, apart from its starting point. This emphasises the fact that a system may run a different course than planned and that it is not always possible to predict the outcome of an intervention. Any manipulation enters a system as only one input into the throughput of different systems. It is to be expected that the output will yield as many variables as there are combinations of throughput and systems. In this study, the effectiveness of the intervention was not only determined by the content of the intervention, but also by other contributing factors, such as the living standards of the research participants and seasonal effects. Exploring these influences gave the researcher an opportunity to test the boundaries of the importance of energy efficiency in a household. The interconnectedness of the research sites in this study was explored bearing in mind the criteria of mind of systems theory.

2.5.3 Interconnectedness and the research sites

The interconnectedness of people with and within their environment is a key concept in systems theory and is one of the six criteria of mind discussed in Section 2.5.2.2, above. Heylighen, Joslyn, and Turchin (2004) describe systems theory as intently focused on the "complex, adaptive, self-regulating systems that we might call 'cybernetic'" (p. 1). These cyclical systems of interaction emphasise a need for a theoretical approach that assumes from the start the interconnectedness between people, and their interaction with the environment – as Uzzell and Moser (2009) state: "[I]ndividuals are the sum of the relations to others and the environment" (p. 304). This relation to others and the environment could also be described as a community.

Traditionally, a community is defined as a geographically located concrete phenomenon. However, systems theory provides the necessary vocabulary to see the research sites in this study as more than just communities of individuals and place. The three research sites chosen can be seen as the communication between people, the roles they play in their work, family and social life, creating, building and changing the very nature of the community continually (Wiener, 1948). In this regard, it is worth noting Capra's (1997) description of a community as an "integrated whole whose essential properties arise from the relationships between its parts" (p. 27).

The link between household electricity consumption, the interaction between members of the households, the various participating households, the intervention and the research sites are explored from a systems theoretical view in the next section.

2.5.4 Intervention and its effects at a micro, meso, exo and macro level

In research, non-living things are often mapped, in effect bringing them into the world of the living, and subjecting them to analysis in an attempt to understand them. Bateson "did not look for truth in concrete entities or events. If there is any truth to be had, it is within this network of interconnecting parts" (Singer, 1995, p. 2). Therefore, an intervention creates an important opportunity to observe interconnected parts by introducing changes into the system.

In this study, the intervention, as part of the study, was aimed at the self-identified participant in each household studied. The intervention presented the first instance of manipulation in the household, attempting to alter what was considered normal behaviour in the household by means of an in-depth interview with an individual participant, to whom energy advice was given (the intervention used in this study is described comprehensively in Section 4.4. Even though the intervention in this research was based on an interaction with an individual member of a household (the participant, thus, on a micro level), the effect of the interaction should be measured on the individual level and should take the meso level of interaction (within the household) into consideration.

Interventions attempt to bring about changes in some way or another. From a systems perspective, interventions could have long-term, far-reaching effects in any system. The effect of the intervention can sometimes be much larger than initially anticipated, since the application of the actions requested in the intervention may be carried over to several other family members who participate passively in a study. Independently from this intervention, an exo and macro level of change may possibly exist within the social system of the participants. At a meso level, for instance, a participant might convince family members to change their routine behaviour. At an exo level, the research participant might become more involved in schools' attempts to address recycling and energy efficiency, and at a macro level start to react to media messages to save electricity. The final model should incorporate these levels in order to reflect the larger system, addressing the dimensions of interaction in residential energy efficient behaviour and the effect of changes in the system of behaviour.

The introduction of a change into an existing system is depicted from a systems theoretical viewpoint in Figure 3. This change enabled the researcher to explore the reaction of the participants to the intervention.

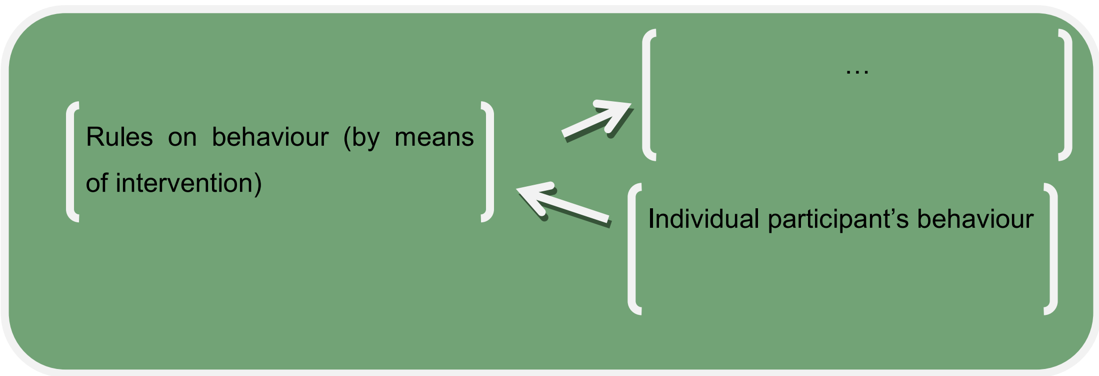

Figure 3 First-order intervention

Following the initial suggestions by the researcher for attaining energy efficiency in the household, rules about behaviour could be accepted, rejected, and/or altered by the research participants themselves. In these instances, the individuals revealed the boundaries of the household to the researcher.

A second order intervention, took place without interaction with the researcher. The second order intervention focuses on the interaction between the members of the household. The research participant demonstrated (or did not demonstrate) certain changes in his or her own behaviour and expressed a desire for change among the members of the household as well. In this way, the research participant might change from being the student in energy efficiency to becoming the teacher in his or her family, simultaneously making more sense of the teaching and comprehending the intervention in a different manner. Brochner (1981) notes that "[t]he messages contained in events and objects are not transferred to us like energy, but are transformed by us. Thus, explanations must centre not on events and objects themselves but on relations between them" (p. 74). In participants' households, rules about behaviour started to change (specifically focusing on electricity use), as indicated in Figure 4.

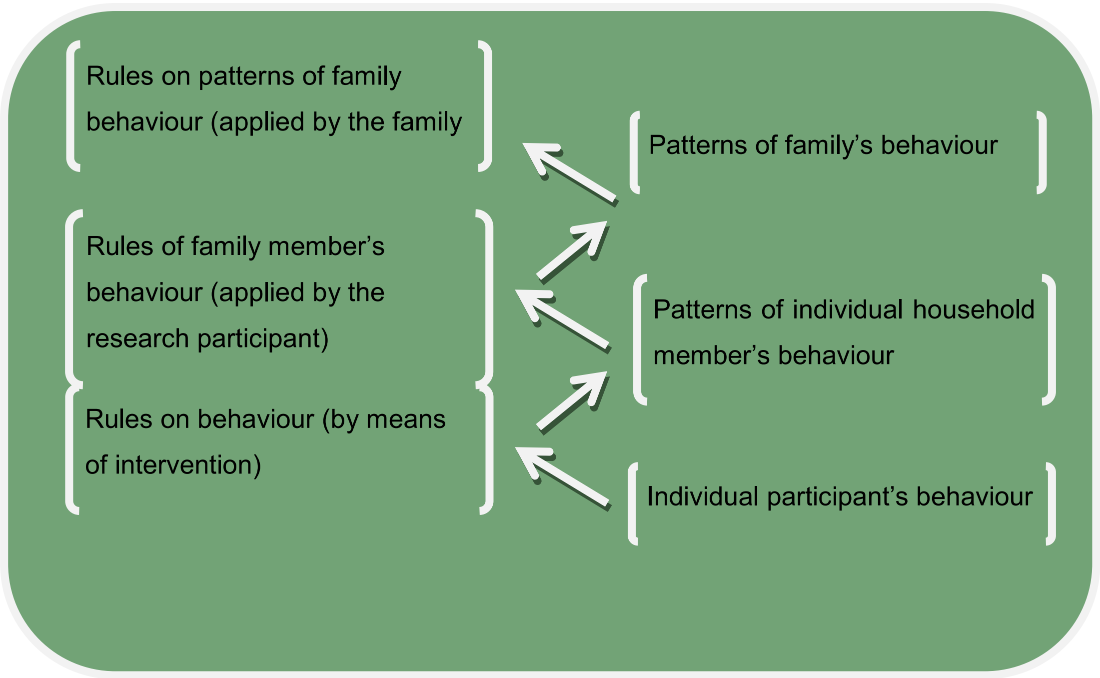

Figure 4 Second order intervention

Subsequent learning may also take place when interaction with the researcher is discussed with friends, family and neighbours. This level of intervention and its effect on the household and larger research site was explored to some extent in this study when the focus group discussions were held, but could not be studied in all its complexity.

Therefore, independently from the administered intervention, a second level of change (among household members and neighbours, at the meso level) and a third level of change (in the immediate physical or social environment of the research participants, at the exo level) may possibly exist within the participants' social system, for instance, where the research participants became involved in programmes such as schools' attempts to recycle and achieve energy efficiency (exo level) or decided to react to energy efficiency messages in the mass media (macro level). These interactions indicate that communication and learning are taking place; however, Visser (2001) emphasises that even where feedback theoretically takes place, many other systems simultaneously impact on an individual, a household or a community and that true change in the fabric of the individual, household or community takes time.

In this section, the researcher's ontology and epistemology were discussed, highlighting the need for both the ecological and systems theoretical frameworks to be used in this research. In the next section, the underpinnings from psychological theory that focus on the micro level (attitude and behaviour theories), as well as the meso and exo levels (social theories) are discussed in more detail.

2.6 Attitude-behaviour theories

In this section, the motivation and behaviour theories that focus on the individual (the micro level) are discussed. These include the Theory of Planned Behaviour (TPB) (Azjen, 1985, 1991) as an extension of the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1977), the theory of interpersonal behaviour (Triandis, 1977) and the value-belief-norm (VBN) theory (Stern, 2000). Deci and Ryan's (1985, 2000) motivational types and the goal frame theory of Lindenberg and Steg (2007) are also discussed, followed by a short conceptual discussion of these theories in the South African context and a description of the empowerment spiral (Mehlmann et al., 2010) applied in developing countries in recent years.

In the first part of this section, two main theories will be discussed, namely, first, the theory of planned behaviour (Ajzen, 1991) and, second, the value-belief norm model (Stern, 2000). This is followed by a comparison between the two theories, in order to explain conservation behaviour better, referring to a study conducted by Kaiser, Hübner, and Bogner (2005). Stern's (2000) value-belief-norm theory indicates several biospheric, altruistic and egoistic values that impact on behaviour. These are similar to the construct of attitudes as discussed by Ajzen (1991). Research has pointed to several demographic predictors that indicate a higher or lower possibility of positive attitudes toward the environment, including gender, age and even ethnic group. Guerin et al. (2000) provide a focused meta-analysis of studies focusing on occupant predictors of household energy behaviour, as discussed in Section 3.2.1.2. In the following section, a short overview of theories that contributed to the development of the Theory of Planned Behaviour (TPB) is given.

2.6.1 Precursors to the Theory of Planned Behaviour

The TPB presents a succinct and effective description of factors that play a role in changing attitudes into behaviour. Some significant theories dating back to the 1970s and 1980s contributed to the understanding of attitudes, perceived behavioural control and subjective norms. These are discussed briefly in this section, as precursors of Ajzen's (1991) theory of planned behaviour.

In his theory of interpersonal behaviour, Triandis (1977, 1980) describes facilitating conditions, in addition to attitudes and risk perceptions. Facilitating conditions are defined as the ability to carry out an act or behaviour. In the current study, however, it is argued that these facilitating conditions form part of the evaluation when behavioural control is perceived and therefore they are not discussed separately in a summary of the attitude behaviour theories in a subsequent section.

MacInnis and Jaworski (1989) developed the ability, motivation and opportunity model. According to their model, behaviour is determined by motivation (goal-directed arousal), ability (the skills and capabilities necessary to perform a behaviour), and opportunity (the contextual and situational constraints relevant to the performance of the behaviour). In this study, it is argued that the theory of interpersonal behaviour (Triandis, 1977, 1980) and the ability, motivation and opportunity model (MacInnis & Jaworski, 1989) both describe similar phenomena in different ways. MacInnis and Jaworski's (1989) "ability" corresponds to Ajzen's (1991) perceived behaviour control (which includes the ability to act or perform the desired behaviour) and to Triandis's (1977, 1980) facilitating conditions. Ajzen's (1991) TPB is widely regarded as one of the most comprehensive theories explaining the inner processes used for planning behaviour.

Intention (Ajzen, 1991) also correlates with motivation, as described by MacInnis and Jaworski (1989). This is confirmed by Ajzen's (1991) own description of intention:

> Intentions are assumed to capture the motivational factors that influence behaviour; they are an indication of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behaviour. As a general rule, the stronger the intention to engage in behaviour, the more likely should be its performance (p. 181).

2.6.2 Theory of planned behaviour (TPB)

According to Kaiser et al. (2005), the theory of planned behaviour developed by Ajzen (1991) is primarily "self-interest-based and rational choice-based" (Kaiser et al., 2005, p. 2150) and distinguishes between three types of beliefs – behavioural, normative and control – and between related constructs of attitude, subjective norms and perceived behavioural control. Ajzen (1991) states:

> Theoretically, personal evaluation of a behaviour (attitude), socially expected mode of conduct (subjective norm) and self-efficacy with respect to the behaviour (perceived behavioural control) are very different concepts each of which has an important place in social and behavioural research. (p. 198)

Ajzen's (1985, 1991) theory of planned behaviour is diagrammatically expressed in Figure 5. Attitudes (A), perceived behavioural control (PBC) and subjective norms (SN) are briefly discussed below, drawing on other theories and bringing them into relation with the theory of planned behaviour.

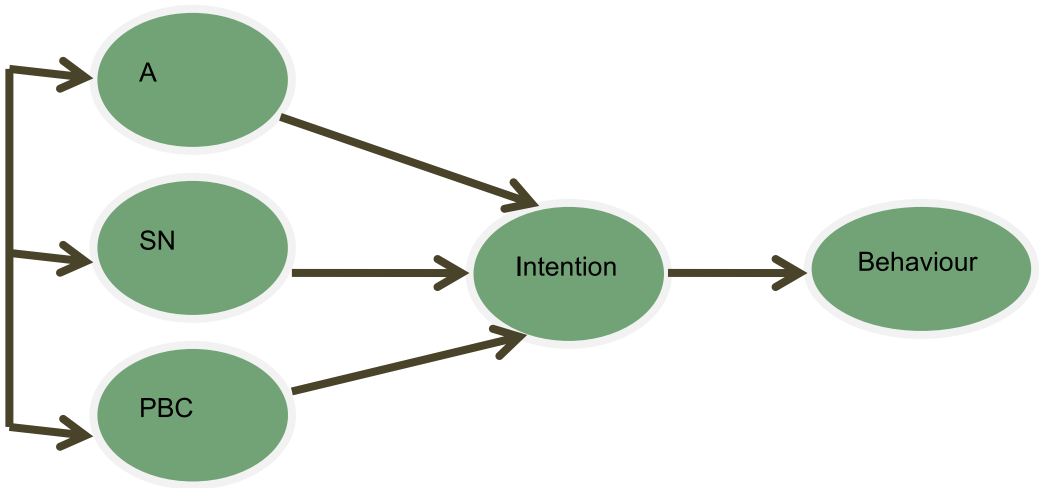

Figure 5 Theory of planned behaviour
(Ajzen, 1991, p. 182)

2.6.2.1 Attitudes

The focus of this section is on the influence of an attitude, defined by Clayton and Myers (2009) as "evaluative reactions to objects or behaviours based on beliefs about those objects and behaviours" (p. 19), on pro-environmental behaviour. Ajzen (1991) defines the "attitude toward the behaviour" as the degree to which "a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question" (p. 188). The acquisition of attitudes is a continuous process of evaluation and feedback which assists people in describing their environment to themselves through short-cuts in the form of attitudes. Attitudes help people to understand and organise the world around them (Feldman, 2001). Bateson (1972) describes an attitude as a necessary flexibility to avoid wasteful computational resources of the brain. He further describes this flexibility (the use of subconscious attitudes) as the ability to classify people and situations fairly quickly, relying on previous experiences, instead of re-assessing every person or situation every time.

2.6.2.2 Subjective norms

Ajzen (1991) describes normative beliefs as beliefs "concerned with the likelihood that important referent individuals or groups approve or disapprove of performing a given behavior" (p. 195). A person might also perceive there to be social pressure that would lead to a decision to perform or not perform a particular behaviour (Amjad & Wood, 2009). Social learning theory advocates that people learn by observing the consequences (albeit positive or negative) of the actions of those around them (Bandura, Ross, & Ross, 1961). Perceived rewarding consequences lead to behaviour imitation. People not only observe these rewarding consequences, but also tend to make some attributions about why the consequence followed. People tend to make judgements about others' behaviour, focusing on either other's disposition or their situation (Zimbardo & Leipp, 1991); thus people take both the person and the situation in which the act took place into consideration when they perceive the reward. Stern (2000) also suggests that beliefs and values are mediated to some extent by the personal norms an individual holds, thus leading to adjusted behaviours due to the perceived or personal norms that person holds.

Social norms play a significant role in the behaviour decisions people make, even more than was anticipated by researchers focusing on social norms themselves. Asch (1951, 1956) was one of the first to discover the intense effect that social norms have on behaviour. He studied the influence of groups on individual behaviour, or conformity. In his study, research participants (all students) were shown a line and asked which one matched the example length. In 99% of the cases, the students chose the correct line. During a second test, all the students except one were replaced with fellow researchers who sometimes selected the correct answer and sometimes the incorrect one. In his study, Asch showed that 75% of the people conformed at least once to what was clearly the wrong answer, and ultimately 37% confirmed the erroneous response as their final answer.

In light of these findings by Asch (1951, 1956), McKenzie-Mohr and Smith (1999) emphasise the importance of normative displays of behaviour. They argue that too little attention has been given to the potentially significant impact of the adaptation of norms and that, in terms of pro-environmental behaviour, it may be sufficient in many cases to "make a community norm salient by modelling it in order to have a substantial impact upon behaviour" (p. 34).

Burgess, Bedford, Hobson, Davies, and Harrison (2003) suggest that social norms and the context of the individual govern the individual's lifestyle construction in such a way that the individual's decisions are not "entirely voluntaristic" (p. 261). This suggests that behaviour is sometimes not "entirely voluntaristic", a radical concept, since behaviour is generally considered as "freely chosen and thus independent of physical causes" (Hergenhahn, 2001, p. 10).

A study by Cialdini, Reno, and Kallgren (1990) revealed the impact of social norms on people's littering behaviour. They studied which type of norms (injunctive of descriptive) impact on people's tendency toward littering or picking up litter, depending on the displayed behaviour. They define two types of norms, "injunctive norms (what most others approve or disapprove) and descriptive norms (what most others do)" (p. 1015). The littering behaviour of observed subjects was tested in five rigorous field studies, and varied depending on the norms activated and displayed by confederates of the researchers. Cialdini et al. (1990) concluded that normative behaviour (most often done or approved or both) “in a society, in a setting and within a person, will in each case, have a demonstrable impact on action, but that the impact will be differential depending on whether the actor is focussed on norms of the culture, the situation, or the self” (p. 1025).

In a more recent study on normative beliefs by Nolan, Schultz, Cialdini, Goldstein, and Griskevicius (2008), the persuasive impact and detectability of normative social influence and the reasons given by participants for why they conserve energy was explored. First, through a survey, Nolan et al. (2008) found that descriptive normative beliefs were “more predictive of behaviour than were other relevant beliefs, even though respondents rated such norms as least important in their conservation decisions” (p. 913). In other words, even though people discounted the normative belief (the socially acceptable belief) as being least important when making decisions about conservation, a field experiment proved differently. In the field experiment, researchers provided several messages to participants encouraging them to conserve electricity. Participants were presented with five encouraging messages to conserve electricity: these included messages focused on a) the descriptive norm, b) self-interest, c) the environment, d) social responsibility, and e) information. When tested, people who received descriptive norm messages described them as “least motivational” (Nolan et al., 2008, p. 919). However, the findings indicated that “normative information spurred people to conserve more energy than any of the standard appeals, such as protecting the environment, being socially responsible, or even saving money” (p. 921). Thus the behaviour displayed was more often in line with what the participants perceived to be the social norm, which shows that “descriptive norms had a powerful, but underdetected effect on important social behaviour: energy conservation” (p. 912). McKenzie-Mohr and Smith (1999) suggest that people often do not detect why they change their behaviour and tend to find other reasons for their behaviour, even if they directly copied the behaviour from an observed other.

Nolan et al.’s (2008) research builds on the importance of perceived social norms. Their research indicates that the persuasive impact of normative social influences is much stronger than was previously believed, even by Burgess et al. (2003). Nolan et al. (2008) emphasise the impact of social norms when they indicate that “normative information spurred people to conserve more energy than *any* of the standards appeals that are often used to stimulate energy conservation” and that “[d]escriptive norms had a *powerful but underdetected effect* [emphasis added] on an important social behaviour: energy conservation” (p. 921). Similarly, Reno, Cialdini, and Kallgren (1993) found that people littered less if they saw others picking up litter. From the studies by Asch (1951, 1956), Nolan et al. (2008) and Reno et al. (1993) cited above, it is increasingly clear that people may be more likely to conform than to do “the right thing” (McKenzie-Mohr & Smith, 1999), even when the option posed through conformation is clearly wrong. These studies are indicative of the importance of social norms.

Nye and Hargreaves (2010) state that, even though normative expectations and self-assessment of personal capability are "undoubtedly important to the enactment of pro-environmental behaviour on an individual level" (p. 139), it is important to note that "the right thing(s)" are constantly "(re)defined and (re)negotiated in unfolding social contexts of interaction" (p. 139) and will themselves shape the enactment of pro-environmental behaviour. Changing social norms would therefore play a significant role in the use of electricity in the household. Nye and Hargreaves (2010) show that "'folk knowledge' about what it means to live a green lifestyle, how to use surrounding systems in greener ways, and why it is desirable to do so" (p. 146) are often dispelled or enforced within a person's close social system. In other words, beliefs are undermined, or alternatively, preserved and even promoted, by means of normative beliefs via family and friends.

Kaiser, Schultz, Berenguer, Corral-Verdugo, and Tankha (2008) studied anticipated guilt and embarrassment in a cross-cultural design (using four different groups, namely high vs. low individualism and English-speaking vs. Spanish-speaking students, in a two-by-two design). They postulated that anticipated guilt would be a strong predictor of behavioural intent in cultures high on individualism, and that the same effect would be seen for anticipated embarrassment in cultures low on individualism. They used cross-sectional surveys with 801 university students in the USA to study interactions. Results showed that both guilt and embarrassment "operate equally well as determinants of intention within the planned behaviour framework" (p. 195) across the four measured cultures. In other words, both embarrassment and feelings of guilt equably predict behavioural intent. This highlights the necessity to consider feelings of guilt and embarrassment in the analysis of individual behaviour, and sheds light on the impact of the subjective norms held by an individual. These findings have important implications for the way in which interventions are planned. In the next section, perceived behavioural control is discussed.

2.6.2.3 Perceived behavioural control

A person's perception on the ease or difficulty of performing a speicifc action was described by Ajzen (1991) as the perceived behavioural control, another factor that would influence behavioural intention. The perception of behavioural control is discussed under three headings: threat or risk assessment, the assessment of the individual's ability to respond, and the future orientation of the individual. These contribute to an individual's assessment of control (or perceived ability to control their behaviour), and may lead to specific behavioural outcomes.

- *Threat or risk assessment*

The concepts of threat and risk perception are used interchangeably in this study. Often, changes in the environment are not easily perceptible, and therefore people are not able to identify a change through normal sensory pathways, due to environmental threats that are usually incremental. Gattig and Hendrickx (2007) explain this as follows:

> Environmental risks seem to constitute a special category of risks. They often are characterised by high levels of uncertainty, by strongly delayed consequences, and by consequences that occur at distant places and are – therefore – borne by others. All of these aspects may result in a discounting of such risks; that is, such risks are taken less seriously than risks with negative outcomes that occur for sure, now, here, and to us. (p. 22)

Clayton and Myers (2009) point out that people are notoriously inaccurate in assessing environmental threats. Their assessments are often "highly subject to bias" (p. 23) and depend on framing (providing a specific background to information in order to change a person's perception of the situation). According to Slovic (2000), environmental threat perception is frequently based on media reports. Leiserowitz (2007) states that perceptions are strongly influenced "not only by scientific and technical descriptions of danger, but also by a variety of psychological and social factors, including personal experience, affect and emotion, imagery, trust, values and worldviews" (p. 3-4). These risks are often perceived to have an effect only on faraway peoples, with low or even no local impact (Clayton & Myers, 2009; Gattig & Hendrickx, 2007; Hardin, 1968; Leiserowitz, 2007).

A perception that a situation is controllable, observable and familiar is unlikely to lead to action, as no risk or low risk is perceived. Risks whose effect will only be felt in the future are also often discounted (Frederick, Loewenstein, & O'Donoghue, 2002; Loewenstein, Weber, Hsee, & Welch, 2001), which results in inaction or action disproportionate to the threat. The environmental threat is rarely perceived as immediate; therefore people's motivation to act is usually in line with the perceived threat and rarely in line with the actual threat. Stern (2000) indicates "perceived ability to reduce threat" (p. 412) as one of the beliefs that would mediate a value before it becomes a behaviour.

At this point, a specific example relating to residential energy efficiency is helpful. Morris and Winter (1978) argue that people who perceive their households to have few deficits in terms of energy efficiency are less likely to make adjustments or alterations in their housing. More recently, Niemeyer (2010) came to a similar conclusion stating that "satisfied householders may be less motivated to make additional changes in their home to increase the energy efficiency. Dissatisfied householders are more likely to take action if…constraints are removed" (p. 142). This goes to show that if the threat is not perceived, behaviour is more difficult to bring about; however, the homeowner should not only be able to identify a 'threat' but also understand how to respond to it. In the following section, the perceived ability to respond is discussed.

- *Assessment of ability to respond to a situation*

Two aspects are dealt with in this section, first, a person's ability to respond to a situation and, second, his or her perceived responsibility in that situation. Ajzen (1991) describes a person's ability to respond as "perceived behavioural control", and defines it as "people's perception of the ease or difficulty of performing the behavior of interest" (p. 183). He notes that "it is assumed to reflect past experience as well as anticipated impediments and obstacles" (p. 188). These past experiences vary across situations and actions and are mediated by a person's attitude and subjective norms.

Lazarus (1966) elucidates his protection-motivation theory in the basis of a study. He posits that once a threat is perceived, it is evaluated. The threat is then appraised, a process whereby the severity and probability of impact on valued goals are assessed. The threat is then either evaluated as high or low. Next, a person's ability to deal with the appraised threat, his or her "perceived response efficacy", and the pros and cons of action are evaluated. This in turn leads to an assessment of his or her ability to cope with the threat. In this process, "discounting" can occur in which risks are considered less serious than they are. Gattig and Hendrickx (2007) warn that this can potentially complicate the ability to deal with environmental risks in general, and subsequently worsens the tragedy of the commons. The tragedy of the commons refers to the effect where the sharing of resources ultimately leads to the depletion of those resources due to the unidentifiable individual use of the resource (Hardin, 1968).

Clayton and Myers (2009) suggest that environmental decision-making provides a distinctive context for moral reasoning. They argue that psychological investigation of moral reasoning shows that "moral action is not possible if people cannot recognize when their desires or self-interest, or the selfish actions of others, conflict with duties to or regarding other entities, including nature" (p. 44). The moral implication of environmental decision-making is increasingly come to the fore – Al Gore Jr. labels climate change a "moral issue" (Guggenheim, 2006). Similarly, Ajzen (1991) states that it might be reasonable "to suggest that moral issues may take on added salience with respect to behaviours of this kind and that a measure of perceived moral obligation could add predictive power to the model" (p. 199). A person's perceived responsibility ties in with the perceived risks as described above, as well as with subjective norms.

- *Future orientation*

Because the environmental threat is incremental and difficult to perceive, it appears to hold no immediate threat, in comparison to daily actions required, such as recycling, using transport and energy efficient and greening urban areas. Gattig and Hendrickx (2007) claim that human decision-making focuses on the occurrences "here, now and for sure" (p. 22). Consequences that are not perceived to be directly correlated to the here, now, and for sure are valued less. It is therefore understandable that Milfont and Gouveia (2006) found that people with a future orientation are especially likely to engage in more pro-environmental behaviour than others. In their study, environmental preservation and environmental utilization were found to be negatively correlated. Environmental preservation was also “positively correlated with future, biospheric and altruistic [factors]. Environmental utilization, on the other hand, was positively correlated with self-enhancement, and negatively correlated with future and biospheric” [factors] (p. 72). Both time perspectives and values accounted for significant variance in environmental attitudes in their results. This emphasised the social dilemma, where short-term and longer-term interests (temporal conflict) and individual and collective interests (social conflict) are weighed up against one another (Milfont & Gouveia, 2006).

In the next section, the value-belief-norm theory championed by Stern (2000) is discussed.

2.6.3 Stern’s value-belief-norm (VBN) theory

Stern’s (2000) VBN theory stresses aspects that influence behaviour. An important difference between the TPB and the VBN theory is that Stern sees the values as mediated by a number of beliefs influencing personal norms and, in turn, behaviours (Stern, 2000). This means that VBN theory places increased emphasis on “moral-norms and is values-centred” (Kaiser et al., 2005, p. 1254), whereas the TPB is more grounded in the assumption of self-interest.

Figure 6 shows Stern’s (2000) VBN theory. He posits that “the causal chain moves from relatively stable, central elements of personality and belief structure to more focused beliefs about human-environment relations, their consequences, and the individual’s responsibility to take corrective action” (p. 412).

Values	**Beliefs**			**Pro-environmental Personal norms**	**Behaviours**
Biospheric	Ecological Worldview (NEP)	Adverse consequences for valued objects (AC)	Perceived ability to reduce threat (AR)	Sense of obligation to take pro-environmental behaviour	Activism
					Non-activist public-sphere behaviours
Altruistic					Private-sphere behaviours
Egoistic					Behaviours in organisations

Figure 6 Value-belief-norm theory
(Stern, 2000, p. 412)

Here, it is clear that the VBN theory places greater emphasis on norms and is more values-centred than the TPB. Below, the ability of each of these theories to explain efficiency behaviour is discussed.

2.6.4 Usefulness of the TPB and VBN theories in explaining conservation behaviour

According to Kaiser et al. (2005), the various theories that have been discussed in attempting to understand "preconditions of people's performance" (p. 2154), the TBP and the VBN models have been the most significant. In one of the first empirical studies to compare the abilities of the TPB and the VBN models to explain conservation behaviour, Kaiser et al. (2005) found that the TPB is "impressive at explaining conservation intention (76%) and conservation behavior (95%), even when moral concepts are not addressed explicitly. In the environmental domain, [moral concepts] are, apparently, already an integral part of people's attitude" (p. 2167). Kaiser et al. argue that the central difference between these two theories relates to the inclusion of morals and values into the VBN model, whereas Manstead (2000) criticises the TPB for neglecting moral considerations. Moral considerations have been thought to be able to influence behaviour, particularly where morally relevant situations are at stake (Gorsuch & Ortberg, 1983). Social theories argue that people are influenced by others in how they perceive the world, their abilities, and their responsibilities (social norms). This emphasises the decreased ability of morals as a sole predictor of behaviour and indicates that moral values form only part of people's attitudes and need to be upheld by the perceived social norms.

The role of motivational personality types and the way in which goals are framed may also play a role in the development of people's intention to behave in a certain way. The motivational type of the individual as proposed by Deci and Ryan (1985, 2000) and the goal frame used to motivate behaviour (Lindenberg & Steg, 2007) are briefly explored below, followed by a description of social theories that describe behaviour change.

2.6.5 Self-determined motivational types

Deci and Ryan (2000) have identified six types of people by ranking people's motivation along a self-determination continuum, reflecting their level of autonomous decision-making capabilities. These are briefly described below with an illustrative quote about caring:

- amotivation: this represents feelings accompanied by a perceived lack of control and feelings of unimportance (De Groot & Steg, 2007); a person might say "I don't care";
- external regulation: people make behavioural decisions based on their perceptions of satisfying external demands; a person might say "I am supposed to care";
- introjected regulation: people act because of a moral sense of obligation; a person might say "You care, I suppose I should also care";

- identification: people are motivated to behave in a certain way because they identify with a behaviour, and in turn, that behaviour becomes part of their identity (De Groot & Steg, 2007); a person might say “I can see myself caring about this”;
- integrated regulation: the person has internalized regulation and totally agrees with it, saying “I care”; and
- intrinsic motivation: this is the most motivated type of person, one who behaves in a specific way because he or she finds it “interesting and enjoyable” (De Groot & Steg, 2007, p. 369); such a person would say, “I like to care”.

Personal motivation plays an important role in behaviour change, although never in isolation. Caring is discussed more systematically as part of the empowerment spiral in section 2.7.4. The way in which a goal is framed my also influence how much a person will express his or her environmental concern. Lindenberg and Steg (2007) argue that the way in which any goal is framed has an effect on whether a person is motivated to act in a pro-environmental way or not. These goal frames are discussed as part of the social behaviour change theories in the next section.

2.7 Social theories

In Section 2.6 above, attitude theories were discussed and, although they are important in coming to understand environmental attitudes of people, they are not sufficient, because they fail to provide a fuller understanding of the social context in which the behaviours occur. The intellectual territories of certain disciplines are not always well delineated, but it is widely accepted that psychology studies the behaviour of individuals, sociology that of groups, anthropology that of cultures and political sciences that of national groups (Uzzell & Moser, 2009). However, Gunther (2009) states that “even psychology, whose principal unit of analysis is the individual, understands that the study of individual behaviour does not take place apart from the social context nor apart from social interactions: behaviour is predicated on the presence, real or imaginary, of others” (p. 359). From a systems theoretical viewpoint, it is impractical to focus solely on the inner workings of the individual without considering the environment in which the individual has to operate.

Lutzenhiser (1993) describes the research trend in the early 1990s as having reached consensus “that adequate models of energy and behavior must be more directly concerned with the social contexts of individual action” (p. 262). More recently, Clayton and Brook (2005) suggested the inclusion of “situational context, existing schemas, and personal motives” (p. 87), and Uzzell and Moser (2009) have expressed a similar view in calling for “the emphasis…[to] shift to the relations of production and consumption and the social and political relations within which values, attitudes and behaviors are formed” (p. 304).

Therefore, in this section the scope is widened and some social theories on change are discussed. The discussion starts with a description of Lindenberg and Steg's (2007) goal-framing theory and then considers Prochaska, Velicer, DiClemente, and Fava's (1988) stages of change, and their extension, the trans-theoretical model of behaviour change (Prochaska, DiClemente, & Norcross, 1992). Lastly, Rogers's (1995) social diffusion theory is discussed. This discussion places the attitudes and behaviours of the research participants in a social context and enhances understanding of the systems in which the participants in this study operate.

2.7.1 Goal-framing theory

Lindenberg and Steg (2007) proposed the goal-framing theory, in which they argue that the way in which a goal is framed has an impact on the way in which people process and act upon any given information. Gollwitzer and Bargh (1996) posit that goals are key determinants of the way in which a person would assess a particular situation. Lindenberg and Steg (2007) therefore studied the literature on environmental behaviour and identified three overriding goals. These goal frames coincide closely with Stern's (2000) VBN theory values, discussed in Section 2.3 above. These frames are highlighted here:

- The hedonic goal frame: This goal frame operates on the premise of feelings in a particular situation, the desire "to feel better right now" (Lindenberg & Steg, 2007, p. 119). This aspect of the goal frame theory coincides with the egoistic value identified by Stern (2000).
- The gain goal frame: This goal frame's main premise is gaining or avoiding losing some resources, "to guard and improve one's resources" (Lindenberg & Steg, 2007, p. 119). This aspect coincides with the altruistic value identified by Stern (2000).
- The normative goal frame: This goal frame involves an attempt to act in accordance with the norms, "to act appropriately" (Lindenberg & Steg, 2007, p. 119). This aspect coincides with the biospheric value identified by Stern (2000).

The normative goal frame is concluded by Lindenberg and Steg (2007) to be the most important goal frame in terms of pro-environmental behaviour, since its main motivation is to act in accordance with commonly accepted codes for behaviour. The hedonic goal frame focuses on the mood of an individual and is considered rather fickle as a basis for "achieving stable pro-environmental behaviour" (p. 128), while the gain goal frame relates the desired behaviour closely to "cost minimization, which may lead to adverse and unexpected behaviour" (p. 129).

Lindenberg and Steg (2007) propose that prominence should be given to smart norms, wherein abstract norms are interpreted by individuals in specific situations. This would assist individuals to judge appropriate behaviour from the smart norm known to them. Smart norms must be linked to lower-level smart norms, which are in turn connected to specific behaviours. Their example is apt for this study and is presented in Table 1.

Table 1

Alignment of Lindenberg and Steg's goal-framing theory with Stern's VBN theory and the ecological approach

Norm	Stern's (2000) value	Ecological level of application	Example
Abstract smart norm	Biospheric value	Exo level	"Do not harm others"
Lower-level smart norm	Altruistic value	Meso level	"Act pro-environmentally"
Specific behaviour	Egoistic value	Micro level	"Shower for a shorter time"

Source: Lindenberg and Steg's (2007, p. 129), Stern (2000)

The link between these norms, values and level of ecological application is important since they provide the impetus for the qualitative interviews that focus on the research participants' values, how they express them and may address to some extent the self-identification of barriers to changing their own behaviour.

Lindenberg and Steg (2007) suggest two factors that may limit the achievement of normative goals, namely, first, that people "do not have sufficient knowledge of environmental problems" (p. 129) and, second, that "people are not aware of the environmental impact associated with their behaviour" (p. 129). These aspects warrant futher exploration with the aim of a better understanding of energy efficiency behaviour. The strength, or even existence, of such normative goals in South African society is doubtful. The ASSAf (2011) reported an absence of social norms that encourage low carbon citizenry, claiming that the perception "regarding pro-environmental behaviour is that it is elitist and anti-development" (p. 159).

Suggested approaches to behaviour changes include providing information (but not in isolation), providing feedback on changed behaviour and getting a commitment from members of the society to behave in a pro-environmental way. The trans-theoretical model proposed by Prochaska et al. (1992) is discussed next.

2.7.2 The trans-theoretical model

The trans-theoretical model developed by Prochaska et al. (1992) describes people's motivation and readiness to change behaviour. Their model is similar to that of Ajzen (1991), but includes the larger context implied by Bronfenbrenner's (1977) work. The two primary components of this theory are the stages of change and the processes of change. Individuals pass through five stages of change during behaviour modification: pre-contemplation, contemplation, preparation, action and maintenance. Table 2 indicates the definitions of these stages.

Table 2

Stages of change and potential change strategies

Stage	Definition	Potential Change Strategies
Pre-contemplation	Has no intention of taking action within the next six months.	Increase awareness of need for change; personalize information about risks and benefits
Contemplation	Intends to take action in the next six months.	Motivate; encourage making specific plans
Preparation	Intends to take action within the next 30 days and has taken some behavioural steps in this direction.	Assist with developing and implementing concrete action plans; help set gradual goals
Action	Has changed behaviour for less than six months.	Assist with feedback, problem solving, social support, and reinforcement
Maintenance	Has changed behaviour for more than six months.	Assist with coping, reminders, finding alternatives, avoiding slips/relapses (as applicable).

Source: Glanz and Rimer (2005, p. 15)

These stages are not linear and should be regarded as cyclical, in that an individual may lapse but move forward continuously. These transitions are effected by the ten processes of change. These processes can be divided into experiential or cognitive and behavioural processes. The cognitive processes involve

- consciousness-raising (seeking new information related to a specific behaviour change);
- dramatic relief (experiencing intense emotions related to the problem behaviour);
- environmental re-evaluation (considering and assessing the physical and social environment effects on behaviour);
- self-re-evaluation (reappraising emotional and cognitive values with regard to the problem behaviour); and
- social liberation (becoming aware of changing social norms in support of the behavioural change).

These cognitive processes will assist in making meaning from the qualitative discussions in the in-depth interviews and focus group sessions.

Behavioural changes involve activities that change overt behaviours. These include, the following, according to Guillot, Kilpatrick, Hebert, and Hollander (2004):

- counter-conditioning (replacing new behaviour with old behaviour);
- stimulus control (controlling situations that could trigger old behaviour);
- contingency management (changing contingencies that control problem behaviour);

- self-liberation (individual choice and commitment to change problem behaviour and the belief that it can be changed); and
- helping relationships (using support from others during change efforts).

Two components of the trans-theoretical model that are thought to determine when change occurs are decisional balance and self-efficacy. Decisional balance involves the perception and evaluation of cons (pain) and pros (pleasure) associated with the behaviour. The distinguishing feature of the decisional balance is the perception of the possible outcomes, rather than the expectation of the outcomes. Thus it is argued that a person will not change his or her behaviour unless the pros (pleasure) are perceived to exceed the cons (pain).

Self-efficacy is the confidence a person feels about performing a particular activity, including confidence in overcoming barriers to performing that behaviour (Bandura, 1977). Self-efficacy beliefs are suggested to be an important prerequisite for behavioural change, and are linked to an increased likelihood that the individual will engage in the behaviour (Guillot et al., 2004). This ties in with the notions of perceived behavioural control of Ajzen (1991) and Lazarus (1966) discussed in Section 2.6. The model, as adapted from Edwards, Jones, & Belton (1999) and Prochaska et al. (1992), is shown in Table 3.

Table 3

The trans-theoretical model of behaviour change

	Stages of change				
	Pre-contemplation	Contemplation	Preparation	Action	Maintenance
Self-efficacy	Confidence Low	Higher Confidence	Increasing confidence	Confidence high	Confidence high
Decisional Balance	Cons > Pros	Cons + Pros	Cons ≤ Pros	Cons < Pros	Cons ≤ Pros
			Processes of change		
	Consciousness Raising Dramatic relief Environmental re-evaluation	Self and Environment re-evaluation	Social and self-liberation	Counter conditioning Stimulus Control Contingency Management Helping Relationships	

This theory takes into consideration relationships and the environment and describes the process of change; which are explored during the analysis of the qualitative interviews with participants however, it fails to describe the way in which this change is diffused into society. In the next section, the way in which social diffusion of an innovation or idea occurs is examined. The social diffusion theory is supported by the findings of Nolan et al. (2008), discussed in Section 2.7.3.

2.7.3 Social diffusion theory

The social diffusion theory explains how “the degree to which an individual is relatively earlier in adopting new ideas than other members of his social system” (Rogers, 1995, p. 40) and thus helps to diffuse an innovation into the social system. An innovation can be described as an idea, practice or object which a person perceives as new. Rogers (1995, pp. 183) identified the following five groups:

- the innovators (these people are venturesome);
- the early adopters (these people tend to want to be seen as respectable);
- the early majority (these people tend to be deliberate);
- the late majority (these people are inclined to be sceptical); and
- the laggards (these people tend to be traditional).

Initially, individual adoption decisions were studied (micro-level analysis), but more recent studies include macro-level analysis, so that diffusion studies now include both micro and macro level innovation. Rogers (1995) suggests four main elements of diffusion of an innovation:

- the moment of innovation;
- communication channels;
- time; and
- the social system.

People assess decisions that are neither authoritative nor collective, leading to their own innovation decisions. The five-step process is summarized by Orr (2003, p. 1) as involving

- knowledge (this refers to a person’s becoming aware of an innovation and getting some idea of how it functions);
- persuasion (at this stage, the person forms a favourable or unfavourable attitude toward the innovation);
- decision (at this point, the person may engage in activities that eventually lead the person to choose to adopt or reject the innovation);
- implementation (this is the stage where, having chosen to adopt the innovation, the person puts it into use); and
- confirmation (in this final stage, the person evaluates the results of the innovation decision he or she has made).

These steps all play a role both at the micro level (individual needs for communication, time and social affirmation) and the macro level (organizational needs for communication, time and affirmation from similar business communities). At the macro level, this theory assumes that social systems (such as social norms) can affect an individual's adoption of an innovation. Both micro level communication (interpersonal relations) and macro level communication (for example, billboards) can be used to establish and affirm social norms.

In this process, the innovators and early adopters are often only a small number of people. The early majority, late majority and laggards are therefore characterised by their search for existing social norms to guide their actions. The existing social norms and social networks are the ones referred to by Nolan et al. (2008). Rogers and Beal (1985) claim that neighbours, family and friends play a very significant role, especially in the lives of the late majority and laggards, in people's accepting a certain innovation. It is also important to note that in every innovation, some people will not conform at all (the laggards, to some extent, and the resistors).

2.7.4 The empowerment spiral

Mehlmann et al. (2010) present a model for living sustainably and changing behaviour often applied in the field of education for sustainable development. These authors describe education for sustainable development as "how we learn to live in ecological and socio-cultural harmony with our neighbours and the Earth and choose to act for sustainability on a daily basis" (p. 177). The empowerment spiral is not an attitude-behaviour theory, nor does it focus on the individual in isolation. It is based on work in developing countries focusing on "programs for sustainable behaviour change, including 'carbon neutral' households, communities, work places and schools" (p. 177).

Mehlmann et al. (2010) strongly criticize educational structures for employing a linear approach to behaviour change, and for failing to describe why certain behaviours are expressed or neglected, even in the light of the "right attitudes". Heath and Heath (2010) found that some of the most significant lifestyle changes are not necessarily rational, but are motivated by desires, beliefs and emotions. In response Mehlmann et al. (2010) state that the linear process of education about sustainability is flawed, as the linear approach holds that information provision would result in knowledge, knowledge would result in a value shift, and consequently behaviour would change. Mehlmann et al. (2010) emphasise, however, that the linear approach does not represent the "full story" of the change in behaviour. Instead, they propose a cyclical view of behaviour change and learning about the environment, as presented in *Figure 7*.

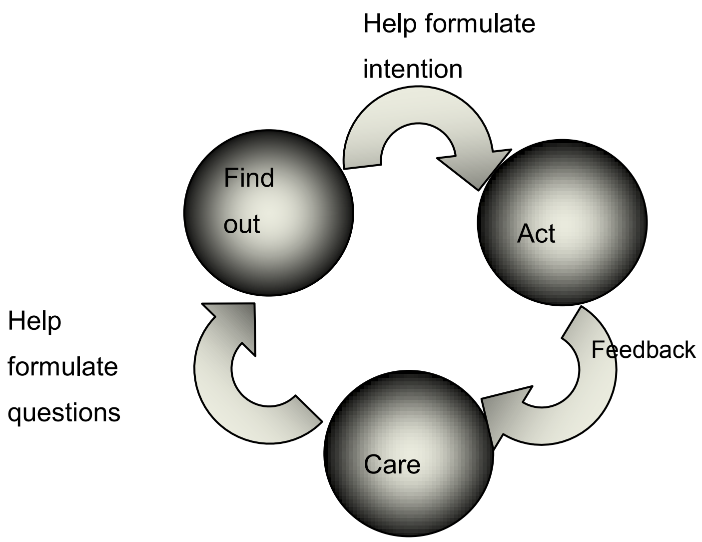

Figure 7 Empowerment spiral
(Mehlmann et al., 2010, p. 178)

The empowerment spiral in *Figure 7* focuses on three main activities of the individual, namely caring, finding out and acting; and three inputs from the environment, namely help formulating questions, help formulating intentions and feedback. Mehlmann et al. (2010) posit that "[e]ach step – 'acting', 'caring', 'informing' – prompts the next. It does not matter where you start; and the cycle is potentially self-reinforcing: a positive feedback loop" (p. 178). The systemic nature of this spiral is discussed in more detail in Section 4.4, along with other principles of systems theory. For the purposes of the current study, the three activities, "caring", "finding out" and "acting" are defined in terms of energy efficiency. The cyclical nature of this model combined with the interaction between the pragmatic and theoretical concepts provide a useful basis for describing residential energy efficiency.

Environmental concern, as a concept, was introduced by Dunlap and Van Liere (1979) and later Dunlap, Van Liere, Mertig, and Jones (2000) as a construct measured as part of their New Environmental Paradigm (NEP) Scale. Arnocky, Stroink, and DeCicco (2007) define environmental concern in line with Sterns' biospheric, altruistic and egoistic values (discussed in Section 2.6.3), indicating a tripartite attitudinal structure of environmental concern. Arnocky et al. (2007) also argue that an individual's environmental concern mirrors three types of "self-construal; either for the self, other people or all living things" (p. 257). These ways of self-construal closely resemble three of the ecological levels described in Section 2.5.1, namely a micro, meso and exo level of concern.

In this study, environmental concern is defined as active care or concern for the environment with a focus on individuals' perceptions of their own concern for the environment or energy efficiency; and individuals' perceptions of other people's concern for the environment or energy efficiency. In the current study, "environmental concern" is equated to "care" in Mehlmann et al.'s (2010) model and is used throughout this study, in line with the conventions in the literature (see Arnocky et al., 2007;

Gatersleben, White, Abrahamse, Jackson, & Uzzell, 2010a; Johnson, Bowker, & Cordell, 2004; Pepper, Jackson, & Uzzell, 2010; and Schultz, Zelezny, & Dalrymple, 2000).

"Finding out" is defined as a conscious attempt by an individual to find information regarding energy efficiency and determine appropriate conservation behaviour in his or her personal situation. "Acting" is defined as specific energy conservation behaviours in which people engage in order to limit electricity consumption. These behaviours include both directed communication about saving electricity and acting in a specific manner in order to consume less electricity. These definitions focus on the individual, but, in context, individuals are not exempt from influences from their immediate environment.

Kaplan (1995) points out that humans are naturally attuned to information: "We yearn for it, we hoard it, we are overwhelmed by it, we trade it, we hide it. We ask questions such as 'How do I get there?' 'How does that thing work' and 'What happened?'" (p. 7). The three information-based aspects of the empowerment spiral (see Figure 7, above) are helping to formulate questions, helping to formulate intention, and feedback. These do not occur inside the individual, but refer to interaction between the individual and his or her environment. The input from the person's context between caring and finding out is identified in the empowerment spiral as "helping to formulate questions". In the current study, this input is defined as an attempt to assist a research participant to identify areas where he or she does not feel confident about energy efficiency and where additional information is necessary. "Helping to formulate intentions" is defined as an enabling exercise in which the individual crystallizes planned actions (intentions) based on what he or she finds out, leading up to behaviour. Feedback is defined in the empowerment spiral as specific information or the reaction of others based on the actions of the individual. Feedback would influence the degree of environmental concern (increase or decrease) and therefore also strongly influence whether the spiral is cyclical or not. Kaplan and Kaplan (2005) point out that in environments where people's informational needs are supported, they are more likely to be cooperative and reasonable.

Behaviour is the last section of the empowerment spiral and refers to the ultimate outcome of caring and information. In response to the feedback received from the environment, a person changes his or her behaviour, thus creating a cycle of interaction between the person and his or her environment. The empowerment spiral provides a model for conceptualisation, and description of the findings of this study in detail in Chapter 6 in conjunction with the ecological levels of Bronfenbrenner (1977).

The final conceptual model should be applied on a micro, meso, exo and even macro level system while providing enough depth to explore, understand and influence behaviour. This spiral encapsulates the individual's attitude, subjective norm, and perceived behavioural control, but also provides a solid basis for a description of the interaction between systems. In order to highlight the individual's interaction with his or her environment (as part of the empowerment spiral), theories on behaviour change from a social psychology point of view are discussed in the next section.

2.8 Summary of the attitude-behaviour and social theories

Clayton and Myers (2009) summarize the psychological and social theories discussed in this chapter, showing not only the internal processes discussed by Ajzen (1991), but also the self and environmental liberation and re-evaluation found in the trans-theoretical model. Both Clayton and Myers's summary and Bronfenbrenner's (1977) micro, meso and exo systems are incorporated in Figure 8, which delineates the macro system of influential cultural and subcultural settings (patterns) in which everyday concrete activities occur. Figure 8 shows how micro level behaviour is influenced by individual attitudes, perceived responsibility and ability to act, the values and beliefs of the individual and his or her motivational types, as discussed in the attitude-behaviour theories reviewed earlier in this chapter. In Chapter 6, a conceptual model incorporating many of these theoreticacl concepts and applying it to residential energy efficiency in the South African context is presented.

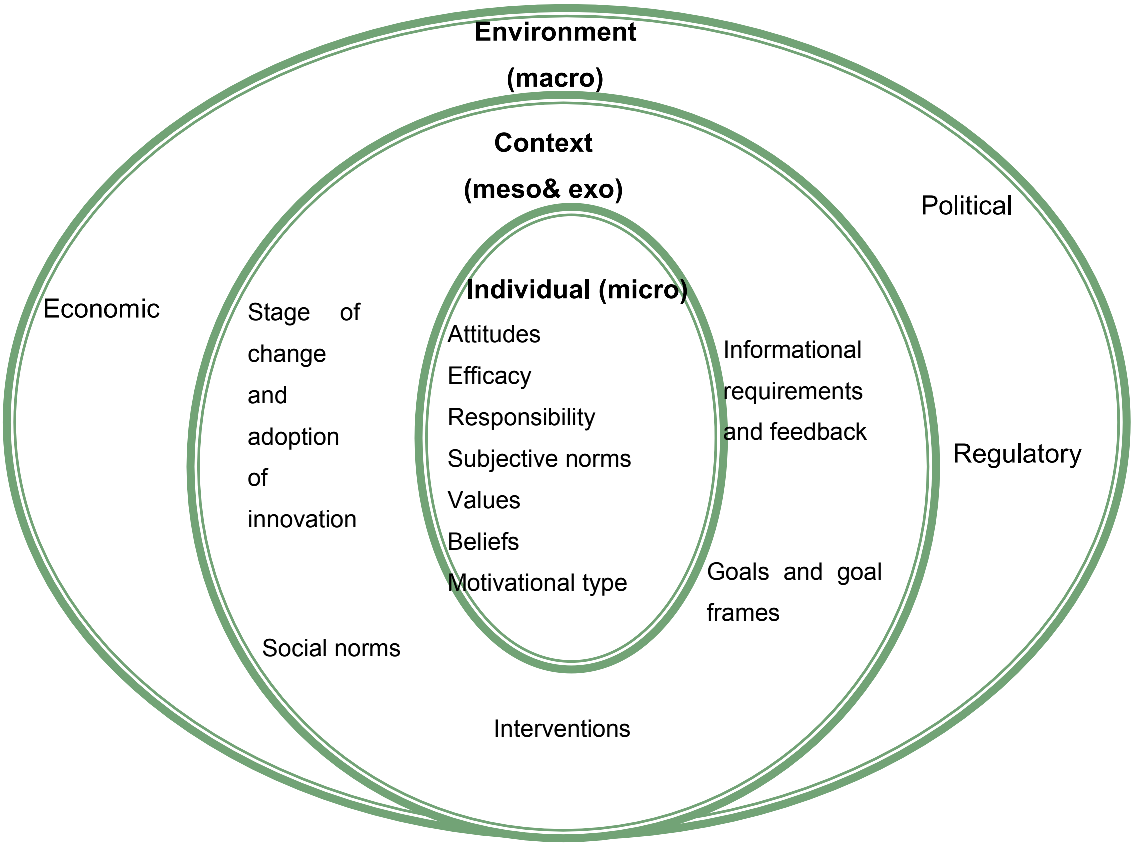

Figure 8 Factors affecting behaviour

At a meso and exo level, social norms, possible interventions, informational needs, goal frames and stage of change and ability to adopt innovation influence behaviour. The macro level delineates the regulatory, political and economic environment that influences behaviour. In each of these levels a continuous cyclical interaction occurs between the spheres of increased/decreased environmental concern, a need for information and consequent behaviour.

2.9 Conclusion

In this chapter, the epistemology adopted by the researcher and the use of the ecological and systems theoretical approaches as discussion frameworks have been described. These approaches challenged the researcher to be constantly on the lookout for factors in the context of the research participants that influenced their behaviour. Each research participant and his or her household are in themselves thinking systems that adjust and adapt to the changes they perceive in the environment. Such changes are often subconsciously indicated through the delineation of boundaries and were used in this study to reach a greater understanding of the in-depth discussions with the research participants.

Subsequently, theories relevant to the current study were discussed in two sections. In Sections 2.6, the attitude-behaviour theories of Ajzen (1991) and Stern (2000) were discussed. These theories' approaches toward the drivers of environmental behaviour were highlighted. These included risk perception, attitudes and subjective norms, ability, motivation and opportunities and a discussion of values, beliefs and norms. In Section 2.7, several social theories, the trans-theoretical model, the social diffusion theory, the goal frame theory and the empowerment spiral were discussed. They were used to explain and describe the cognitive and behavioural actions involved in the transition between attitudes and behaviour at the micro, meso and exo levels, culminating in a final conceptual model of residential energy efficiency in South Africa.
In the next chapter, prior research is reviewed, focusing primarily on energy efficiency studies in a residential context.

Chapter 3:

Literature Review

3.1 Introduction: research in the field of household electricity use

In this chapter, previous research on energy efficiency from a psychological perspective is reviewed. There has been a considerable amount of research in the field of household energy efficiency in North America and Europe (some of which is reviewed in this chapter), but there is a dearth of research on this topic focusing on South Africa and even the rest of Africa. In this chapter, prior research is reviewed, and in order to address the knowledge gap, relevant current issues and issues for future research are highlighted.

The chapter begins with a discussion on the unit of research in residential energy efficiency studies, examining the methodology employed in previous studies to understand the interaction between individuals and household members. The demographic characteristics of household occupants and predicted impact on electricity consumption in the household are then explored, followed by an examination of the potential impact of the socio-economic and cultural contexts of households on their potential energy efficiency.

Residential energy efficiency presents a predicament for a researcher who assesses individual behaviour and perceptions, since household electricity consumption does not reflect the actions of only one individual, but of the household in totality. Based on previous research, the modus operandi used to study electricity consumption is explored and discussed, focusing on the individual in the household, the occupant predictors of energy efficient behaviour, the impact of the gender of the research participants on the study, the socio-economic standing of the household and the household culture concerned. This is followed by an exploration of the barriers for energy efficiency. Strategies that can be employed to change behaviour in the residential sector are discussed in two categories, namely antecedent strategies and consequence strategies. The application of these strategies is then discussed in the social context of individuals or households. This section concludes with an in-depth discussion of a study done in the United Kingdom (UK) by Brandon and Lewis (1999), due to its similarities to the current research.

This chapter concludes with a description of the shortcomings of previous research and their recommendations for future research, highlighting the research questions and overall objectives of the current study that emerged as a response to some of the concerns raised in the prior research.

3.2 The unit of research in energy efficiency studies

In this section, the unit of research is considered in detail, using previous studies to inform the current study. Aspects that are discussed include the issue of assessing an individual as opposed to a household, and the demographic predictors of a tendency toward pro-environmental behaviour based on the occupants in a household. The impact of household culture and the socio-economic status of a household on pro-environmental behaviour are then discussed.

3.2.1 The individual in the household

Because the study is conducted from a psychological perspective, the main focus is on individuals; however, measuring electricity consumption at an individual level is often difficult (if not impossible) in a household, because electrical provision points often serve more than one person co-inhabiting a unit. The electricity use of one individual in a household cannot easily be isolated from that of other members of the household. The methodological implications of this problem are discussed in Chapter 4, and the limitations these impose on the study are examined in Section 6.5. It is thus important to understand that the dynamics within a household are never static. This presents a number of challenges for research, since households are not merely “units of human living: they are social assemblages – homes – in which families bond, people invest emotions and undertake all kinds of identity work beyond the putatively ‘environmental’” (Gibson, Head, Gill, & Waitt, 2010, p. 4). These authors further emphasise the broader context of the household:

> [H]ouseholds must be understood within broader contexts. They are ‘enrolled’ in networks (social, industrial, governmental), with consequences for behaviour and resource use and for the extent to which households are actually able to change (or at least for the amount of ‘friction’ and corporate marketing savvy they must act against). (p. 5)

In the next section, the influence of specific occupant characteristics on the occupants’ ability to conserve electricity is discussed in detail.

3.2.2 Occupant predictors

In their review of energy studies on human behaviour between the years 1975 and 2000, Guerin et al. (2000) claim that “it is widely agreed today that occupant energy behaviour has a major influence on the amount of energy used in the house” (p. 53). This sounds logical, and if this is true, it warrants in-depth research to gain insight into the way in which occupants’ energy behaviour influences a households’ energy use.

Weihl and Gladhart (1990) found that family schedules and comfort preferences are strong contributors to the patterns of behaviour that a household’s occupants ultimately exhibit, but that these patterns differ considerably from one household to another. Therefore comparison between households may be extremely difficult, because even if households have similar characteristics, there are still big differences in energy use, largely attributed to the occupants rather than the specific houses' attributes. Aspects such as these were highlighted in a study on occupant predictors by Guerin et al. (2000).

According to Guerin et al. (2000), the energy consumption predictor elements can be grouped into two patterns, "either having the propensity to change energy consumption (i.e. energy-consumption behavior), or producing actual energy consumption change" (p. 57). The propensity to change (where there is no evidence of actual energy-consumption change in the study) is compared to a predictor where changes would necessarily occur. Thus, the predictors were divided between producing actual change, or being merely indicative of a propensity to change. In studies where actual energy-consumption change took place, predictors directly relating to the occupants were identified. Age was found to be one of the most important predictors of actual energy consumption change (Guerin et al., 2000).

Predictor categories and the number of studies that have been able to identify a significant relation between a certain variable and either energy saving propensity or energy consumption change are summarised in Table 4.

Table 4

Occupant predictors of energy behaviour consumption

Occupant predictor category	Energy-conservation behaviour	Energy-consumption change
Occupant characteristics		
Age	5	6
Income	4	5
Home ownership	7	-
Education	5	1
Number of occupants	1	4
Physical size of house	-	4
Daily occupancy rate	1	2
Appliance/home technology ownership	-	2
Gender	1	1
Presence of a home handy person	-	1

Continued overleaf

Occupant predictor category	Energy-conservation behaviour	Energy-consumption change
Occupant attitudes		
Comfort	7	1
Health concerns	6	-
Motivation	5	-
Folk knowledge/source credibility	2	1
Occupant actions		
Major weatherization	-	8
Response to incentives	3	3
Participation in energy audit	2	2
Installing flow limiters/restrictors	1	1
Lowering space-heating temperatures	1	1

Source: Adapted from Guerin et al. (2000, p. 59)

From Table 4 it is clear that age, income, home ownership, education, the size of the house and the number of people in the house influence electricity use most directly. These demographic parameters have been included in the current study. However, the predictors included in the study by Guerin et al. (2000) suggest an assumption that household occupants are homogeneous in terms of their socio-economic standing and cultural influences. Gibson et al. (2010) advocate seeing a household as making economic decisions, such as purchases, reduction behaviour, and sharing resources. They emphasise the values that shape household behaviours, postulating that these are essentially cultural "because preferences and behaviours stem from norms and beliefs" (p. 5). Households have traditionally been encouraged to be more sustainable, without much attempt to interpret the transactions and networks within households in the cultural or socio-economic contexts in which they develop (Gibson et al., 2010). In the next few sections, previous research on occupant predictors that were of particular importance in the current study is highlighted, looking at gender, household income and culture.

3.2.2.1 Influence of gender on energy efficiency

Previous research, mainly in Europe and North America, suggests that the gender of a participant does not seem to have a large impact on the quality of data collected about household behaviour. Several studies noted that it did not matter who in a household participated in their research. For example, Gatersleben, Steg, and Vlek (2002) stated that in their study, done in the Netherlands "[o]nly 37% of the respondents were women. However, because the questionnaire mainly addressed household behavior, this should not be too much of a problem" (p. 342). In a study of household recycling behaviour in the USA , Schultz et al. (1995) claimed that "[b]ecause recycling is often a household behavior, the person doing the recycling on a given occasion may be replaced by a person of the opposite gender on other occasions" (p. 108). Similarly, the task of managing energy efficiency in the home is also expected to be household behaviour rather than being driven by an individual of a specific gender.

3.2.2.2 Household income

As Table 4, above, shows, household income also plays a significant role in energy consumption. Household income has been proven to predict environmentally responsible behaviour fairly accurately (Collins, O'Doherty, & Snell, 2006). Schultz et al. (1995) found that "high income is a good predictor of recycling" (p. 105), but that gender and age were not such good predictors. Similar findings have been reported by Clarke, Kotchen, and Moore (2003) and Poortinga, Steg, and Vlek (2004). This discussion provides a clear indication of the occupant predictors that contribute toward physical energy consumption or a propensity to save energy in a household.

The Australian Conservation Foundation (ACF) (2007) also found evidence that one of the strongest predictors of greenhouse gas emissions is affluence and economic activity. This means that at both the macro and the meso levels, affluence is strongly linked to the use of fossil fuels; consequently, the poor have a more limited impact on the environment in this regard due to their restricted use of fossil fuels. Gatersleben, White, Abrahamse, Jackson, & Uzzell (2010b) point out that people hold the contradictory values of materialism and pro-environmental behaviour. Gibson et al. (2010) describe this contradiction as follows:

> The rich pollute more through high levels of travel (vehicle and air); more and bigger houses; more food wastage; more consumption generally. Yet the rich and well-educated may be among the strongest advocates of 'green' practices: recycling, composting, buying organic food, taking reusable bags to the supermarket. They may also be leaders in buying still-expensive technology: hybrid cars, solar electricity panels and green energy. (p. 4)

In South Africa, the chasm between rich and poor is extremely pronounced – Leibbrandt, Finn, and Woolard (2012) state that "South African inequality is still at world beating levels and serves as a stark reminder of the lingering footprint of apartheid" (p. 33). In this study, it would be important to include households from different socio-economic backgrounds, allowing an exploration of the impact of socio-economic background (living standard) on the use of electricity. Lutzenhiser and Gossard (2000) argue that people's living standard has a larger influence on electricity usage than the area in which they live. Based on the findings of the ACF (2007), Gatersleben, White, Abrahamse, Jackson, and Uzzell (2010a), Gibson et al. (2010), and Lutzenhiser and Gossard (2000), in the current study, it was decided to use the living standard of research participants, as measured using the SAARF LSM (2010), rather than people's race or the geographical locations of their homes, to classify respondents. The living standards measurement (LSM) is described in detail in Section 4.8.2. In the next section, people's embeddedness in their culture is explored, highlighting the extent to which entrenched beliefs may influence behaviour on a daily basis.

3.2.2.3 Individuals and households embedded in culture

The seminal work of Lynn White (1967) deals with “the historical roots of our ecological crisis” (p. 1203). Contemplating where our world views originate, she says:

> Our science and technology have grown out of Christian attitudes toward man's relation to nature which is almost universally held not only by Christians and neo-Christians but also by those who fondly regard themselves as post-Christians. Despite Copernicus, all the cosmos rotates around our little globe. Despite Darwin, we are not, in our hearts, part of the natural process. We are superior to nature, contemptuous of it, willing to use it for our slightest whim. (p. 1206)

In this study, it was important that the eco-systemic context (as discussed in Section 2.5.2) of the participants be taken into consideration in order to understand the participants’ views on nature, information dissemination in the family and the consequent efficient use (or not) of electricity in the home. This broader eco-systemic context includes “cultural factors and worldview, as the context of individual behaviours and functioning often extends beyond the family to culture” (Thomas, 1998, p. 24).

Thomas (1998) defines culture as the interdependence and interaction of issues such as language, age, gender, race, religion, socioeconomic status, education and sexual orientation. Culture also influences the behaviours and beliefs of family members and determines expectations of members in that particular group (Gushue, 1993). For the purposes of this study, the word “culture” is used as an all-encompassing term referring to the abovementioned aspects. These aspects are often indistinguishable parts that influence individuals’ understanding of social norms, thus guiding attitudes and ultimately also behaviour. Thomas (1998) summarises culture as follows:

> Culture influences the behaviors and beliefs of family members and determines expectations for family members…The culture of a family affects individual behaviors, child-rearing practices, discipline, and the importance of achievement and education. Culture often determines the type of family, family size, and shape…and culture defines boundaries, rules for interaction, and communication patterns between family members and within the community…Finally, culture defines for families ways of defining problems and outlines specific coping skills. (p. 24)

The effects of culture in the form of ethnicity cannot be avoided. Even though cultural differences are not the main focus of this research, it is important to acknowledge the impact of culture on people’s perceptions of electricity consumption and efficiency. Electricity is not normally “seen” by its users (due to its physical imperceptibility), but rather serves as a tool for effecting “normal cultural practices” such as cooking a large lunch on a Sunday, or taking a long bath after a trying day at work. The outcomes of energy use (a long bath, family and personal habits and household traditions) come under the magnifying glass. This topic not only warrants, but demands exploration of household culture in the light of household habits and the impact it has on electricity consumption. Previous studies focusing on the impact of ethnicity on pro-environmental behaviour are briefly discussed, bearing in mind, however, the criticism of such studies that education plays an extremely significant role in a households' culture, due to its effect on other socio-economic aspects in the household.

Studies conducted by Johnson et al. (2004) in North America explored the impact of ethnicity on environmental concern. Environmental concern was measured by means of surveys. Johnson et al. (2004) found that gender, age and political orientation were consistent explicators for both environmental concern and reported behaviour. They report that among "Asian Americans and U.S. born Latino environmentalism was most similar to Whites. African American concern and behaviour was least similar to White environmentalism" (p. 158)

In South Africa, Van Staden et al. (2002) studied the impact of language groups on environmental concern, also measuring environmental concern through surveys. As in the case of Johnson et al (2004), Van Staden et al. reported that gender and age differences, as well as involvement in political and environmental conservation activities, were predictors of environmental concern. They reported that more educated respondents expressed a stronger environmental concern, stating that "Afrikaans-speaking and English-speaking respondents reported stronger concern, willingness to contribute to change as well as being more actively involved in dealing with environmental problems than Zulu-speaking and Sotho-speaking respondents" (p. i).

In both studies, belonging to a specific cultural or language group was indicated as a predictor for environmental concern. The levels of education and income of the least concerned ethnic groups were lower than the norm for the other ethnic groups measured. The conclusion that a specific cultural group is less concerned than the norm might therefore not revolve around the group's culture at all, but rather around education and income levels. While this will be explored in this study, it might impose some limitations on the findings of this study (see Section 6.5). The explorative nature of this study, however, serves as motivation for inclusion of these different groups.

Culture is an integral part of the approach people take toward the environment and their behaviour in their homes. In this regard, Magistro and Roncoli (2002) assert that cultural perspectives shape the way in which people receive and interpret incoming information, along with assessing the trustworthiness of the information itself and the information source. They even suggest that objective scientific information needs to be interpretively framed, as was later affirmed in the South African context by the ASSAf (2011), who advised that local and indigenous knowledge be used to increase the effectiveness of pro-environmental intervention programmes.

This study also to some extent explores the underlying culture that drives specific energy-efficient behaviour, but it does not assume that it is possible to understand fully the impact of embedded culture of the research participant on the energy efficient behaviour displayed (or lack thereof). Neither culture nor ethnicity is the focus of this research; rather, the focus is on specific behaviours and their underlying motivations in energy efficiency in households. In the next section, barriers to improving energy efficiency at several ecological levels are discussed.

3.3 Motivations and barriers to environmental action

In this section, the motivation for participation in environmental action and the barriers identified in prior energy efficiency studies are highlighted.

3.3.1 Conservation motives

Thorne-Holst, Strandbakken, and Sto (2006) identified people's motives to participate in conservation behaviour as an important part of a multinational approach to behaviour change in Europe, specifically focusing on energy efficiency. These motives are very broad, but take all aspects that come to play into consideration. They are grouped from macro to micro perspectives:

- physical and structural issues;
- political issues;
- cultural- normative issues;
- economic issues;
- knowledge- based issues; and
- individual-psychological issues.

Physical and structural issues (within the ambit of engineering and politics) play a key role in decisions about the energy system, and hence about energy efficiency. This includes issues such as the economic feasibility of any new technology or economic structure. Three of the issues (cultural-normative, knowledge-based and individual-psychological) fall into the ambit of psychology and sociology. The motivators for conservation have been investigated in more detail by Gmelch and Dillmann (1988).

Gmelch and Dillmann (1988) posited four conservation motivators: "(1) economic benefit, (2) conservation ethic, (3) personal benefit, and (4) social conformity" (p. 141). These motivators refer, in practical terms, to reducing one's energy bills, feeling that one is doing one's share, maintaining personal comfort and adhering to social pressure regarding social norms (peer pressure and guilt for not conserving). These propositions are directly in line with theories that focus on motives ranging from values, beliefs, perceived risks and norms, to action. These theories have already been discussed in detail in Section 2.6 and are related to Thorne-Holst et al.'s (2006) energy saving issues.

Motivation relating to energy saving is often related to the magnitude of the conservation motivators proposed by Gmelch and Dillmann (1988). A person assesses economic benefit, his or her conservation ethic, personal benefit and social conformity before making a decision. Often, the ability to respond, or the decision about how to respond, is influenced by the ability to gain pleasure or avoid pain. Motivation to respond is directly related to the magnitude of each (the higher pleasure or pain, the higher the motivation), and the immediacy of the experience (the more immediate the pain or pleasure, the higher the motivation). Motivation can be framed in a cost versus benefit context (Wymer, Knowles, & Gomes, 2006) or as perceived behavioural control (Ajzen, 1991). Freud's (1922) pleasure-pain principle also posits that, at the most basic level, humans are motivated to maximise pleasure and minimize pain. Similarly, Fritz (1996) and Senge (1990) claim that change occurs when there is a reasonable balance between dissatisfaction and hope. Dissatisfaction and hope could also be renamed pain and pleasure. These dissatisfactions (pain) and hopes (pleasures) manifest in many ways, and an event's certainty, immediacy, location and people who are involved play a definite role in the perception of that event. Gattig and Hendrickx (2007) explain: "When dealing with environmental risks, it is frequently necessary to balance benefits that occur for sure, immediately, here, and to ourselves against losses that are uncertain, delayed, might occur elsewhere, and to others" (p. 22). In the next section, the barriers to environmental action are explored in more detail.

3.3.2 Barriers to environmental action

Barriers to environmental action or pro-environmental behaviour play a role not only at the individual level where norms are entrenched and perceived, but also at a macro level. The macro level was discussed in Section 1.3. It is indicative of how changes in patterns of behaviour are hampered by the environment in which pro-environmental behaviour should ideally occur. The focus of this study is on the individual and their immediate relational context, the micro and meso levels of the energy efficiency system.

Niemeyer (2010) points out that there are several constraining variables that impinge on the adoption of energy-efficient practices, materials, equipment and technology by individuals and their households, in other words, at the micro and meso levels. These barriers to the adoption of residential energy-efficient practices are listed as a need for

a) 'financial assistance or discount of costs',
b) 'additional information',
c) 'professional or additional assistance', and
d) 'more time to do it myself'. (p. 142)

These barriers for implementation of energy-efficient practices are indicative of Ajzen's (1991) perceived behavioural control. The limited access to money, information, and time may cause a person to experience a pronounced perception that he/she does not have the necessary tools to enact control over the situation. Niemeyer goes on to say that it might make more sense to educate people and remove barriers for those who already have a positive attitude about the need to increase energy efficiency, rather than to focus on unmotivated individuals. The fruitfulness of widespread education programmes has been challenged to a large extent, with evidence of little uptake on innovative technologies and behaviour as a result of education alone (see De Young, 1993, 1996; Geller, 1981). McKenzie-Mohr and Smith (1999) have suggested a more practicable approach, called the Community-based Social Marketing (CBSM) strategy, discussed later in Section 3.4.2.2.

In line with suggestions from Brandon and Lewis (1999), McMakin, Malone, and Lundgren (2002) and Niemeyer (2010) have found that people are more likely to adopt a new behaviour if

- it is easy and convenient to perform,
- it fits their skills and resources,
- neighbours and friends change similarly; and
- commitments to change have been made in public settings.

They also suggest that individuals need to have the necessary self-control and efficacy in order to be able to take environmentally responsible action that may also benefit others. Brandon and Lewis (1999), McMakin et al. (2002) and Niemeyer (2010) all show that working with participants who are already “environmentally on-board” may increase the effectiveness of any type of intervention.

These barriers link strongly with the TPB discussed in section 2.6.2 which posits that a positive attitude toward the environment, a perceived ability to effect the current situation by means of access to information, money and time, is supported by the subjective norm that neighbours and friends make similar changes. The intervention used in the current study was designed to address these barriers and to change behaviour effectively and is discussed in detail in section 4.4.3. Commitment-making is slightly different, because it does not clearly form part of the TPB, however the link with commitment to subjective norms and attitude is described by Lokhorst, Werner, Staat, van Dijk, and Gale (2013).

In a recent meta-analysis of the success of commitment-making in environmental behaviour change, Lokhorst et al. (2013) suggest that commitment-making could be attributed two aspects: 1) a cognitive attitudinal approach and 2) a normative approach. A cognitive attitudinal approach requires participants to feel that their commitment is voluntary, and would result in an alignment of their attitudes to the commitment made initially. This may occur through self-perception changes or the effects of dissonance (Aronson, 1999), with the aim of aligning their attitudes with their behaviour. A normative approach suggests that behaviour change following a commitment may be due to concerns of what others may think, possibly leading to social disapproval or scorn. This also emphasise why commitment is especially successful when made in public (Abrahamse et al., 2005).

In the next section, the actual changes that are often made to effect energy efficiency are discussed, followed by the strategies employed to encourage people making these changes (the antecedent and consequent strategies).

3.4 Strategies for saving electricity

According to the APA (2010), people use electrical energy for transportation, space heating/cooling and appliances and electronics (such as refrigerators and geysers). Different classifications of consumption patterns in respect of transportation, heating/cooling and household appliances have been made by Kempton, Darley, and Stern (1992) and Kempton, Harris, Keith, and Weihl (1985). These classifications differentiate between financial investment in technology and equipment, the management of equipment and the way in which it is used (APA, 2010) and they are used in the final chapter of the current study to classify specific energy-efficient practices employed by the participants.

Gardner and Stern (2008) argue that investments in energy efficiency require infrequent actions, but higher initial investment in order to automate energy efficiency and save more electricity than habitual, or repeated efforts through equipment management or changes in use. The classification is illustrated in Table 5, which highlights investing, maintaining and changing the intensity of appliance use in order to improve energy efficiency.

Table 5
Types of behaviours and examples

	Investment in equipment and technology	**Management of equipment and technology**	**Intensity of equipment and technology use**
Transportation	Number and fuel efficiency of personal and public transportation vehicles	Number of people in the vehicle; engine maintenance	Distance travelled
Heating and cooling of buildings	Size of buildings, efficiency of furnaces and air conditioners; amount of insulation.	Maintenance of furnaces; caulking of windows	Temperature settings
Household appliances and electronics	Energy efficiency of water heaters, televisions and refrigerators	Cleaning freezer coils; reducing standby power	Amount of hot water, time spent with TV on

Source: APA (2010, p. 36)

A classification of the way in which South African participants in this research study approaches energy efficiency in their own homes and why, will be explored in this study. In the next section, research on behaviour change strategies is reviewed. Antecedent and consequent strategies are discussed, followed by a description of their application in a social context in recent years.

3.4.1 Strategies for changing behaviour – intervention at the individual and social levels

As noted earlier, one of De Young's (2013) definitions of the purpose of environmental psychology is to develop and empirically validate practical intervention strategies to conserve the environment. This section explores interventions (behaviour change strategies) at both an individual (micro) level and social (meso) level. Most of these strategies have previously been used specifically in energy conservation programmes. Abrahamse et al. (2005) review research studying the effectiveness of interventions intended to increase household energy conservation. Similar to a study by Dwyer et al. (1993), they use a taxonomy and classification system for behavioural change interventions suggested by Geller et al. (1990). Behavioural change interventions are grouped into two groups: antecedent strategies and consequence strategies.

3.4.1.1 Antecedent strategies

Antecedent strategies introduce interventions that influence determinants of behaviour *before* environmentally significant behaviours are exhibited (Abrahamse et al., 2005). Many of the antecedent strategies used previously in motivation for behaviour change are listed in Table 6 and are then discussed. Table 6 defines and summarises antecedent strategies, citing authors who completed studies assessing the effectiveness of one or several strategies, and indicating the success of the intervention on its own and combined with other intervention strategies. This illustrates the wealth of research on these particular aspects in the field of environmental psychology.

Table 6
Definitions of terms and studies focused on antecedent strategies (1970 – 2013)

Definitions of terms	Antecedent strategies	Evidence base
Commitment: Commitment refers to a voluntary statement of loyalty to "engage in a particular type of environmental behaviour" (Lokhorst, Van Dijk, & Staats, 2009, p. 400), either verbal or written, formal or informal, and in private, as a group, or on a public platform	***Commitment:***	

Personal commitment: A commitment made by an individual	***Personal commitment:*** Abrahamse et al. (2007); Davis, Green, & Reed (2009); De Young (1993); Katzev & Johnson (1983); Katzev & Pardini (1987-88); Pallack & Cummings (1976); Werner, Cook, Colby, & Lim (2012)	
Group commitment: A commitment made by a cohesive group	***Group commitment:*** Wang & Katzev (1990)	
Public commitment: A commitment made in public by an individual or group	***Public commitment:*** Burn & Oskamp (1986); Lokhorst et al. (2009)	Public commitment groups showed lower increase rates than personal commitment or control groups (Abrahamse et al., 2005; Pallack & Cummings, 1976) although when combined with information no significant difference was found over the longer term between experimental and control groups (Katzev & Johnson, 1983 1984**).**
Goal: A "goal is a combination of a motive and an activated knowledge structure" (Lindenberg & Steg, 2007, p. 118)	***Goal Setting*** Abrahamse, Steg, Vlek, & Rothengatter (2007) Becker (1978); Fontunato & Williams (2002); Lindenberg & Steg (2007); McCalley & Midden (2002); and Werner et al. (2012)	Goal setting as an intervention strategy is never administered individually, however, goal setting in combination with other interventions seem to indicate that self-setting goals and voluntary participation enable goal setting to be more

Foot-in-the-door strategy: With the aim of attaining a goal, this "procedure consists of bringing an individual to perform a not very costly act…, in order to then obtain a much more costly act from him, the so-called final request or 'target act'" (Souchet & Girondola, 2013, p. 306)	***Foot-in-the-door strategy:*** Katzev & Johnson (1984); and Souchet & Girondola (2013)	effective (McCalley & Midden, 2002);
Information strategies: ***Leaflets:*** Educational pamphlets with specific information on reduction of resources (De Young et al., 1993)	***Information strategies:*** *Leaflets:* Carrico & Riemer (2011)	Tailored information only, no changes in number of energy saving activities engaged in (McDougall et al, 1982-1983).
Prompting: Reminders to engage in pro-environmental manner (McKenzie-Mohr & Smith, 1999)	*Prompting:* De Young (1993); Geller (1971); Kurz, Donaghue, & Walker (2005); and Luyben (1982)	Prompting was shown by de Young (1993) to be untrustworthy of changing behaviour while Geller (1981) was able to show some successes, especially where behaviour is simple to change, such as switching off a light.
Workshops: Conservation information presented by means of lectures, discussions, slide shows, and demonstrations (Geller, 1981)	***Workshops:*** Geller (1981)	Workshops lead to higher levels of environmental knowledge and concern but did not translate into behaviour change (Geller, 1981)
Mass media campaigns: Campaigns through the mass media (national television, national newspapers, billboards) employed to increase public awareness (Staats, Wit, & Midden, 1996)	*Mass media campaigns:* Hutten & McNeill (1981); Lowery & DeFleur (1995); Luyben (1982); and Staats et al. (1996)	Information via a televised plea (Luyben, 1982) did not yield any changes in thermostat settings.

Tailored information: Tailored information meets individualized information needs by using data about a specific individual in relation to a specific outcome (Abrahamse et al., 2007)	*Tailored information:* Abrahamse et al. (2007); Gonzales, Aronson, & Costanzo (1988); McMakin et al. (2002); and Winett, Love, & Kidd (1982-83)	
Community-based social marketing: Promoting behaviour change (using various intervention approaches) at a community level involving direct contact with members of the community concerned (McKenzie-Mohr &Smith, 1999)	***Community-based social marketing:*** Kotler & Andreasen (1991); Kotler (2002); and McKenzie-Mohr & Smith (1999)	
Motivational interviewing: This involves simple counselling techniques, such as listening, reflecting back and encouraging own argumentation from a subject to motivate behaviour change (Quick, 2003)	***Motivational interviewing:*** Quick (2003)	Evidence base of motivational interviewing is not clear
Modelling:	***Modelling:*** Winett, Leckliter, Chinn, Stahl, & Love (1985) Cialdini et al. (1990)	Modelling resulted in a 10% saving in electricity following a TV program, however results were not maintained over the longer term
Participation: People like playing a role, contributing and participating in what is going on around them (Kaplan, 2000)	***Participation:*** Costanzo, Archer, Aronson, & Pettigrew (1986); Kaplan (1990, 2000); McKenzie-Mohr & Smith (1999); and Staats, Harland, & Wilke (2004) *Group discussions:* Werner et al. (2012)	The EcoTeam program (Staats et al., 2004), reported 7% reduction in water and 32% reduction in solid waste deposition.

The first antecedent strategy discussed in this section is commitment, which can be described as a statement of loyalty toward a specifically defined environmental goal. It has been argued that commitment, albeit private or public, formal or informal, by an individual or by a group, can encourage people to “find their own reasons for recycling, to begin to even like doing so, and, as a result, to continue to perform these behaviours on their own” (Pardini & Katzev, 1983-1984, p. 253). Thus it is suggested that commitment is one of the few strategies to have longer-term effects on pro-environmental behaviour (Katzev & Johnson, 1983; Katzev & Pardini, 1987-88; Pallak & Cummings, 1976; Wang & Katzev, 1990).

The second antecedent strategy, setting a goal (preferably a challenging one), has also been shown to increase pro-environmental behaviour geared towards attaining the set goal (Becker, 1978). McCalley and Midden (2002) have demonstrated that goal-setting is more successful if it is combined with feedback than goal-setting on its own, allowing the person in pursuit of the goal insight into the success of his or her attempts to achieve the set goal. Moreover, the type of goal also impacts on its effectiveness. Lindenberg and Steg (2007) note that the goal frame (that is, the intended outcome of a goal, albeit normative, hedonic or gain) also influences the extent to which a goal motivates individual behaviour. Therefore a goal should not only be framed in line with the attitudes of an individual, but should also be quite challenging and paired with feedback in order to be most effective. Information that would allow people to attain the goal should also be provided.

Dissemination of information on its own is largely ineffective (Staats et al, 1996), but combining information strategies with other interventions is more successful (Van Houwelingen & Van Raaij, 1989). Geller (1981) cautions that “workshops, informational pamphlets, and media promotion should not be relied on to promote energy conservation unless they are supplemented with other techniques designed to motivate action” (p. 334). Information strategies often lead to an increase in knowledge, “but this did not necessarily result in behaviour changes or reductions in energy use” (Abrahamse et al., 2005, p. 282). From their research about mass media campaigns, Staats et al. (1996) conclude that “knowledge and problem awareness may be less instrumental in promoting behaviour change than was assumed before the campaign” (p. 189). *Social persuasion* through the use of energy auditors trained in communicating in a clear and animated fashion proved to have a “greater likelihood of [households] acting on the auditors' recommendations” (Gonzales et al., 1988, p. 1049). Tailored information has been highlighted as an important attribute of home energy audits (Brandon & Lewis, 1999; McMakin et al., 2002; Winett et al., 1982-83).

One way of making information accessible is by prompting, providing reminders of specifically pro-environmentally desired behaviour. However, strategies such as prompting have been found to be “notoriously untrustworthy” (De Young, 1993, p. 498). Kurz et al. (2005) notes that labels designed to “attune residents to the environmental impact affordances of various appliances around their home” (p. 1281) resulted in a 23% reduction in household water use, but had no impact on electricity conservation. Kaplan (2000) argues that people want to be part of something, to contribute to what is going on around them, and therefore stresses the effectiveness of participation.

Kaplan (1990) suggests that a powerful behaviour change force is available when people perceive a role for themselves and have a sense that their contribution is not optional, but a necessity. Participation strategies seek to encourage voluntary pro-environmental behaviour change through the participation in community-based projects. Participation strategies are combined with social interaction in order to effect durable positive change in behaviour (Staats et al., 2004). Motivational interviewing highlights the individual's own reasons for a particular behaviour in order to increase the sustainability of the changes in behaviour; however, according to Quick (2003), it is not a very successful strategy.

Effective strategies to reduce residential electricity consumption are described in detail by Abrahamse et al. (2005). Although some strategies on their own were not shown to be very effective in reducing energy consumption, combinations of these interventions are more effective that any one intervention on its own. Becker (1978) reports a 15% saving in electricity consumption when a 20% savings goal, regular feedback (three times per week) and information is provided. Goal setting improves the savings achieved when providing feedback (McCally & Midden, 2002) and tailored information in combination with goal setting, feedback and prompts achieved between 4 and 115 savings (Slavin et al., 1981).

Of all the behaviour change strategies summarised above, commitment, feedback, goal-setting and participation seem to have emerged as the behaviour change strategies that achieve the most success, most of the time. Information always needs to be part of the intervention, in combination with the mentioned strategies, in order to attain the set targets. A "combination of interventions are especially effective" (Abrahamse et al., 2005, p. 278). In the next section, the consequence strategies are discussed in detail.

3.4.1.2 Consequence strategies

Consequence strategies influence determinants *after* environmentally significant behaviour has occurred; the most significant of these is feedback. Feedback is an effective strategy for reducing household energy (Bittle, Valesano, & Thaler, 1979-80; Brandon & Lewis, 1999; Darby, 2006; Hayes & Cone, 1981; Hutton, Mauser, Filiatrault, & Athola, 1986; Midden & Ham, 2103; Seligman & Darley, 1977; Völlink & Meertens, 1999). There are indications that the more frequent the feedback, the better the saving results (McClelland & Cook, 1979-1980). Brandon and Lewis (1999) and Katzev, Cooper, and Fisher (1980-81) indicate some exceptions, where low energy use households have *increased* their use as a result of feedback. No difference between feedback given in terms of monetary or environmental cost has been found (Brandon & Lewis, 1999). Also, feedback comparing one household's use with another did not prove more effective than comparing the household to itself (Midden, Meter, Weening, & Ziervink, 1983). Where feedback and incentives are used together, behaviour may change, but the changes are likely to fade away when the incentive is removed. Multiple feedback is essential: "As a rule of thumb, a new type of behaviour formed over a three-month period or longer seems likely to persist – but continued feedback is needed to help maintain the change and, in time, encourage other changes" (Darby, 2006, p. 4).

The combination of comparative feedback (comparing a household's use with itself or similar others) with *rewards* in the form of a competition has proved effective for the duration of the competition (McClelland & Cook, 1979-1980). The combination of feedback and goal-setting has proved to be reasonably effective (McCalley & Midden, 2002), especially if the goal is an ambitious one (Becker, 1978). Rewards have been found to elicit only short-term effects (Slavin, Wodarski, & Blackburn, 1981), but with good results over the duration of the intervention (Winett, Kagel, Battalio, & Winkler, 1978). Table 7 lists the definitions of consequence strategies and cites authors who researched feedback on electricity or gas consumption. This list is not exhaustive.

Table 7

Definitions of terms and studies focused on consequence strategies (1970-2013)

<table>
<tr><th>Definitions of terms</th><th>Consequence strategies</th><th>Evidence base</th></tr>
<tr><td>Feedback:
"Information about the result of a process or action that can be used in modification or control of a process or system … especially by noting the difference between a desired and an actual result" (Darby, 2006, p. 7)
Visible record of consumption and displayed effectiveness of attempts for conservation (Brandon & Lewis, 1999)</td><td>Feedback</td><td rowspan="2">Feedback resulted in reduction in electricity consumption most often:
• 10% reduction in electricity consumption in the study by Seligman & Darley (1977),
• a shift to off-peak consumption in Sexton et al (1987),
• 4.6% saving (Staats et al., 2004)
• 15% saving (Vollink & Meertens, 1999)
• 13% savings (Winnett et al, 1979).</td></tr>
<tr><td>Continuous feedback:
Real-time feedback on consumption</td><td>Continuous feedback
Darby (2006)
Hutton et al. (1986)
McClelland & Cook (1979-80)
Midden & Ham (2013)
Sexton, Brown, Johnson, & Konakayama (1987)
Van Houwelingen & Van Raaij (1989)</td></tr>
</table>

Daily feedback: Feedback based on the consumption during one day	***Daily feedback*** Bittle et al. (1979-80) Darby (2006) Katzev et al. (1980-81) Midden & Ham (2013) Seligman & Darley (1977)	
Weekly and monthly feedback: Feedback based on larger time units such as weeks or months (electricity bills)	***Weekly and monthly feedback*** Darby (2006) EPRI (2009) Hayes & Cone (1981) Heberlein & Warriner (1983) Kantola, Syme, & Campbell (1984) Völlink & Meertens (1999)	
Comparative feedback: **Feedback based on the performance of others (Abrahamse et al., 2005)**	***Comparative feedback*** Brandon & Lewis (1999) Darby (2006) Kurz et al. (2005) Midden, Meter, Weenig, & Zievering (1983)	Comparative feedback resulted in a 4.6% saving of electricity consumption in the Brandon and Lewis study (1999)
Group-level feedback: Feedback in the workplace to specific departments or groups within the company (Carrico & Riemer, 2011)	***Group-level feedback:*** Carrico & Riemer (2011)	Group level feedback lead to a reduction of 7% of electricity consumption in office buildings

Rewards "As opposed to most government subsidies, a tax credit is given directly to the citizen after the desired behavior is accomplished" (Pitts & Wittenbach, 1981, p. 335)	**Rewards** ***Monetary rewards*** Hayes & Cone (1981) Katzev & Johnson (1984) Katzev & Pardini (1987-88) Slavin et al. (1981) Winett et al. (1978) ***Competitions*** McClelland & Cook (1979-1980) ***Tax Credits*** Pitts & Wittenbach (1981)	Rewards are used in conjunction with feedback, individual evidence base cannot be illustrated.
Penalties	**Penalties** Heberlein & Warriner (1983) Van Houten, Nau, & Merrigan (1981)	

The use of incentives, penalties, competitions and tax credits have also been found to be effective in encouraging behaviour change; however, due to the lack of such measures in South Africa at the time of the study, these consequent intervention strategies have not been considered.

The importance of feedback is highlighted in Table 7 as the single most effective measure that can be used to encourage a reduction in electricity consumption. Brandon and Lewis (1999) show that computerised feedback on a regular (daily) basis is most effective. Based on the literature, an intervention should make use of feedback on a real-time basis, it should be coupled with tailored information, a goal setting exercise and a formal commitment to save a goal set by the participant him/herself. In this section, the importance of both antecedent and consequent strategies was illustrated in effecting lasting behaviour change. Recent developments and theirinclusion in group or community level engagement on pro-environmental behaviour has also been successful. These social strategies are discussed below.

3.4.2 Social marketing, group decisions and persuasive models

Behaviour theories such as the expectancy-value theory (Williams, Anderson, & Winett, 2005), social cognitive theory (Bandura, 1977), the theory of planned behaviour (Azjen, 1991), the theory of ability, motivation and opportunity (MacInnis & Jaworski, 1989), and more recently the empowerment spiral (Mehlmann et al., 2010) all make worthwhile contributions towards greater understanding of sustainably changing behaviour, and was described in more detail in Section 2.7.4. There has been a shift away from a behaviourist approach, where one or a combination of interventions was believed to have a lasting effect toward more civic involvement and attempts to change behaviour through participation (De Young, 2000; Hoffmann & High-Pippert, 2009; McKenzie-Mohr & Smith, 1999; Staats et al., 2004).

Such civic involvement in decision-making was already described decades ago by Lewin (1947). The minor effects in behaviour change brought about by lectures and even individual communication has been shown to be small, compared to allowing people the opportunity to discuss the advantages and disadvantages of a suggested situation. Lewin concluded that an explicit statement of the group standard before the decision is made to change an aspect in the environment was responsible for the success in changing the behaviour in a small group setting. Therefore, the explicit statement of a group value is in itself a motivation for action. Hopper and Nielson (1991) used Lewin's theory in their attempt to improve pro-environmental behaviour when they studied the influence of social interaction on group standards about recycling. They adopted a "block leader approach" using an individual in a community to "approach and actively encourage" (Staats et al., 2004, p. 345) neighbours to participate in a recycling programme. In that way, personal and social norms were redefined. The approach proved very successful compared to two control measures, namely information sharing and monthly reminders.

Several recent approaches towards fostering sustainable behaviour change are discussed by Clayton and Myers (2009). These include applied behavioural analysis (ABA) (Geller, 2002), community-based social marketing (McKenzie-Mohr & Smith, 1999), the psychological-social-environmental transactional model (Werner, 2003), and the promotion of an autonomy-supportive environment (DeCaro & Stokes, 2008). These approaches are discussed below as some examples of programmes used to effect behaviour change.

3.4.2.1 Applied behavioural analysis (ABA)

Applied behavioural analysis can be summarised as three basic principles (Geller, 2002). It

- focuses on observable behaviour;
- explores external rather than internal factors that could improve performance; and
- uses principles of behavioural reinforcement such as feedback.

The process uses the acronym DO IT to summarise the steps in addressing behaviour change. D: define the behaviour to be addressed, O: observe the occurrences of the behaviour, I: intervene or modify the behaviour, and T: test the intervention's effectiveness.

This model falls into the behaviourist psychology school of thought, in that it addresses specific habitual behaviours. However, Geller (2002) also emphasises the need to address internal motivations.

3.4.2.2 Community-based social marketing

McKenzie-Mohr and Smith (1999) suggest four steps for addressing change in ecological behaviour that are very similar to those suggested by Geller (2002):

- identify barriers to and benefits from an activity;
- develop a strategy for change;
- pilot the strategy; and
- evaluate the strategy.

This method has an increased focus on social involvement, for instance, interventions focus largely on social commitment, and changing social norms by providing prompts, incentives and active communication (Clayton & Myers, 2009).

3.4.2.3 Psychological-social-environmental transactional model

The psychological-social-environmental transactional model developed by Werner (2003) focuses on specific social factors omitted by both Geller's (2002) and McKenzie-Mohr and Smith's (1999) models. Clayton and Myers (2009) summarize it as such:

- create a norm by embedding the desired change in individual's social groups;
- Embed messages about behaviour in the actual physical environments in which individuals already operate using behaviour streams and language they already use;
- use messages that clearly guide attitudes encouraging scrutiny and accessibility in order to guide behaviour
- "[r]ecognize that change is a dynamic process in which information is effective at different stages, and that the same information may be relevant in new ways at different times; and
- "[e]ncourage long-term change, including institutional supports" (Clayton & Myers, 2009, p. 157).

These approaches focus on incorporating social networks into the desired behaviour changes in order to make the changes more sustainable. There is a strong link here between the empowerment spiral (Mehlmann et al., 2010) and this model suggested by Werner (2003). Both models consider the norm, information input and feedback approaches that will lead to behaviour change over time. Staats et al. (2004) describe the Eco Teams and "block leader approach" where social networks are intimately incorporated into the ecological programmes that promote pro-environmental behaviour at a local community level.

3.4.2.4 Promoting an autonomy supportive environment

This method described by DeCaro and Stokes (2008) attempts to foster intrinsic and internalised motivations aligned with a person's core interests and identity, side-lining the ineffective use of economic incentives. The characteristics of this approach are summarised by Clayton and Myers (2009) as follows (cited verbatim):

a) Empathic understanding, ensuring accurate communication information and respect for others.
b) Provision of choice – freedom to solve problems for themselves and generated responsively
c) Transparent administration – including regulations. Access to decision-makers and making rationales, necessity and value of rules clear.
d) Non-controlling communication and feedback. Managers should avoid a dictatorial style and instead emphasise the voluntary nature of participation. The communicative style must convey approachability and ideals that are worth buying into. (p. 176-177)

This last approach not only increases the focus on intrinsic motivations, but also encourages large scale social interaction in fostering the desired behaviours. From the descriptions of the models of persuasion above, it is clear that social interaction and support have enjoyed increasing attention in recent years. It has become clear that without social involvement and adequate support, the sustainability of any given project or programme cannot be assured.

In the next section, a study by Brandon and Lewis (1999) is discussed in detail. This study is presented separately due to its significant impact on the current study.

3.4.3 Brandon and Lewis's study

Brandon and Lewis's (1999) research among 120 households was the "largest household energy field feedback experiment ever undertaken in the UK" (p. 76) up to that time. They measured household electricity consumption over a period of nine months and provided feedback about electricity use in a variety of ways: consumption compared to previous consumption/others with similar use, use of leaflets/use of computer generated feedback, and feedback relating to financial/environmental costs. After commencement of the study, respondents were interviewed in order to collect data relating to their socio-economic status, demographics, environmental attitudes and current conservation activities. After final meter readings of electricity use had been taken at the end of the nine-month period, focus group sessions were conducted with participants. Brandon and Lewis reported that the group with pre-existing positive pro-environmental attitudes and the group receiving computerized real-time feedback on their own electricity consumption were the most likely to have effectively decreased electricity consumption.

Themes that emerged from the focus group discussions included the "trade-off between comfort and expenditure, with money being identified as the main motivator for conservation" (Brandon & Lewis, 1999, p. 82). Although people expressed sympathy with the environmental agenda, there was no broad agreement that one should bring "one's environmental attitudes home, when it comes to heating, lighting, cooking and washing" (p. 82). Brandon and Lewis deduced that stressing environmental issues may not necessarily be the best way to motivate people to change their behaviour. Visibility of feedback was pointed out as a major benefit; however, the method used, the installation of a computer in the respondents' homes, was neither feasible nor desirable on a larger scale, due to financial and logistical constraints. The location of the device was also important – participants preferred places with high visibility such as the kitchen, rather than cellars or under the stairs. Brandon and Lewis indicate that study respondents were disappointed with the lack of personalised information they received during the measurement period. Participants in their study did not see general leaflets as useful, and Brandon and Lewis concluded that the "only feedback form, irrespective of social or economic circumstances, in which the present study can place any confidence is information, some of it interactive, supplied by computer software" (p. 84).

Brandon and Lewis (1999) mentioned three areas with implications for policy development: addressing behavioural potential, particularization, and visibility. This means that potential for behaviour change should be targeted where it already exists (using people who already hold positive environmental attitudes) and by providing tailored information and advice in highly visible ways. Ultimately, to get people to conserve energy, Brandon and Lewis (1999) advise that "[f]eedback, coupled with practical conservation advice…[should be] targeted at people who already hold positive environmental attitudes" (p. 84).

The limitations identified in Brandon and Lewis's (1999) study were addressed in the current study and are discussed in Section 4.3.2, specifically with regard to the methodology. These limitations were addressed in the current study by improved feedback visibility (technology advancements enabled a wireless real-time feedback monitor in this study, compared to the desktop computer-based feedback in Brandon and Lewis's study), the fact that the participating sample volunteered (this is regarded as indicative of positive environmental attitudes), and the provision of practical in-home and personalized advice.

The next section presents a summary of the literature reviewed in the preceding sections with specific reference to the research recommendations made in these studies. These were used to inform the research design of this study.

3.5 Shortcomings in prior studies and opportunities for research

A rich array of studies focusing on the unit of research in energy efficiency studies, the barriers to environmental behaviour change and strategies to encourage such change have been discussed in the preceding sections. These studies are primarily from North American and European countries. There are a few examples of empirical research focusing on the electricity use of small and medium enterprises in South Africa (Van Eeden et al., 2003; Viviers, 2009), but no prior study that specifically explores the energy efficiency strategies employed by households in South Africa could be found, even though electricity supply has become a crisis. South Africans' understanding of global climate change, their interpretation of the threats it poses, the perceived options for behaviour and the way people choose to react have not been extensively studied in the context of efficient electricity use.

Abrahamse et al. (2005) summarise the need for an in-depth study of electricity use when they state that “evaluations of an intervention’s effectiveness should be focussed on (changes in) behavioural determinants as well as (changes in) energy-related behaviours. Most studies reveal only to what extent interventions have been successful, without providing insight into the reasons why” (p. 283). They add that “the effectiveness of interventions and possible determinants of behaviour should be examined simultaneously. A thorough monitoring of determinants of energy use and energy savings may increase our understanding of the success or failure of intervention programs” (p. 283). Abrahamse et al. (2005) rightly demand that interventions should be explicitly mentioned with a clear indication of the content, describing the intervention adequately. It was noticeable that most of the studies reviewed in this study only recorded whether the intervention was successful or not, without providing insight into the reasons for success or failure.

In Table 8, a brief indication of the shortcomings identified in some of the studies that were discussed in this chapter is provided, along with suggestions of how these limitations could be addressed in the current study.

Table 8

Summary of recommendations from studies on behaviour change in electricity use in households

Authors	Shortcomings	Opportunities
Brandon & Lewis (1999)	“Customers want customized or particular advice” (p. 84).	Provide personalized feedback.
	“General leaflets with often inappropriate information or vague statements were not viewed…as useful” (p. 84).	Provide personalized feedback, and in person.
	“The only feedback form…is information, some of it interactive, supplied by computer software” (p. 84).	Provide real-time consumption displays (high visibility).
Vandenbergh & Steinemann (2007)	“This paper demonstrates the substantial contributions of individuals and households to carbon dioxide emissions, but much remains to be understood about the contributions from individuals as well as the social, economic, and legal influences on individual carbon-emitting behaviors” (p. 1739).	Explore the household and individual contribution and the influences on consumer behaviour.

Authors	Shortcomings	Opportunities
Scott & Oelofse (2009)	Addressing only the "information deficit" is too simple and is inadequate for addressing "awareness-raising in a multi-cultural society where the majority of the population has low levels of education and high levels of poverty" (ASSAf, p. 153).	Intervene in poor households, but do not simply provide information, combine best-practice interventions to bring about the best behaviour changes in the households.
Brandon & Lewis (1999) McMakin et al. (2002) Niemeyer (2010)	Educate and remove barriers for those who already have a positive attitude about the need to increase energy efficiency.	Make use of a volunteer sample.
Abrahamse et al. (2005)	A combination of strategies is especially effective.	Combine best-practice strategies to bring about the best behaviour changes in a household.
Abrahamse et al. (2005)	Most studies reveal only to what extent interventions have been successful, without providing insight into the reasons for success or failure.	Explore in detail how changes are brought about and why.

In the process of identifying these opportunities for future research, the research questions were developed. These are discussed in the next section.

3.5.1 The research questions

The context in which a person lives every day has a complex impact on how he or she chooses to act, the possibilities he or she is able to identify, and the dreams he or she dares to dream. No context in which a person finds him- or herself is neutral. One of the challenges of environmental psychology, according to Uzzell and Moser (2009, p. 307), "is to persuade other areas of the discipline that the environmental context is not simply the neutral backdrop to human agency but a critical part of the story". The socio-economic context in the South Africa in which we live today, its impact on our decision-making, the barriers, abilities and motivation we perceive, and how these translate into action are the focus of this research.

In order to use the most successful interventions from the literature in combination with a context-focused energy efficiency study in South Africa, the following three research questions were explored in this study:

- What is the effect of a psychological intervention, using particularization, real-time feedback, goal setting and commitment-making, with an individual in a household on the households' electricity usage?
- What energy conservation strategies (if any) are employed by households, as perceived by the individual (participant) and why?

- How do participants from different socio-economic backgrounds attempt to save electricity?

In answering these questions, the final research objective aimed at developing a conceptual model of residential energy efficiency in South Africa can be achieved. The overall aims and objectives of this study are discussed in the next section.

3.5.2 Overall aims and objectives

On a practical level and based on the limitations of prior studies summarized in Table 8, this study attempted to address some of the shortcomings in previous research by

- engaging with the participants in a sustainable, healthy and unobtrusive manner;
- describing the effects of a specific intervention with an individual to encourage energy efficiency in participating households;
- attaining insight into and describing the success of the use of the chosen intervention to encourage energy efficiency in households;
- attaining insight into the barriers, motivation and perceived abilities of different individuals with regard to energy efficiency, in particular, from a South African perspective;
- exploring barriers unique to the South African context that prevent energy efficient behaviour from occurring;
- helping participating individuals to identify their own reasons for changing their behaviour rather than introducing external incentives;
- making recommendations for future interaction with individuals in order to encourage energy efficiency; and
- making recommendations for future research.

These objectives operationalized the research questions and informed the research design and methodology, which are discussed in Chapter 4.

The theoretical objective of this study is to develop a conceptual model that describes energy efficiency attitudes and beliefs, the subjective norms and perceived behavioural control of residential energy consmers in South Africa, delineating current themes in each ecological level.

3.6 Conclusion

The literature review in this chapter has highlighted research in the field of psychology and energy efficiency, with a particular focus on the unit of research in residential energy efficiency studies (the individual). An assessment of the occupant predictors indicates that family schedule, occupant age and household income are significant predictors of high energy consumption in a household. The prior studies did not suggest that the research participants' gender was a significant contributor to the success of an intervention. The socio-economic standing and the culture of a household was also discussed, in order to place the South African household into context. Prior literature on possible barriers to energy conservation was reviewed, followed by a description of the antecedent and consequence strategies and their social application in recent years. Finally, the chapter indicated shortcomings and limitations in prior research and stipulated the research questions and overall pragmatic and theoretical objectives of the current study. In the next chapter, the research methodology and design used to answer these research questions are discussed in detail.

Chapter 4:
Research Methodology

4.1 Introduction

From the discussion in the previous chapter, it is clear that a researcher's epistemology affects the study approach chosen, as well as the way in which data are collected and analysed. In this chapter, the chosen methodology, the collection of data and the subsequent analysis are highlighted, illustrating how the epistemology of the researcher was put into practice in this study.

This chapter starts with background to the study. Section 4.2, which contains the background to the study, provides some context in the form of a pre-feasibility study, and presents the research questions. The research questions necessitated a mixed methodology approach, which is described and discussed in Section 4.3, with a rationale for its use.

This is followed by a discussion of the research design (including the pilot study and the different phases in this research) in Section 4.4. The research design was structured in three phases that were followed during data collection. Phase 1 involved the recruitment, sampling and initial assessment of the research participants, Phase 2 consisted of two parts, the first dealing with qualitative data collection and the second with the quantitative data collection. Phase 3 involved with the qualitative data collection during the follow-up focus groups. These phases are referred to throughout the descriptions of the research methodology, the data gathering, and analysis of the gathered data. The findings in Chapter 5 are also presented using this same structure. Phase 4 was the analysis stage, where the qualitative and quantitative data collected in Phases 2 and 3 were analysed collectively. The process of analysis is explained in this chapter and the findings are discussed in Chapter 5 along with the findings from the analysis of the data from Phases 2 and 3.

Finally, in Sections 4.6 the ethical considerations related to this study and its validity and reliability are considered.

4.2 Background to the study

This research builds on a pre-feasibility study conducted by the Nova Institute in 2009 for its own purposes, while the researcher was working as a volunteer at this organization. In this section, the outcomes of Nova's initial research and the subsequent role of the Nova Institute in the current research project are outlined. The "Nova study" referred to below refers to this pre-feasibility study, unless otherwise stated.

4.2.1 Involvement of the Nova Institute

The Nova Institute is a Section 21 (non-profit organization) company that works with households in poor communities. This study builds on a project that commenced in 2009, and that was supported by a team of experts from the European engineering industry company Imtech (s.a.),, the Protestant Church in the Netherlands and the South African Netherlands Research Programme on Alternatives in Development (SANPAD). The researcher has been involved with the People's Power Project, run by the Nova Institute (Nova, n.d.), since its initial phases.

The aim of Nova's project was to conduct an initial exploration of the barriers and opportunities in reducing household energy consumption. From the initial interaction with the participants in the People's Power Project, it seemed that a lack of feedback on electricity consumption exacerbated energy efficiency problems in homes. The first step was to find a technical solution for providing user-friendly real-time feedback on individual appliances' electricity consumption in households. The Nova Institute addressed this challenge by providing feedback using the Plugwise system in its study. The Institute also provided technical support for the use of these monitors to home owners who participated in the Nova study. The researcher studied the use of these monitors during her time as a volunteer at Nova and thus the Nova study also became a pre-feasibility study for the current research. The scope and results from the study done by the Nova Institute are discussed below, also indicating how the Nova study influenced the decision to conduct the current study.

4.2.2 Nova's pre-feasibility study

The study conducted by the Nova Institute was done in order to identify opportunities for saving electricity in the residential sector, identify appropriate technical solutions for providing feedback to residential electricity consumers on their use, and determine the household appliances that contribute most to electricity consumption in the home under real-use circumstances, about which very little information was available in South Africa at the time. The Plugwise monitoring system (specialised electricity consumption measurement equipment, see www.plugwise.nl) was tested. Technical interventions, such as the use of a geyser timer and the impact of defrosting a freezer, were also tested to ascertain possible residential electricity savings under real-use circumstances. At the start of the People's Power Project, nine households were contacted and audited in respect of their electricity use. These included lower, middle and high income households in Mamelodi, Garsfontein and Woodhill/Menlopark respectively (the same geographical locations areas used in the current study).

Plugwise was used to measure each household appliance's electricity consumption individually; in other words, it took a reading of the electricity used by each major appliance in the household in kilowatt (kW). The study was conducted by engineers from Imtech (as part of its community engagement programme). Researchers came from the Netherlands and Germany. The tests conducted by the pre-feasibility team provided important information for the current study, since few data were available on the energy requirements of South African household appliances under real-use conditions.

The discussion below on the outcome of the measurement focus on two technical interventions and their savings potential as identified by the Imtec/Nova research team. These included a timed geyser and the effect of defrosting a freezer on energy efficiency. Geysers and refrigerators are known to be some of the largest contributors to a household's electricity consumption (Eskom, n.d.).

Although the Nova study dealt largely with technical verification of these interventions, the researcher of the current study had an opportunity to explore electricity consumption using a qualitative approach. As a volunteer in the Nova team, the researcher of the current study explored the experiences of the participating volunteer households upon completion of the technical tests, by interviewing them about their experiences. This involvement with Nova's project led the researcher to identify the need for a further research project on residential electricity consumption in different residential areas. A short interview guide with open-ended questions was developed for this purpose. Results from both Imtec/Nova's technical measurements (see Sections 4.2.2.1 to 4.2.2.3) and the open-ended interviews that the researcher did for Nova (see Section 4.2.2.4) are presented below.

4.2.2.1 The household water heater (geyser)

The Nova study confirmed that the household water heater (geyser) contributes most to household electricity consumption. In the Nova study, comparisons between various settings of a geyser were made. The factory-fitted integrated thermostat (which regulates the supply of hot water throughout the day and night) was tested on its own, and in combination with a timer (regulating the on and off setting of the household water heater, leaving it on for only limited times during the day). The study showed that using a timer saves around 40% of electricity. In Figure 9 the difference in electricity use with and without a timer is indicated for one of the nine participating households.

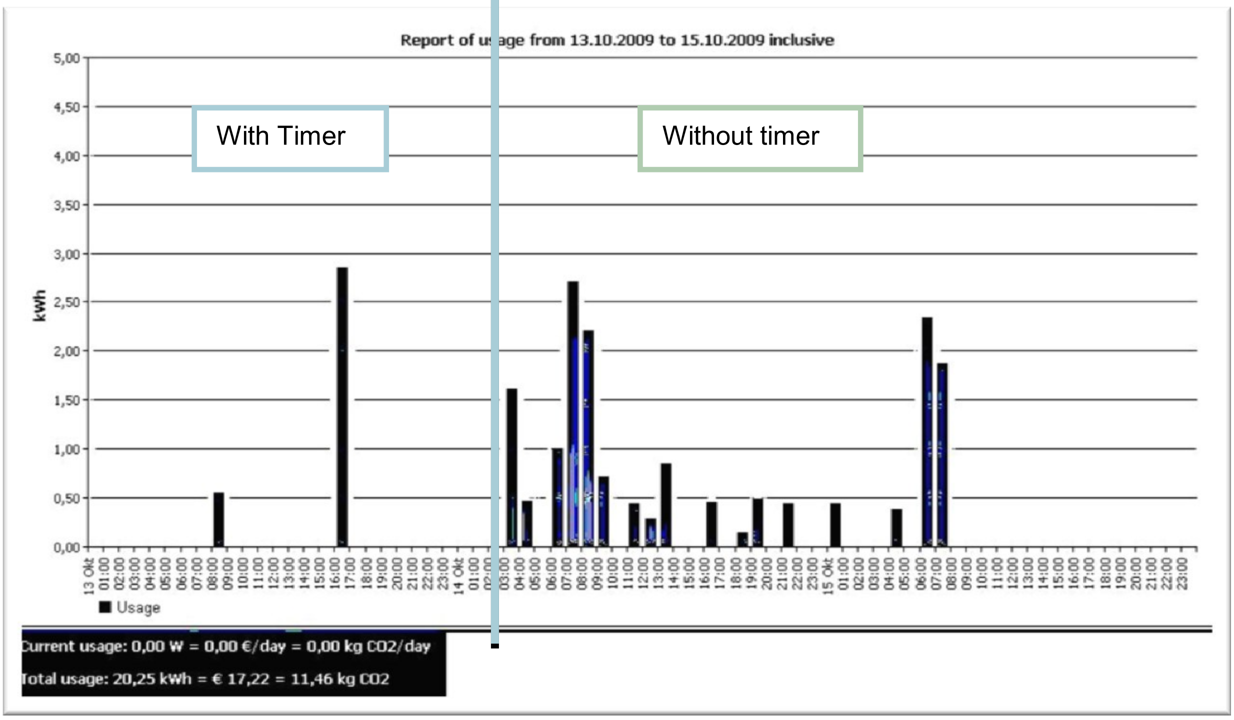

Figure 9 Geyser use with and without a timer

Other findings indicated that

- geyser temperatures are often too high (resulting in high losses of unused heat energy);
- owners often do not know how (or where) to adjust temperature settings; and
- some participants believed that externally regulating a geyser (by means of a timer or manual switching at the distribution board) would result in malfunction or cause the geyser to "pop" (burst).

4.2.2.2 Household refrigeration

Household refrigeration turned out to be another source of potential saving in households. Approximately 30% of total household electricity consumption in the nine participating households was made up of refrigeration. This is an important finding, since until that time, most energy efficiency advice from the national energy regulator (Eskom) to households focused mainly on the water heating system. The finding was mainly explained by the fact that the houses where measurements were done had

- more than one refrigerator;
- old refrigerators and freezers;
- refrigerators and freezers with broken refrigerator seals; and
- empty refrigerators that were always left on.

Figure 10 shows a refrigerator photographed during the study. Ice in the compartment is compacted, and the refrigerator then uses a lot more electricity to remain at the desired temperature.

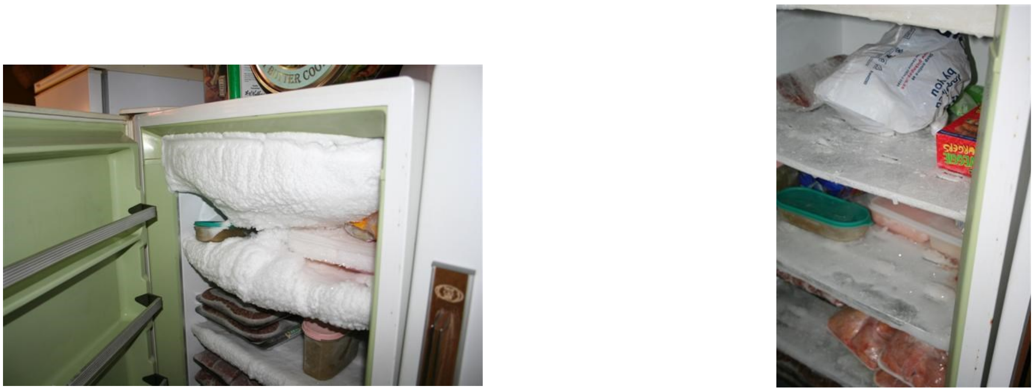

Figure 10 Before and after the refrigerator was defrosted

Figure 11 presents the electricity consumption recorded by the Nova team using the Plugwise measurement instrument, before defrosting the fridge and thereafter. It is clear that defrosting a fridge regularly saves a lot of electricity.

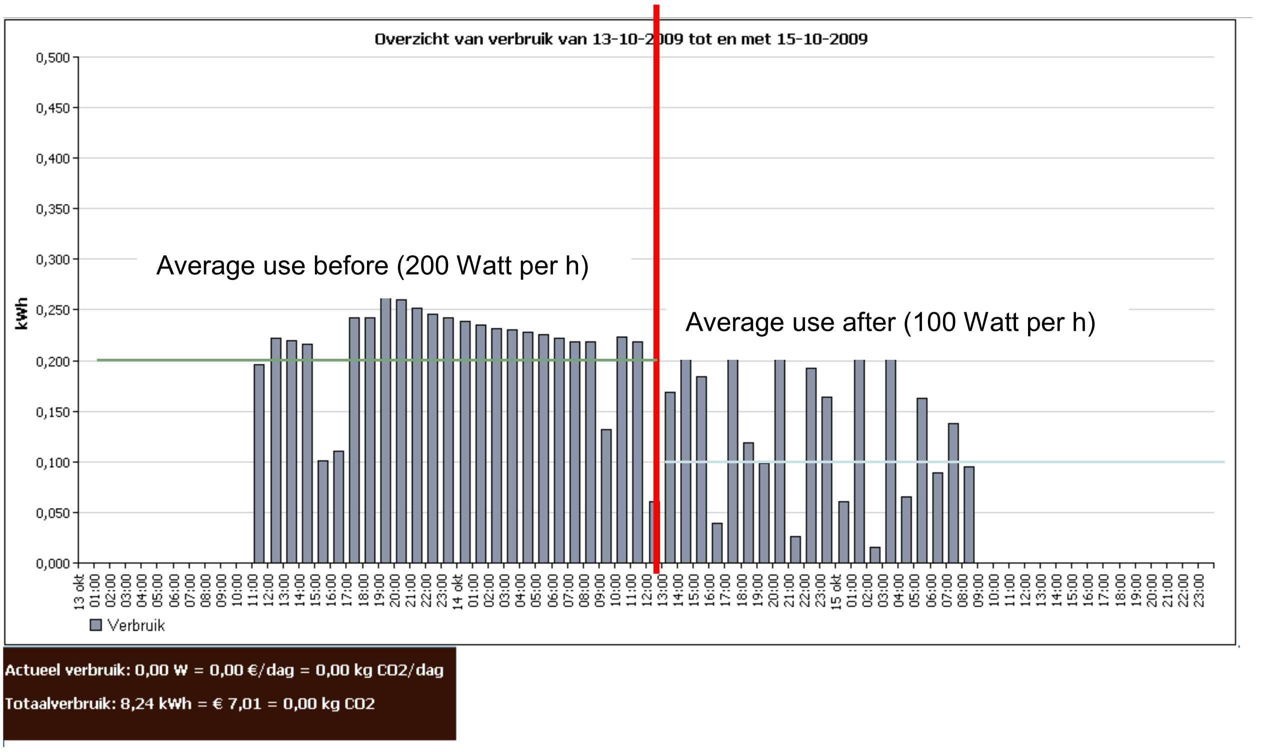

Figure 11 Electricity use before and after defrosting

Other aspects that needed to be addressed included using the space in fridges and freezers optimally, defrosting freezers regularly, checking that the seals are in proper order and switching off empty or unused freezers.

4.2.2.3 Other findings: computers, televisions, standby and washing machines

Other findings indicated that computers where often left on "idle" (hibernate/sleep) for long periods, due to the belief that computers either use more energy every time they are switched on compared to hibernating/sleeping, or that they sustain some kind of damage when switched on and off too often and are therefore left to hibernate or sleep, sometimes for weeks at a time. The same approach is also often applied to the satellite TV decoder, music systems and other entertainment equipment.

The technical outcomes of the Nova study showed the following:

- The Plugwise measurement system was too complicated and expensive for residential use, so another option had to be explored (another method of measuring household electricity consumption was later found and used in the pilot study for the current study, described in Section 4.4.2).
- Information on the functioning of appliances in homes was not accurate, and erroneous beliefs held by residents led to the wasting of large amounts of electricity – a potential saving was identified (e.g. timing geyser use and rethinking fridge and freezer habits).

After completion of Nova's pre-feasibility study, initial exploratory discussions were held with the participants of the Nova study. This is described below.

4.2.2.4 Feedback in the Nova study from an exploratory interview

The participating households were contacted by the current study's researcher on behalf of Nova for follow-up feedback after completion of the Nova study. Each household was provided with information specifically tailored to its electricity consumption to help the members to continue to reduce their use, and each household was given an opportunity to ask questions about the readings taken in the home. The interaction in the feedback sessions proved to be very beneficial in informing the development of future interactions with the households that were included in the Nova research project. The interviews highlighted the following:

- participants' awareness of the electricity consumption and price of electricity improved during the study (self-reported);
- participants noted an increase in specific interactions about electricity use in their households and with neighbours or colleagues;
- participants wanted feedback on their whole household consumption, not just a few appliances;
- participants noted behaviour changes in their households, including switching off lights, and appliances on standby;

- some participants made changes to their equipment (changing light bulbs to more efficient ones, defrosting freezers and replacing worn insulation on fridges/freezers) and their use-habits (switching off extra fridges/freezers and manually/automatically timing geysers), and wanted clear feedback on the effects of these changes;
- participants expressed the need for personalised feedback; and
- participants found information on some erroneous beliefs they held surprising (erroneous beliefs were indicated by the research team).

The discussions with the participants in the Nova study made the researcher of the current study aware of the need to understand people's electricity consumption patterns not only in a qualitative way, but also by quantifying electricity consumption and savings. The researcher became interested in people's reasons and attitudes toward electricity consumption, their behaviour and the ways in which they attempt to achieve energy efficiency in their homes. Nova's pre-feasibility study therefore led to the development of research questions related to this interest as presented in the next section.

4.2.3 Development of the research questions

The Nova pre-feasibility study evoked several questions for the researcher. These questions include some of the following 'How do we think about electricity?', 'What impact does this thought process have on how we will act?', 'Are we enabled to act?', 'Do we perceive an ability to change our situation?' When people are threatened by looming price hikes and want to investigate their options, how do they do it? and What is the impact of their social context on how these problems will be faced?

Taking into consideration the lessons learnt from the Nova pre-feasibility study, extensive litareture reviews and the research questions for the current study (as previously indicated in Chapters 1 and 3) were developed. These are:

- What is the effect of a psychological intervention, using particularization, real-time feedback, goal setting and commitment-making, with an individual in a household on the households' electricity usage?
- What energy conservation strategies (if any) are employed by households, as perceived by the individual (participant) and why?
- How do participants from different socio-economic backgrounds attempt to save electricity?

The second and third research questions imply a need for qualitative data, as they require in-depth information about the experiences of and meaning participants (and other members of the household) attach to reducing their household's electricity consumption. The first research question required measurement of actual electricity consumption. Two sets of information were therefore needed for the study: first, actual electricity measurement data (in answer to the first research question), and second, qualitative data in which the participants talk about their view of the environment and their experiences of and meaning made of electricity management in the home (in answer to the second and third research questions). Therefore both qualitative and quantitative data collection methods were necessary, in other words, a mixed methodology was indicated. In the next section, mixed methodology is described.

4.3 Mixed methodology

In this section, the research design is described. A mixed methodology was used. It is explained below, followed by a rationale for its use and a description of the pilot study process. This section concludes with a detailed description of the final research design used in this study.

4.3.1 What is a mixed methodology?

Mixed methodology is defined by Tashakkori and Creswell (2007) as research in which the "investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry" (p. 4). According to Onwuegbuzie and Leech (2005), using mixed methodology requires the combined use of qualitative and quantitative methodology and enables a researcher to allow "the research question [to] drive the method(s) used" (p. 377). In general, the goal of mixed method research "is not to replace either of these two approaches [qualitative or quantitative] but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies" (Johnson & Onwuegbuzie, 2004, p. 14). The mixed methodology approach is ideal for addressing real-world research, interchangeably studying theory and practice (Leech & Onwuegbuzie, 2008). Newman and Benz (1998) argue that researchers using mixed methods to understand the world are more likely to view research as a holistic endeavour. This creates a natural fit with the ecological approach and systems theoretical thinking, as discussed in Section 2.5 and offers researchers a "practical and outcome-orientated inquiry" (Newman & Benz, 1998, p. 17), answering different kinds of research question in a study.

4.3.2 Rationale for using a mixed methodology

As indicated above, this study attempted to explore individual households' electricity consumption and the difference between groups of households (by means of a quantitative measurement), the meaning attributed by individuals to their use of electricity (by means of qualitative data), and the interaction between these two. Clearly, the research questions necessitated the use of a mixed methodology. Moreover, methodological issues identified during the literature review also guided the researcher in the direction of a mixed methodology. A justification for this choice of methodology is presented below.

Mixed methodology offers an alternative to traditional qualitative or quantitative research, enabling a researcher to study a specific phenomenon taking both the numerical data and meaning of the research phenomenon into consideration. In addition to the research questions, the current study's theoretical framework and previous literature on energy efficiency in the household informed the choice of a mixed methodology. With regard to the theoretical framework, systems theory posits that the "real world" is complex and segmented, and that the discovery of meaning is a continuous process (Capra, 1997). Mason (1996) advocates the use of multiple data collections methods, which provide diverse approaches to describe and explore the systems being researched. Hence, in this study, using both quantitative and qualitative methods was deemed compatible with the theoretical framework.

Some methodological limitations in prior studies were also identified during the literature review (Chapter 3). These suggested the need for a mixed methodology approach. Studies about household energy consumption described in Chapter 3 predominantly made use of only one method of data collection. Typically, they focused on quantitative data, gathered by means of questionnaires, and providing no qualitative information about changes in electricity consumption (e.g., Hayes & Cone, 1981; Howenstine, 1993; Katzev & Johnson, 1984; McMakin et al., 2002; Poortinga, Steg, Vlek, & Wiersma, 2003; Schultz et al., 1995; Van Houwelingen & van Raaij, 1989; Winett et al., 1985). In these studies, questionnaires or feedback letters were posted to households and the residents in a household selected one person to complete the questionnaire, providing quantitative data on the households' behaviour.

Exceptions to this approach are a study by Becker et al. (1981) which required written responses from both spouses, and a study by Brandon and Lewis (1999) which closely resembles the current study, and which included an exploratory section in the form of interviews. Brandon and Lewis (1999) used both qualitative and quantitative methods to explore household electricity use in the UK. Their recommendations (as described in Section 3.4.3) include the use of visible feedback, and detailed and personalised recommendations for households to reduce electricity consumption. These suggestions were taken into consideration during the development of the research design and intervention in the current study.

Actual electricity usage data is also not typically collected in studies on household electricity consumption. Abrahamse et al. (2007) reviewed 38 studies on household electricity consumption and lamented the lack of actual electricity usage data in the literature. The studies under review generally included self-reports of electricity usage. Abrahamse et al. maintain that self-reported behaviour is only an estimation of the actual use, as participants might be prone to provide socially desirable answers. This potential problem was first indicated by Luyben (1982), who found that self-reported thermostats settings were considerably lower than the settings observed by interviewers who visited the homes of participants in Luyben's study.

In many of the prior studies, either qualitative or quantitative data on energy efficiency in households are therefore the norm. Since there is a dearth of information on people's experience of an energy audit, the meaning that they make about using electricity efficiently and its impact on their electricity consumption, a qualitative component to the research approach adopted in the current study was deemed desirable to make a contribution to the body of knowledge. In addition, due to the potential risk that participants might provide socially desirable answers, measurements of actual electricity usage were included in the current study.

Creswell and Plano Clark (2011) emphasise that mixed methods research is best suited where

> …one data source may be insufficient, results need to be explained, exploratory findings need to be generalized, a second method is needed to enhance the primary method, a theoretical stance need to be employed, and an overall research objective can best be addressed with multiple phases, or projects. (p. 8)

In the current study more than one data source was needed in order to understand the effect of an intervention on actual electricity consumption, and to explore in-depth the reasoning behind certain changes in the residential consumption. Therefore, mixed methods research was used in this study with the following aims:

- determining the effect of the intervention on household energy use through the usage data gathered (quantitative);
- determining the socio-economic level of each household through the use of the LSM (quantitative);
- determining the impact of the LSM on the effectiveness of the intervention (quantitative);
- understanding individual participants' perceptions of their environmental responsibility and role in the household by means of an in-depth interview (qualitative); and
- determining how and why the changes took place/did not take place through discussion with the individual participants in a focus group (qualitative).

Clearly both the qualitative and quantitative approaches needed to be employed in order to address these issues. These two approaches, the qualitative and the quantitative, are described by Creswell and Plano Clarke (2011) as "strands" (p. 63). In the next section, the way in which these two strands are intertwined is explored, explaining the research design and some key decisions about the interaction of the strands.

4.3.3 Key decisions in mixed methods approach that inform the research design

In order to ensure a well-designed mixed methods study, the moment of mixing the data can be enacted at several points during the research process (Onwuegbuzie & Leech, 2005). In other words, data can be mixed at a design level, or during the data collection, analysis or interpretation of the data. Important decisions regarding the structure of mixing the strands in this study are explained below, looking at decisions regarding the level of interaction between the strands, the timing and the priority of each of the strands.

4.3.3.1 Level of interaction between the strands (or Interactive approach leading to an embedded design)

Either an independent or interactive approach can be followed in mixed methods research (Creswell & Plano Clark, 2011). In an independent approach, research questions, data collection and analysis are kept separate. In this study, however, the qualitative and quantitative data collection methods interacted. An interactive approach means that interaction of the strands occurs before analysis is done. For this particular study, this means that the qualitative data collection opportunity was embedded in the quantitative data collection opportunity. The embedded design is defined by Creswell and Plano Clark (2011) as occurring

> …when the researcher collects and analyses both qualitative and quantitative data within a traditional qualitative or quantitative design…In an embedded design, the researcher may add a qualitative strand to a quantitative design, such as an experiment, or add a quantitative strand within a qualitative design… (p. 71)

and the researcher is in effect "mixing [the data] before the final interpretation" (p. 65). The embedding of a qualitative strand in the quantitative (experimental) design is discussed in detail in Section 4.3.3.2, since this was the particular approach used in this study. The qualitative strand (the interview) was embedded in the quantitative experimental design for three reasons:

- to understand the participants, context, and environments so that the intervention would work;
- to grasp the participants' current level of pro-environmental behaviour and habits; and
- to document a need for the intervention.

These aspects are reflected in the questions posed in the interview guide. The interview guide and the data collection methods are discussed in detail in Section 4.4.4. A final qualitative data collection opportunity in the form of a focus group is also discussed later on. Two other important decisions that affected the research design are the priority of each strand and the timing of measurement.

4.3.3.2 The priority and timing of the strands (QUAL+quan)

The two decisions that are discussed below dealt with the focus on the priority of each strand and the timing of implementation of each strand. In a mixed methods study, the qualitative and quantitative sections of the research could be paired in different ways with an emphasis on either the qualitative, the quantitative or both. In Table 9, developed by Johnson and Onwuegbuzie (2004), the emphasis on different research approaches (quantitative or qualitative) and the time order in which they are executed is shown. Emphasis is indicated by capital letters. The timing of the strands could be achieved by ordering them either sequentially or keeping them concurrent.

Table 9

Mixed method design matrix

	Priority decision	Time order decision	
		Concurrent	**Sequential**
Paradigm emphasis decision	**Equal Status**	**QUAL + QUAN**	**QUAL → QUAN** QUAN → QUAL
	Dominant Status	**QUAL + quan** QUAN + qual	**QUAL →quan** qual→QUAN QUAN→qual quan→QUAL

Source: Johnson and Onwuegbuzie (2004, p. 22)

In Phase 2 of this study (Phase 1 was the recruitment, experimental group allocation and installation phase), the priority strand was qualitative (indicated by QUAL) and the quantitative design served a supportive basis (indicated by quan). The QUAL strand was embedded within the quantitative design; therefore they were concurrently collected (QUAL+quan). In Phase 3 of this research, another opportunity for qualitative data collection was created after the completion of Phase 2, and thus a sequential QUAL phase was added to the design. The multi-phased research design in terms of timing and priority of the qualitative and quantitative strands is presented in Table 10.

Table 10

Timing and priority of qualitative and quantitative strands in the research phases of this study

Phase 1	Phase 2	Phase 3
Sampling, experimental group allocation and installation	Embedded QUAL+quan	→ QUAL

Based on the decisions on the interactive nature of the strands, their timing and priority, the research design emerged. This is discussed in the next section.

4.4 Research design

The research design is discussed in this section, first by means of an overall description, providing context and the timeline during data collection. This is followed by a description of the pilot study and changes that were made to the design before the implementation of the main study. The methodology, research instruments and research procedure are then presented in detail in the three phases identified in the overview of the research design.

4.4.1 Overview of the research design

This study used a multi-phased combined experimental and ex post facto research design. Phase 1 consisted of the recruitment of participants, assigning them to the different groups and installing the electricity monitoring equipment. Phase 2 consisted of an in-depth interview (embedded qualitative data collection) and a quantitative data collection opportunity (in the combined experimental and ex post facto design). In this study, two qualitative data collection opportunities were used, one as Phase 2, Part 1 and the other in Phase 3. An overview of the research design is presented in Table 11, indicating the concurrent (QUAL+quan) data collection during Phase 2 and the sequential (→QUAL) data collection in Phase 3. Finally, Phase 4 represents the combined analysis of the findings and is only discussed from the analysis of the data section onwards.

Table 11
Overview of the four phases in this research design

Phase	Activities
Phase 1	**Recruitment, group allocation and installation of metering equipment**
	The research sites
	The LSM
	Random allocation
	Installation of metering equipment
Phase 2: QUAL+qaun	**Embedded combined experimental and ex post facto research design**
Phase 2, Part 1	Qualitative: the in-depth interview
Phase 2, Part 2	Quantitative: the electricity consumption data and household inventory
Phase 3 →QUAL	**Sequential qualitative data collection**
	Focus groups
Phase 4	**Combined analysis**

The use of the embedded combined experimental and ex post facto research design in Phase 2 held several advantages for the study. It allowed the researcher to study how the intervention influenced energy consumption and how the LSM of the research participants interacted with the intervention, using two experimental groups. Participants were divided into these groups based on their living standard (LSM 6-9 and LSM 10).

Leedy and Ormrod (2013) indicate that such a research design enables a researcher “to study how an experimental manipulation may influence a particular dependent variable and how a… pre-existing characteristic interact with the manipulation” (p. 244). In this case, the pre-existing characteristic was the living standard of the research participants (indicated by the LSM score). The “experimental manipulation” of the research design allowed an exploration of two experimental groups (each receiving a different intervention). In Phase 2, the analysis of the qualitative and quantitative strands was embedded, as described in Section 4.3.3 above; therefore the qualitative strand (the interview) is embedded in a quantitative experimental design, as depicted in Table 12: This is explained in more detail in Section 4.4.4.

Table 12

Phase 2: The combined experimental and ex post facto design with qualitative strand (the in-depth interview)

Pre-existing characteristic (Living standard)		**Investigation period**				
		Random assignment to experimental groups	Continuous observations for all households throughout			
Group 1	LSM 6-9 (n=13)	Exp 1(n=9)	Obs	Obs	Obs	Obs
				Interview	Intervention 1	
		Exp 2 (n=4)	Obs	Obs	Obs	Obs
					Intervention 2	
Group 2	LSM 10 (n=23)	Exp 1 (n=10)	Obs	Obs	Obs	Obs
				Interview	Intervention 1	
		Exp 2 (n=13)	Obs	Obs	Obs	Obs
					Intervention 2	

Before implementing the intervention in this study, a qualitative data collection opportunity (by means of an in-depth interview) was included for two reasons, as discussed by Creswell and Plano Clark (2011). These enabled the researcher to “[u]nderstand participants, context, and environment so that the intervention would work; and […] [d]ocument the need for the intervention” (p. 192). The impact of the inclusion of a qualitative data collection opportunity into an experimental design might have an impact on the validity of the quantitative data findings. These are discussed in the limitations of the study, in section 6.5. The emphasis on the qualitative exploration of people’s underlying motivations for energy consumption, however, serves as a justification for the inclusion of the interview.

Due to the complexity of the research design, an outline of the format of the four phases is presented in Table 13, which illustrates the four phases, and the type of data collected in each phase, and provides a concept of the timeline for this study.

Table 13

The multi-phased embedded combined experimental and ex post fact research design

Time	**PHASE 1: Recruitment, Informed consent and group allocation**		
	Informed consent, installation of quantitative monitor and collection of LSM data for group allocation		
Week 1	*Quantitative data collection*	*Qualitative data collection*	*Detailed description*
	Installation of monitor and blind measurement for one week (baseline measurement), collection of LSM data, informed consent		Phase 1 Phase 2, Part 2 – start of quantitative data collection
	PHASE 2: Embedded combined ex post facto and experimental research design		
	Concurrent QUAL and quant data collection during a 3 week measurement period (QUAL+quan)		
End of Week 1		In-depth interview (Experimental Group 1)	Phase 2, Part 1
	Administering the intervention (different in Experimental Groups 1 and 2)		Phase 2, Part 1
Weeks 2 & 3	Continuous measurement of electricity usage (quantitative data)		Phase 2, Part 2
		Optional comments on data logging sheets	Phase 2, Part 2
End of Week 3	Remove electricity monitor		
Weeks 5/6	Written feedback to each household	Written feedback to each household	Phase 2, Part 2
PHASE 3: Focus groups			
Qualitative data collection 4-6 months after completion of Phase 3 (→QUAL)			
4-6 months following Phase 2		Focus group sessions	Phase 3
PHASE 4: Combined analysis			

The research design was initially implemented in a pilot study (with the exception of collecting the LSM information from participants) to test whether the approach was suitable. The outcomes of the pilot study and how it influenced the application of the research design in the main study are discussed in detail in Section 4.4.2, below.

4.4.2 Pilot study

In order to ensure that the research design could be implemented, a pilot study for the current study was conducted from May to August 2010. This served to streamline the interaction between the researcher and households, ensuring that the paperwork would be sufficient to capture all the necessary data and checking that the intervention was possible on a larger scale. It also allowed the researcher to finalise the recruitment strategy. These aspects are described in the sections below.

4.4.2.1 Recruitment of participants

Participants in the pilot study were invited to participate in the pilot study by means of an invitation distributed by leaders of existing civic organizations (such as churches, libraries and clinics). A volunteer sample similar to the one used in the main study (described in detail in Section 4.4.3) was included. In total, 19 households participated in the pilot study. These participants were allocated to low, middle or high income groups on the basis of the researcher's assumptions about their socio-economic standing.

4.4.2.2 Installation and interaction

Energy auditors were used during the pilot study. These were undergraduate engineering students at the University of Pretoria who had to complete a community engagement project as part of their studies and therefore volunteered to participate in this particular project. They were trained to install the electricity meters, administer the intervention and remove the monitor at the completion of the measurement period. Several potential risks that posed a threat to the quality of the data due to the use of the students were identified during the pilot study, as set out in Table 14.

Table 14
The effect of the use of energy auditors on data collection

Threat to the study	Effect on the study
Energy auditors did not arrive on time (or at all) in order to do the installation (or intervention)	Participants might not want to participate if the interaction is unreliable. If they decide to participate it might create doubt about the integrity of the remainder of the interaction (including advice)
Energy auditors installed the monitor incorrectly	The usage data gathered is useless and no deductions about the intervention can be made.
The feedback monitor was not hidden	There is no baseline for comparison therefore there can be no inferences about the impact of the

	intervention
The planned intervention was not conducted appropriately, by leaving paper work behind or forgetting to leave necessary information at the households	The effect of the intervention is not visible or measurable due to an ineffective intervention. (If none of the households show an improvement in electricity use after the intervention it might be proof that the intervention is not effective)
Date of intervention was not noted	Impossible to distinguish between baseline and after intervention usage data
Monitor was not removed after two weeks	Households with extended access to the electricity monitor (longer than other households with two week access) might have a different experience due to prolonged exposure to feedback. This was especially important for focus group discussions later on
The audit number of the household was not filled in on the paperwork	Impossible to determine which household's paperwork it is
Paperwork or usage data were lost or incomplete	Unable to make use of the usage data as no information about the household occupants and size is available

The potential effect of the use of energy auditors on the quality of the data was deemed too significant to allow their use in the main study. Instead the researcher decided to appoint a research assistant and to collect all the information personally, or with the help of the (trained) research assistant.

4.4.2.3 Changes to the main study as a result of the pilot study

The main changes that were implemented in the main study as a result of the pilot study were the following:

- Upon completion of the pilot study, the assumptive allocation to a low, middle or high income group proved unfounded. Lutzenhiser and Gossard (2000) claim that living standard has a larger influence on electricity usage than the geographical living area, and the need for a segmentation tool that would highlight the pre-existing living standard of the research participants was identified. This led to the inclusion of an abbreviated LSM in the main study (see the description in Section 4.4.3.3) in order to enable the researcher to differentiate between low, middle and high income participants.
- New batteries for monitors were used for each measurement.
- Appointments were made by the researcher (either Mathilda du Preez or research assistant Brian Weaver) for visits and confirmed a day in advance.
- Complete details of the participants were collected.
- An audit number was allocated to each household.

- Rapport with the volunteers in households was established through regular contact with the same researcher.
- The intervention was standardized in terms of sequence of interaction.
- Participants were contacted weekly to ensure the monitor was still in place and to check whether the participants had any questions.
- Paperwork was standardized and ordered, and it was clearly indicated what had to be provided to the participants.
- The intervention discussion was audio-recorded.
- Usage data were downloaded and tagged immediately.
- Backups of usage data and interviews were made regularly.
- An administrator was used for tracking and filing all the paperwork that was collected.
- Standardized templates were developed for personalized feedback to households.

After reflection on the lessons learnt during the Nova pre-feasibility study and the pilot study for the current study, the research design was finalised and a research procedure was developed. The research procedure included sampling, and the method in which data were collected and stored. Each phase of the research process is described in detail in the following sections.

Phase 1 included recruitment, experimental group allocation and installation of the monitoring equipment. The research sites, sampling of participants, use of the LSM, and monitoring equipment is presented as part of Phase 1. The second phase is presented in two parts: Part 1 explains the procedure and instruments used in an in-depth interview; and Part 2, the procedure and instruments used in quantitative data collection. Lastly, under Phase 3, the focus group instrument and procedure are discussed. As a result of the problems identified with the use of energy auditors in the pilot study, the researcher administered all measurements in Experimental Group 1 herself, while a research assistant was mainly responsible for Experimental Group 2.

4.4.3 Phase 1: Recruiting and allocating the research participants to the experimental groups

The procedure used to conduct sampling and field work is described in this section. The research sites, sampling method and use of the LSM of the research participants are highlighted. Thereafter the allocation of the research participants to experimental groups is discussed followed by a description of the measuring equipment that was installed in each household at the onset of the measurement period.

4.4.3.1 The research sites

The research sites were selected based on one of the aims of the study, namely understanding how low, middle and high income households strategize energy efficiency. The same three geographical locations, within a 20 km radius, in the east of Pretoria, as were used in the Nova study and the pilot study were selected. These locations were Mamelodi, Garsfontein and

Woodhill/Menlopark . The participating households in this study are identified by pins on a geographical map (see Figure 12).

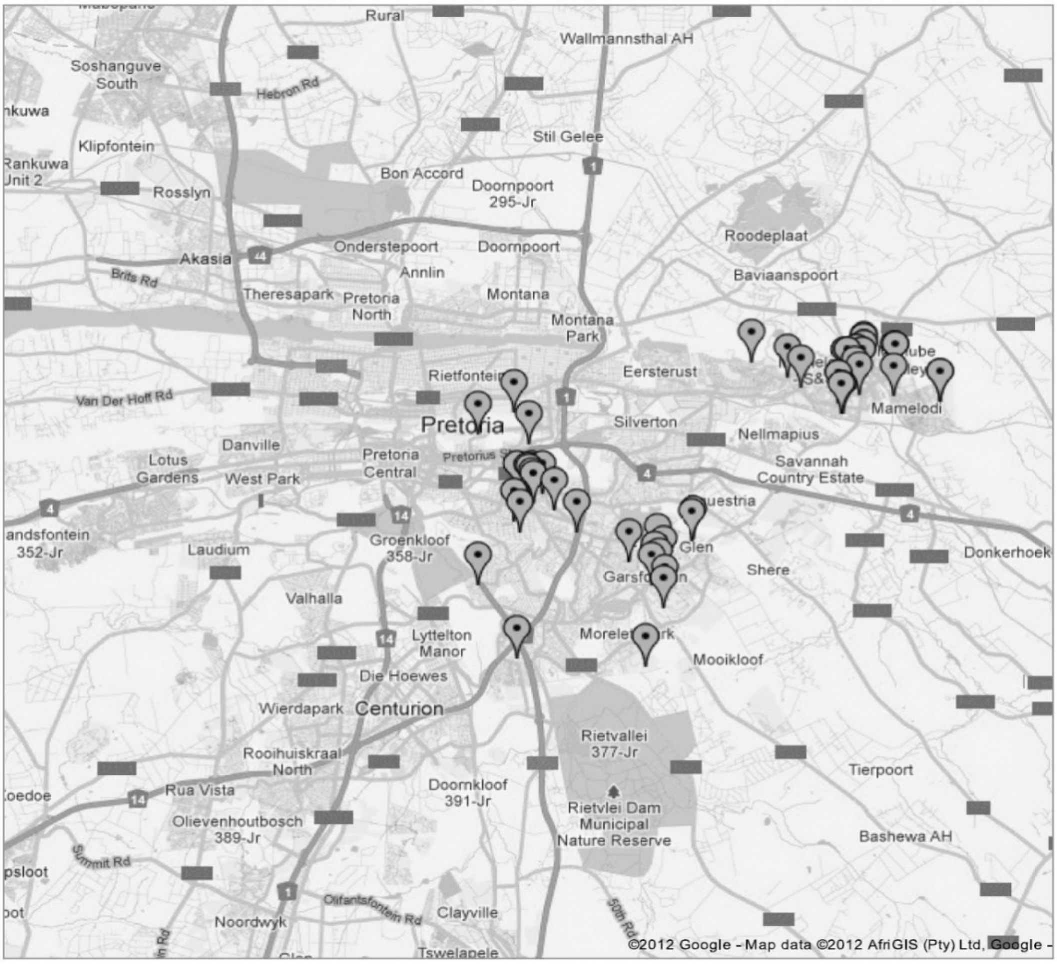

Figure 12 Geographical distribution of research participants

Research participants were recruited from three different geographic areas around Pretoria/Tshwane. However, instead of their geographical location, a standardized LSM was used in order to clearly classify the research participants. The LSM is discussed in detail in Section 4.4.3.3. In the following section, the sampling method is described.

4.4.3.2 Sampling of participants

Purposive sampling, a non-probability sampling method, was used to select the participants in this study. According to Leedy and Ormrod (2013), a purposive sample is chosen for the specific characteristics that the participants possess. Although purposive samples often result in biased data (Teddlie & Tashakkori, 2009), the exploratory nature of this study and the focus on understanding people's electricity use through collecting qualitative data did not necessitate a randomly selected sample.

As in the pilot study, the participants were recruited through existing social networks (such as churches, and community organizations) in each of the targeted geographic locations by means of an invitation (see Appendix A). The invitation contained information about the goal of the research, the research process, how to participate, the participation criteria and the researcher's contact details. Invitations were distributed by leaders in the various organizations located in the vicinity of the selected research sites. This included ministers and managers of civic organizations such as the YMCA, community centres, libraries and clinics.

Households indicated their willingness to participate by providing their contact details to the researcher on a list supplied by the researcher at the institutions where the invitations were distributed. Each household was free to nominate the individual who would participate in the research. The researcher contacted the households and ensured that the participant nominated met the following criteria for participation:

- participants had to be 18 years or older;
- participants had to have permanently resided in the area for at least three months prior to the audit;
- participants had to live in permanent houses supplied with electricity by the municipality;
- participants had to pay for their electricity use; and
- participants had to be willing to participate and signify such willingness by giving formal written consent.

It was acknowledged that if a particular person in a household volunteered his or her participation, the person was likely already to hold positive environmental attitudes, and the effect of this on the study could be questioned. However, possibly holding such an attitude did not necessarily mean that the attitudes led to environmentally responsible behaviour (Azjen, 1991; Costanzo et al., 1986; Du Preez, 2005; Glanz & Rimer, 2005). Moreover, this possibility might hold some advantages for the study, as Brandon and Lewis (1999) concluded their study by recommending that research on household energy efficiency should specifically target a sample of people with "behaviour potential for change" (p. 83), and that "feedback, coupled with practical conservation advice, can,…go some way to overcoming this situation if targeted at people who already hold positive environmental attitudes" (p. 84).

The fact that research participants volunteer may also be indicative of their readiness for change, as indicated in the stages of change by Prochaska et al. (1992) discussed in Section 2.7.2. Therefore, it was decided to invite people who were willing and positive toward participation in this study. Volunteers were visited at their homes, where they completed an informed consent form and an LSM questionnaire. The electricity monitoring equipment was subsequently installed in their homes. Each of these steps is discussed in more detail below.

4.4.3.3 Living standards measurement (LSM)

Lutzenhiser and Gossard's (2000) argument that living standard had a larger influence on electricity usage than the area in which one lives provided evidence in support of the argument for the use of the LSM. Lamb, Hair, McDaniel, Boshoff, and Terblanche (2008) describe the LSM segmentation tool developed by the South African Audience Research Foundation (SAARF) as a tool to measure social class, regardless of race, gender, age, income and education. The main purpose of using the LSM is two-fold: first, "to group people with similar living standards together" and, second, to "distinguish between the different groups of people in South Africa" (Jason, 2011, p. 38). The SAARF LSM was used in order to quantify the living standard of the research participants. The LSM has become a widely used marketing segmentation research tool in South Africa, dividing the population into LSM groups from 10 (highest living standard) to 1 (lowest living standard) (SAARF, 2012). Each household's LSM score is calculated by using 29 variables, summing the weights of the 29 variables for each participant, and adding the constant 0.81052 (SAARF, 2011), as indicated in Table 15.

Table 15

LSM group allocation table

LSM® Group	Total Weight		
1	Less than	-1.390140	
2	-1.390139	to	-1.242000
3	-1.242001	to	-1.011800
4	-1.011801	to	-0.691000
5	-0.691001	to	-0.278000
6	-0.278001	to	0.382000
7	0.381999	to	0.801000
7 - Low	0.381999	to	0.583000
7 - High	0.582999	to	0.801000
8	0.800999	to	1.169000
8 - Low	0.800999	to	0.977000
8 - High	0.976999	to	1.169000
9	1.168999	to	1.745000
9 - Low	1.168999	to	1.418000
9 - High	1.417999	to	1.745000
10	More than	1.744999	
10 - Low	1.744999	to	2.080000
10 - High	2.079999	and more	

Source: SAARF (2011, n.p.)

In general, the South African population is distributed very widely across the living standard range, with the highest percentage of people in LSM 6, as can be seen in Figure 13.

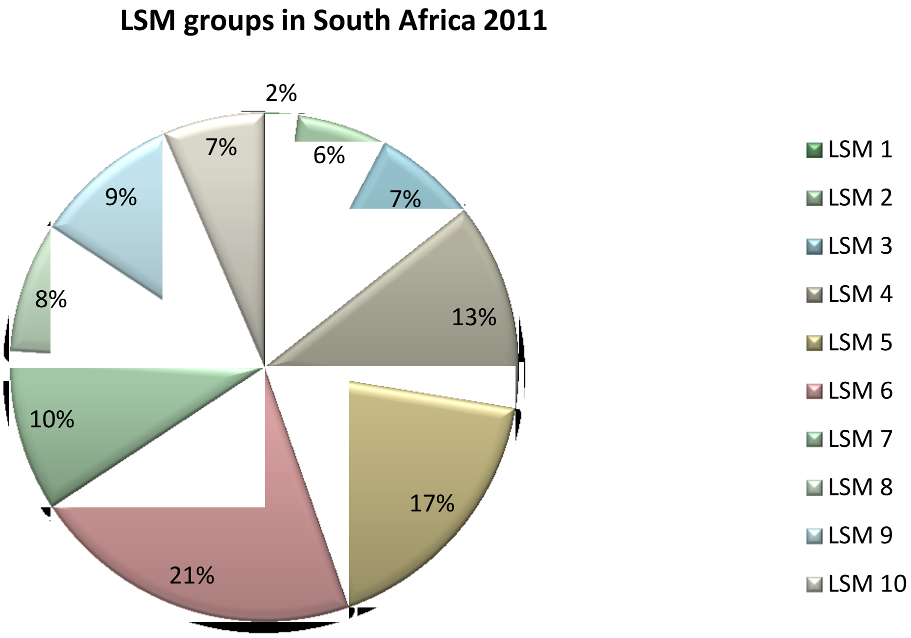

Figure 13 LSM groups in South Africa 2011
(SAARF, 2011)

Market-based descriptions of the groups in the general LSM classification system are presented in Table 16. Since the lowest LSM for the participants in this study was 6, only LSM 6 up to LSM 10 are described.

Table 16

Descriptions of LSM segments 6 to 10

LSM 6 -10 descriptions					
	LSM 6	LSM 7	LSM 8	LSM 9	LSM 10
Age	25-49	25-49	35+	35+	35+
Education	Up to Gr. 12 and higher	Matric or higher	Matric or higher	Matric or higher	Matric or higher
Rural/Urban	Larger urban	Urban	Urban	Urban	Urban
Income	R 6 322 average household income per month	R 9320 average household income per month	R 13 210 average household income per month	R 17 988 average household income per month	R 26706 average household income per month
Media (Radio, TV, print, internet)	Commercial: mainly ALS stations, community radio TV: SABC 1,2,3, e.tv, no internet, daily newspapers	Wide range commercial radio, SABC 1, 2, 3, etv, TopTV, All print, Internet	Wide range commercial radio, SABC 1, 2, 3, e.tv, DStv, TopTV, All print, Internet,	Wide range commercial radio, SABC 1, 2, 3, e.tv, DStv, TopTV, All print, Internet,	Wide range commercial radio, TV, DStv, All print, Internet,
Leisure activities	Take away in past 4 weeks, bake for pleasure	Outdoor activities	Cinema and outdoor activities	Cinema and outdoor activities	Cinema and outdoor activities
Access to banks	Limited bank accounts	Savings accounts	Cheque and savings accounts	Full access to banks and accounts	Full access to banks and accounts
Durables ownership	Electricity, water, flush toilet outside / communal, TV sets, hi-fi/radio set, stove, fridge	Ownership of DVD players and motor vehicles	Ownership of durables,	Ownership of durables,	Ownership of durables,
Participation in activities	Hire DVDs, go to night clubs, attend gatherings, buy lottery tickets	Participation in activities	Increased participation in activities	Increased participation in activities	Increased participation in activities

In this study, the lowest representative LSM score that was attained was 6. This was mainly due to the urban nature of the research sites, and a fairly high infrastructure requirement for electrified households. Households with LSMs below 6 are normally rural, do not have access to electricity in the home and do not have piped water in the home or yard. The racial distribution of the LSM has been discussed by Haupt (2011). He warns that the LSM may be a different way of talking about race. He indicates that:

> …initially LSMs did correlate highly with race, with most blacks falling into LSM 1 to 6, and the higher LSMs being multiracial. This, however, is because the LSMs reflect the reality of South Africa – they weren't created to obscure it, but to reflect it. (par. 2)

In this study, a similar trend was noted, with all the black participants falling in the lower LSMs and all the white participants (except two) falling in the higher LSMs. Once the LSMs of the participants had been established, the researcher divided the participants into two main groups according to their living standard. The households with LSM scores between 6 and 9 were grouped in order to prevent segregating the sample too much, and included 16 participants. The group consisting of LSM scores of 10 included 25 participants..Table 17 indicates the distribution of the participants based on their residential area and their LSM scores.

Table 17

LSM scores per geographic residential area

	Mamelodi	Garsfontein	Menlo Park	
LSM 6-9	14	1	1	**16**
LSM 10	0	14	11	**25**
	14	**15**	**12**	**41**

Two participants, one from Woodhill/Menlopark and the other from Garsfontein lived alone, one in an apartment and one in a rented garden cottage, and had a single income and fewer appliances, which consequently placed them in a lower LSM than the rest of the participants in the same geographical area. One of the limitations of this study is this demographic division of the sample. Suggestions in order to address this kind of problem are made in the discussion of limitations in Section 6.5. In the next section, the allocation of the participants into the experimental groups is discussed.

4.4.3.4 Experimental groups

Once the LSM score of each participating household was known, the sample could be assigned to the two experimental conditions of the study. The LSM grouping was used as the pre-existing characteristic (the ex post facto entity) in the combined ex post facto and experimental research design. Using the pool of participants that volunteered, the participants were randomly assigned to either Experimental Group 1 (n=19) or Experimental Group 2 (n=17), in order to ensure inclusion of both LSM groups in each of the experimental groups.

The sample size in the study was small (n=41) and the sample was divided into several sub-categories for the LSM, experimental group and season of measurement. Since winter provides a stronger reaction to the elements and exacerbates energy use circumstances in households (Littleford, Firth, & Ryley, 2012), assessments conducted during winter were specifically identified. These smaller groups held a number of implications for analysis and these are discussed in Section 4.8. Participants were not aware of their experimental group allocation. Table **Error! Reference source not found.**18 presents the distribution of the 41 households into the LSM and the experimental groups.

Initially, the sample included in this study consisted of 41 households. However, some of the households did not participate in all the data collection phases for various reasons (these are discussed where relevant). Each of the sections that contain the data from the different collection phases presents a demographic breakdown of the participants and households that participated in that particular phase.

Table 18

Experimental and LSM group allocation of participants

	Experimental Group 1	Experimental Group 2	Total per LSM group
LSM 6-9	9	7	**16**
LSM 10	10	15	**25**
Total per experimental group	**19**	**22**	41

Each of the participating households was allocated an audit number to be used on all documentation. This was done to ensure confidentiality during all stages of the research. Only the lead researcher had access to the list linking audit numbers with personal particulars of the research participants.

Following the random experimental group allocation and audit number assignment, an electricity monitor was installed in each of the households in both groups. This measuring instrument and the procedure followed are explained in detail in Phase 2, Part 2 (see Section 4.4.4) as it is part of the design of the experiment. In the next section, Phase 2, Part 1, the in-depth interview as a research instrument and the procedure employed to conduct the interview, are discussed.

4.4.4 Phase 2: Data collection in the combined experimental and ex post facto research design

As described in the overview of the research design, an embedded combined experimental and ex post facto design was used (Phase 2). First the embedded qualitative data collection by means of an in-depth interview is discussed (Phase 2, Part 1), followed by a description of the experimental design (Phase 2, Part 2).

4.4.4.1 Phase 2, Part 1: An embedded design (qualitative data collection)

The in-depth interview served as the embedded qualitative design section of this research. In this section, the instrument for data collection and the procedure followed to collect the data are discussed.

- *The instrument: the in-depth interview guide*

The use of in-depth interviews gave the researcher an opportunity to come to understand the participants' context and environment and ascertain whether these of the participants that could have an impact on the planned intervention. This is especially suitable when "applying interventions in real-life situations" (Creswell & Plano Clark, 2011, p. 192) as is done in this study. It allowed the researcher to document the need for the intervention (as described by Creswell & Plano Clark, 2011) and compile a comprehensive description of the context before the intervention took place. Miles and Huberman (1994) comment on the usefulness of qualitative methods such as interviews to explore phenomena:

> Qualitative data, with their emphasis on people's 'lived experience', are fundamentally well suited for locating the meanings people place on the events, processes, and structures of their lives; their 'perceptions, assumptions, prejudgements, presuppositions' and for connecting these meanings to the social world around them (p. 10).

In-depth interviews as a research method are particularly effective when a researcher has some idea about the area of interest and pursues specific questions (Smith, 1998), but would prefer the open-ended opportunities to explore a phenomenon that an interview affords. In the current study, the use of in-depth interviews also allowed the researcher to probe areas that she believed to be of particular interest and that built on the broad ideas gathered during the literature review. As previously mentioned, while a fair body of research on specific aspects of the use of household electricity is available, few studies concurrently investigate both the actual consumption of electricity and the psychological mechanisms underlying changes in people's behaviour (if such changes occur at all). Smith (1998) comments that with the use of flexible interviews, the "psychological and social world of the respondent" (p. 12) becomes visible to a researcher.

In line with the TPB (Ajzen, 1991), the interview guide explores participants' attitude toward the environment, their perceived behavioural control and the subjective norms they hold. The interview guide (see Appendix C) was designed to explore participants' motivation(s) for participation in an energy efficiency study, current practices in the household that support sustainability, their beliefs around global climate change, their feelings and thoughts around the natural environment, the impact that their families might have on new energy efficiency practices in the home, their perceptions of the social environment in which they operate, the impact of the local municipality and government on electricity consumption, and past and/or present experiences of using electricity more efficiently. This is in line with an ecological approach (Bronfenbrenner, 1977, 1995), which investigates various levels of interaction between people and their social environment. The interviews explored not only a participant's point of view on global climate change and general environmental action, but also focused on the person's concepts of the self and world view, the interactions of the person with his or her family, the family's possible reaction to changes, and the strategies for reducing electricity use already in place in the household. The last question was included because the researcher had to assume the possibility that some participants had already implemented energy efficiency measures in their homes. In the next subsection, the procedure followed during the interviews is described.

- *The procedure: the in-depth interview*

An interview was conducted with each of the 19 participants in Experimental Group 1. One recording failed due to technical problems and thus 18 recorded interviews are reported on. These interviews were conducted at the end of the baseline week, when the researcher visited the household of the participant, to reveal the electricity meter readings and administer the intervention. Each interviewee signed a consent form (see details of the ethical procedures in Section 4.6).

The interviews were conducted in either English or Afrikaans, and were digitally recorded for transcription purposes. Each interview lasted between 20 and 45 minutes. The first language of some research participants in Mamelodi was neither English nor Afrikaans. Therefore, an interpreter was used in the initial contact with the participants from Mamelodi, and thereafter, if so requested by the research participants, during the subsequent contact. The interpreter was trained in explaining the participation information sheet and consent forms (see Appendix B) clearly to research participants.

In this section, the in-depth interview as a research instrument and the procedure followed to collect the research data have been explained. In the next section, the same is done for the instruments used in the combined experimental and ex post facto experiment.

4.4.4.2 Phase 2, Part 2: A combined ex post facto and experimental research design (quantitative data collection)

Quantitative data collection in this study was done by means of two measurement tools. The first was an inventory list enquiring specifically about the household content and the physical appliances inside the house, and the second was the actual metering data collected from each household by means of the Efergy E2 electricity monitoring tool. The measurement tools and the procedures in collecting data using these instruments are discussed below. The two interventions (as presented to Experimental Groups 1 and 2 respectively) are also discussed in this section.

- *The household inventory: instrument and procedure*

As with the study conducted by Brandon and Lewis (1999), a household inventory was used to assist the researcher in determining the number of appliances inside the household. This inventory was constructed during the pre-feasibility study in collaboration with the Nova Institute and Imtech. The inventory consists of a meticulous audit of the appliances and amenities both inside and outside the participating homes, as well as demographic descriptions of each research participant and some aspects about the household as a whole. It assisted the researcher to understand the context of the household and enabled personalized feedback on the electricity consumption of the household. The demographic information included data on

- the participant's age;
- the participant's gender;
- the participant's level of education; and
- the number of adults and children in the house.

The following details on characteristics that usually influence a households' electricity consumption (in line with the literature) were also recorded:

- the estimated number of square metres of the home (in order to establish the kWh consumption per square meter. This is in line with the South African National Standard SANS 1544:2014);
- room counts for living rooms, bedrooms and bathrooms;
- appliance counts (specifying older ones, in other words, appliances purchased before 2005);
- the number of household water heaters (geysers); and
- energy efficiency measures already in place (CFLs in each room, geyser blankets, lower geyser temperatures, use of timers and motion sensors on outside lights etc.).

Please refer to Appendix D for the inventory list that was used.

The procedure that was followed to collect the data using the household inventory was as follows: during the first interaction with the research participants, they were requested to complete the household inventory with the researcher's help. Due to the sensitive nature of the questions (the contents of the entire house was declared), the allocated audit number was used as a document identifier, and the researcher reassured the research participants of the confidential use of their information. The household inventory was filed, along with the signed consent forms, and is kept in a safe.

- *The electricity monitor: instrument and procedure*

An electricity consumption measurement was done in each household, using the Efergy E2 monitor (www.efergy.com) depicted in Figure 14.

Figure 14 Efergy E2 monitor

This monitor enables a detailed recording of a household's electricity consumption data. A monitor was installed in each household at the first meeting with the research participant concerned. This instrument was selected due to the following characteristics:

- the relative ease of installation;
- cost effectiveness (the monitors retailed at around R 1000 per unit in 2010);
- ease of use;
- aesthetic appeal;
- ability to provide real-time feedback for the whole household's use; and
- ability to capture and store data for up to a year with hourly averages being logged into a user-friendly Excel sheet when downloaded.

The procedure used to install the Efergy E2 energy monitor is described below.

The researcher was trained by an electrical engineer (associated with the Nova Institute) on the installation process. Due to the non-invasive character of the monitor, no certification was required for installation. The monitor was installed by the researcher in each household at the start of the three-week measurement period. The installation involves linking a current transducer (CT) on the main feed-in cable into the household from the main distribution box to send consumption data to the wireless monitor (pictured in Figure 14) and provide real-time feedback on the household's electricity consumption. During the first week, a baseline was created by placing the monitor in a sealed A5 envelope, hiding the feedback from the participants' view.

After one week of baseline measurement, the researcher returned to each participant's home and administered the intervention, as described in Section 4.4.4.3, depending on the household's allocation to either Experimental Group 1 or Experimental Group 2. In all the households, the monitor was opened to view. Participants were requested to place the monitor in a conspicuous location (such as the kitchen) and encouraged to explore the real-time feedback that was made available to the research participant. This real-time feedback meant that the participant and members of the household were able to see on the electricity monitor's display when an appliance was switched on, and how much electricity it used, with a maximum of a five-second delay. The data logged by the E2 monitor were summarized in an hourly average for each hour of the day, and for each day during measurement from the date of installation.

Upon completion of Phase 2 of the study, the E2 monitors were removed from the households and data were downloaded from the E2 monitor onto the researcher's computer via USB. The data were saved in the form of an Excel spreadsheet. Each participant had his or her own monitor and consequently his or her own spreadsheet, indicating the individual households' electricity consumption over the measurement period. This formed the basis of the quantitative data used in Phase 2, Part 2.

In the next section the different interventions used in Experimental Groups 1 and 2 are described in detail.

4.4.4.3 Intervention

In this section, the intervention as an instrument of manipulation and the procedure for applying the intervention in each of the experimental groups is discussed. As part of any experiment, a manipulation is introduced in order to ascertain its impact on behaviour (Leedy & Ormrod, 2013). Although both Experimental Groups 1 and 2 received an intervention, the intervention in Experimental Group 1 differed significantly from the one administered in Experimental Group 2. Both experimental groups received the same real-time feedback on electricity consumption, but the purpose of the intervention (in Experimental Group 1 in particular) was to encourage and maximize residential energy conservation.

- *Development of the intervention*

The intervention in Experimental Group 1 combined best practice intervention strategies reported in the behaviour change literature, as discussed in Chapter 3, and based on theories discussed in Chapter 2. The evidence base for these best practice strategies presented in Table 19, was discussed in section 3.4.1.1.

Table 19

Best practice interventions combined in this study

Best practice strategy	Source
Sampling people who already held a positive environmental attitude	Brandon & Lewis (1999)
Doing an energy audit in the home of the participants	McMakin et al. (2002); Winett et al. (1982-83)
Providing real-time continuous feedback about electricity usage (by means of an electricity monitor with high visibility);	Bittle et al. (1979-80); Hayes & Cone (1981); Hutton et al. (1986); McCally & Midden (2002); Seligman & Darley (1977); Völlink & Meertens (1999)
Providing information on electricity consumption norms per appliance (provided for South Africa by Eskom)	Abrahamse et al. (2005); Geller (2002); Staats et al. (1996)
A walk-through of the house identifying possible areas where savings could be made, i.e. particularization	Brandon & Lewis (1999)
Doing a goal-setting exercise for saving electricity	Becker (1978); McCalley & Midden (2002)
Signing a personal commitment to save at least 10% electricity (as that is what is required by the national energy regulator in order to avoid load-shedding)	Katzev & Johnson (1983); Katzev & Pardini, (1987-88); Pallak & Cummings (1976); Wang & Katzev (1990);
Requesting continued note-keeping for possible reasons of electricity increases by means of a data logging sheet	Reid, Hurter, & Sutton (2009)

These best practice interventions have been proven to be effective to some extent in limiting electricity consumption. In short, the intervention consists of the particularization of information, real-time feedback, goal setting, and commitment-making. In the following section, each of these aspects are briefly discussed and linked to the attitude behaviour theories, indicating the reasons why they are successful.

Sampling people who already hold positive attitude: According to Ajzen (1991), attitude is an important factor that would lead to behavioural intention. From the empowerment spiral (Mehlmann et al., 2010), a level of environmental concern (have a caring attitude toward the environment) would influence a consequent search for information.

Particularization of information: The perception of behavioural control leads to behavioural intention and ultimately also changes in behaviour (Ajzen, 1991). Particularized information in the form of an energy audit in the home of the participant will not only give information but would enable decision-making, remove barriers of misinformation and improve perceived ability to deal with the situation at hand.

Feedback: Real-time continuous feedback is effective in strengthening the link between electricity curtailment behaviour and its impact on kWh consumption (Abrahamse et al., 2005). Feedback might be effective because it emphasises awareness of the effect of habitual behaviour on energy consumption (Fischer, 2008). This is described by Prochaska et al. (1992) as the consciousness-raising or environmental re-evaluation stages of change.

Goal-setting: McCalley and Midden (2002) however states that a goal without feedback is useless and feedback without a goal is not sensible. This is because the goal gives a standard for a person to judge the feedback and determine whether he is doing well or not. The effectiveness of the feedback can only be assessed when you understand the goal. It was therefore imperative to include a goal-setting exercise that would guide the research participants' understanding of the feedback.

Commitment-making: Commitment-making encourages participants to state their intentions outright. Lockhorst et al (2013) states that "when people commit to certain behaviour, they adhere to their commitment, and this produces long term behaviour change" (p. 3). This is because commitment-making work on both the cognitive attitudinal approach and the normative approach. The cognitive attitudinal approach deals with cognitive dissonance. Festinger (1957) describes cognitive dissonance as the negative state that people experience whenever they hold ideas or attitudes that are not psychologically consistent. After stating their commitment outright, they re-align their attitude in order to 'fit' with their behaviour and avoid the dissonance between their attitude and behaviour. The normative approach forces the change in behaviour due to the public statement of a commitment and the resulting appraisal by others. The commitment statement strengthens the social norm which in turn influences behavioural intention (Ajzen, 1991). Both the cognitive attitudinal approach and the normative approach lead to positive changes in energy efficiency (Lokhorst et al., 2013).

The final intervention used these strategies in order to assist participants in achieving the best potential electricity consumption savings possible. In the next subsection, the procedure for the administration of the interventions in both Experimental Groups 1 and 2 are described in detail.

- *The procedure followed during implementation of the intervention*

As described in Phase 1 of this research design, the participants in Experimental Groups 1 and 2 were randomly allocated to each group. This enabled the researcher to assume that both groups were similar with regard to their environmental concern and current electricity consumption patterns at the start of this experiment. The intervention administered in

Experimental Group 1 aimed particularly at involving the participant in every step of the energy audit (describing, explaining, personalizing and answering questions of research participants) while in Experimental Group 2 only information was provided to the participants (with as little interaction as possible). The interaction between the researcher and these two groups is summarised in Table 20.

Table 20

Interventions in Experimental Groups 1 and 2

	Intervention in Experimental group 1 (interactive intervention)	**Intervention in Experimental Group 2 (limited intervention)**
	Activity	**Activity**
1	Sign consent forms, collect data for LSM and household inventory	Sign consent forms, collect data for LSM and household inventory
2	Interview about environmental attitudes, motivations and barriers experienced	No interview
3	Describe functioning of electricity monitor that provides real-time visible feedback (monetary, kWh use and kg/CO_2 use)	Describe functioning of electricity monitor that provides real-time visible feedback (monetary, kWh use and kg/CO_2 use)
4	Describe data logging sheets (detailed description and encouragement to complete)	No description, provide participant with data logging sheets
5	Do residential walk-through and provide personalized advice	No residential walk-through
6	Give participant general residential advice pamphlet and discuss it with participant	No discussion, provide participant with general residential advice pamphlet
7	Provide specific tailored advice to enable achievement of goal	No specific advice
8	Request a signed commitment to reduce electricity consumption by 10% in the following two weeks	No commitment
9	Encourage completion of data logging sheets	No encouragement
10	Remove electricity monitor after another two weeks	Remove electricity monitor after another two weeks

The data logging sheets provided an opportunity for the research participants to monitor their own electricity consumption qualitatively and quantitatively during the measurement period, as suggested by Reid et al. (2009). An example of the logging sheet can be found in Appendix D. At the start of the second week (after completion of the baseline measurement), the researcher logged the daily kWh averages of the baseline measurement week together with the participant on the data logging sheet, and enquired about any unusual circumstances that might have led to increased electricity use. Thereafter, the researcher showed the participant how to do this him- or herself and requested that he or she continue doing this for the next two weeks, noting any qualitative descriptions of exceptional or even routine increases in electricity. These logging sheets were also provided to the participants in Experimental Group 2. The qualitative notes made by the participants in both of the groups on the data logging sheets proved useful in understanding the quantitative electricity consumption figures. These notes are described in Section 5.4.4.

4.4.4.4 Conclusion of Phase 2

Upon conclusion of Phase 2, several forms of data had been collected. Table 21 presents the forms of data collected for each group at the close of Phase 2.

Table 21
Data available for each experimental group

Forms of data	Experimental Group 1	Experimental Group 2
LSM	X	X
Household inventory	X	X
Recorded interview	X	
Hourly electricity readings for at least three weeks	X	X
Signed commitment to save electricity	X	
Data logging sheets	X	X

The electricity consumption data were used to write a small report to each participating household (regardless of whether it had been allocated to Experimental Group 1 or 2), indicating where the household could possibly improve, and highlighting the changes in electricity consumption during the three-week measurement period. These reports were delivered to each of the households within two to three weeks of removing the electricity monitors from the homes. This concluded Phase 2 of the research.

The final phase of interaction with the participants in this study entailed holding focus group sessions with participants after removing the electricity monitors from their homes. This sequential qualitative data collection phase is discussed in the next section.

4.4.5 Phase 3: Sequential qualitative collection – focus groups

At the completion of Phase 2, as described above, a follow-up qualitative data collection opportunity was included (as a sequential QUAL assessment, Phase 3), in response to a recommendation by Abrahamse et al. (2005) to gain insights on why interventions are successful or not. Creswell and Plano Clark (2011) highlight the benefits of the inclusion of such a qualitative data collection opportunity following an experiment. They state that it can help a researcher to

- understand how participants viewed the interaction and intervention during the experiment;
- receive feedback about the intervention;
- explain irregularities in the recorded data;
- determine any long-term effects of the intervention; and
- understand how participants applied knowledge following the experiment.

Brandon and Lewis (1999) indicate in their research on household energy efficiency in the UK that focus group discussions provided the richest data on “participants’ own accounts of their behaviour and what might encourage changes in the household consumption” (p. 82). Focus group discussions were thus used to collect qualitative data, and aimed to explore and improve understanding of the aftermath of the intervention by using the interactive nature of the focus group discussion. Fontana and Frey (1994) suggest that focus group participants provide each other with memories of an event and subsequently spark enthusiastic discussions on the aftermath. A discussion guide was developed to increase the depth of questions used during the pilot project by systematically structuring the discussion in line with Bronfenbrenner’s ecological approach. This allowed for an in-depth exploration of the impact of energy efficiency on each of the ecological levels. (The guide is available in Appendix C.) The procedure used for focus group data collection during Phase 3 of the research design is described below.

4.4.5.1 Focus groups: Procedure

According to Hyden and Bulow (2003), some problems may occur with interaction in a focus group. The first problem could be that participants need to “establish a common ground” (p.305) and feel at ease enough to add their contributions to the discussion. Second, Babbie and Mouton (2001) warn that “the more heterogeneous your group is, the more groups you will need to have in order to separate idiosyncratic individual characteristics from data” (p. 293). In order to put the research participants at ease, they must be enabled to establish common ground and add their contributions freely; in this case, participants were invited back to the venues where they were originally invited to participate in the research in an attempt to create a homogeneous group. Kitzinger and Barbour (1999) note that in focus groups, collecting rich data is only possible when participants feel comfortable interacting within the focus group setting.

It was not assumed that participants from each site are necessarily homogeneous; however, as participants from the different sites reside in similar geographic areas, they may face similar challenges in terms of municipal supply of electricity and other services, and also find themselves in similar socio-economic groups. It was assumed that the issues affecting energy use and how people think about it in these areas may be shaped to some extent by aspects that are geographically specific due to South Africa, where socio-economic differences are often found to be associated with place of residence.

The qualitative focus group discussions were held between four and six months after the completion of the energy audit in each home, once their round (either winter or summer) was concluded, in other words, there were. six planned focus group sessions, two (one in summer, one in winter) in each of the three geographical locations. Invitations were sent out at least two weeks before the planned focus group sessions. Despite reminders being sent one week and again two days before the planned meetings, the attendance at the focus groups was rather poor, and in total only five group sessions were held (one of the planned focus groups repeatedly failed to attract any participants). Group sessions were held at a suitable venue in the vicinity of the participants' homes. In Mamelodi, this was the public library, in Garsfontein, a local church boardroom, and for Woodhill/Menlopark, the University of Pretoria's Department of Psychology boardroom. Each focus group discussion was audiorecorded, and manual notes were taken by assistants during the discussions. The recordings were transcribed; this process is described in detail in Section 4.5.

Consequently, the data collected during Phases 1 to 3 were analysed. In the next section, the process of analysis in each phase is discussed in more detail, enabling the reader to judge the accuracy of the interpretations in later chapters.

4.5 The process of analysis

Bateson (1979) describes analysis as an elaboration of the interactions in the field, done by bringing the studied phenomena under the magnifying glass. In this section, the process of analysing the collected data is discussed using the same phases discussed in the research design.

The analysis of the data collected in Phase 1 is not discussed in this section, as the data relate to the demographics of the participants which are presented in Chapter 5. In this section, the methods of analysis of the interview data (qualitative) (Phase 2, Part 1), the electricity consumption data (quantitative) (Phase 2, Part 2) and the focus group discussions (qualitative) (Phase 3) are discussed in detail. An additional phase is added in the analysis stage, where both the quantitative and qualitative data are analysed together (mixed analysis), presented as Phase 4.

4.5.1 Phase 2, Part 1 and Phase 3 – Analysis of qualitative data

The qualitative data analysis from Phase 2, Part 1 and Phase 3 are discussed together in this section, due to the similarity of the method used. The transcription and translation of the interviews and focus groups are discussed, followed by a description of the thematic analysis using Atlas.ti ver 7.

4.5.1.1 Transcription and translation of the qualitative data

Bateson (1972) notes that the first transcript of an interaction is in itself already an interpretation, reflecting that “no data are truly “raw”, and pointing out that every record is subjected to some “editing and transformation” (p. xviii). As previously mentioned, both the interviews and the focus group discussions were conducted in either Afrikaans or English, depending on the preferences of the research participants. This posed a very particular challenge during analysis. Although the researcher is bilingual and comfortable in both languages (Afrikaans is her first language), the analysis needed to be presented in such a way as to be transparent and suitable for an international audience. Wong and Poon (2010) encourage an open discussion on translation and argue that only by making “translation visible and through open dialogue can researchers uncover the richness embedded in the research data and facilitate multiple ways of knowing” (p. 151).

Valid and reliable representation of the data protects participants from a misinterpretation of their words and allows the researcher to produce transcriptions that are as “faithful to the original” (Gibbs, 2007, p. 102) as possible. Therefore, the qualitative research recordings (interviews and the focus group discussions) were transcribed verbatim (and in their original language). Analysis was done using these transcripts. The coding process, however, was done in only English which encouraged the researcher to define themes carefully in English, whether the original transcript was in English or Afrikaans.

Braun and Clarke (2006) indicate that thematic analysis “does not require the same level of detail in the transcript as conversation, discourse or even narrative analysis” (p. 17), therefore a simple verbatim account of the verbal utterances was used. Lapadat and Lindsay (1999) recognise transcription as the first interpretive act of analysis; using the original language of the participant allowed the researcher to remain “close to the data” (Henning, Van Rensburg, & Smit, 2004, p. 7) and eliminate additional interpretation that might have occurred if the data were translated prior to the initial coding process (Wong & Poon, 2010).

Although the Afrikaans interviews were used for analysis purposes, in the presentation of the findings, the researcher translated the Afrikaans transcripts into English to allow readers access all the interview and focus group data. For ease of reading, only the English translations of the direct quotations from the interviews and focus groups that were conducted in Afrikaans are provided when the data are presented in Chapter 5. The transcripts of the interviews and focus groups were analysed by using a computer-assisted qualitative data analysis system (CAQDAS), Atlas.ti (ver. 6 and later 7). A description of the process of analysis using Atlas.ti is given in the next section.

4.5.1.2 Thematic analysis using Atlas.ti

In this section, the epistemological fit with the chosen method of analysis is discussed, followed by a description of the process of analysis. The first steps were to get to know the datasets, as recommended by Schilling (2006), generating initial codes, and thereafter grouping, refining and naming themes and conceptually linking the themes to the literature. This process of analysis is described in the next section.

Braun and Clarke's (2006) method of thematic analysis was used to analyse the transcribed interviews. They describe thematic analysis as

> …a method for identifying, analysing, and reporting patterns (themes) within data. It minimally organises and describes your data set in (rich) detail during the first stage of content analysis and coding. However, it also often goes further than this, and interprets various aspects of the research topic. (p. 6)

In order to manage large data sets, Lewins and Silver (2009) argue for the use of qualitative data analysis packages because they "provide almost instantaneous access to all source data files" and "'live' contact to source data is always easy, which increases the researcher's closeness to data" (p. 4). Below, the fit between the chosen epistemology and the selected method of analysis is explored and discussed.

- *Epistemological fit*

In line with the epistemological argument that phenomena need to be assessed in the system in which they occur (real-world) (discussed in Chapter 2), the researcher needed to conceptualise the codes in some way, moving away from the detail of the codes and "re-focusing the analysis at the broader level of themes" (Braun & Clarke, 2006, p. 19). This was done using the process of thematic analysis described by Braun and Clarke (2006). This process is indicated in Table 22 and its specific application in this study, using Atlas.ti, is described in the subsequent sections.

Table 22

Phases of thematic analysis

Phase	Description of the process
Familiarise yourself with the data	Transcribing the data (if necessary), reading and re-reading the data, noting down initial ideas
Generating initial codes (content analysis)	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code
Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme
Reviewing the themes	Checking in the themes work in relation to the coded extracts (level1) and the entire data set (level 2), generating a thematic 'map' of the analysis
Defining and naming themes	On-going analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme
Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of the

	selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis

Source: Braun and Clarke (2006, p. 35)

In the paragraphs that follow, the description of the process of identifying codes through content analysis, and forming themes, allows the reader insight into how the themes emerged and how they were identified. This heeds the warning by Attride-Stirling (2001) that forsaking the description of analysis may alienate a reader and dilute the impact and trustworthiness of the qualitative findings.

- *Familiarisation with the data and generation of the initial codes*

Methods to familiarise oneself with the data include transcribing the data (discussed in section 4.5.1.1), reading and re-reading the data, and initial coding. Initial coding is aimed at generating as many categories as possible, reflecting the "creative, exploratory character of the process" (Boutlon & Hammersley, 2006, p. 252), and producing a systematic and comprehensive summary of a whole data set (Wilkinson, 2011), providing insight into instances of recurring data (Gibbs, 2007), and systematically identifying these instances (Braun & Clarke, 2006). The "participant's utterances" (Wilkinson, 2011, p. 170) are used as the initial unit of analysis (codes); however, later, themes take precedence.

Open coding was used to label the initial sections of conversation-texts that appeared to belong together. Gibbs (2007) describes open coding as a process "where you examine the text by making comparisons and asking questions" (p. 50), trying to avoid labels that are mere descriptions of the text. Using Atlas.ti, the codes were grouped together and highlighted, allowing the researcher to manage numerous documents easily and systematically work through them, organizing thoughts and ideas. The outcome of the coding process is highlighted texts throughout the primary documents that are tagged and grouped into different codes. Each code is defined by the researcher. In this analysis, the researcher looked for:

- meaningful concepts in
    - actions described by the interviewees,
    - expressions of perceptions/concepts/beliefs,
    - specific answers to the research questions, and
    - mentions of aspects not introduced by the researcher;
- flow in the conversation, labelling as the conversation progressed;
- re-reading the open coding codes (155 for the interviews, 117 for the focus groups), re-defining and placing them into context with one another, and finally re-defining them.

In addition to easing the initial exploration of the data, Atlas.ti allowed for closeness to the data, the ability to code data freely, and to both organize and interrogate the coded data effortlessly. Gibbs (2007) points out that CAQDAS programmes allow a rich display of the text, enabling the construction of code lists and retrieval of coded text, allowing the researcher to see the text in context and memos to be written while coding is done. The analysis was therefore data-driven, focusing on what was actually in front of the researcher, instead of merely looking for specific theoretical themes identified during the literature review (Braun & Clarke, 2006).

Although the literature had already been reviewed prior to data collection, and the researcher was well aware that the issues raised in the literature might come up, she attempted to remain data-driven during the coding process, as recommended by Charmaz (2003, 2006). A researcher is always personally invested in the generation of each code and theme by means of interpretation, as Schmidt (2004) points out; however, this does not detract from the attempt to remain close to the data and understand the expressed meaning of the research participants.

The number of times a code was mentioned by participants is indicated in Section 5.3.3 (interviews) and Section 5.5.2 (focus groups) where the findings are discussed. Once coding was complete, as suggested by Taylor and Ussher (2001), "the data were examined for differences and commonalities both within and across code categories. In this way…the underlying systems of meaning, could be made apparent" (p. 297). These findings are presented in the mixed analysis, Phase 4.

The data analysis audit trail is packaged in the form of Atlas.ti ver 7 outputs, and is included in Appendix G and H allowing the reader an opportunity to peruse the audit trail, including each code with its definitions and the reflections of the researcher, as recommended by Archer (2012). The codes were subsequently grouped into "families" or themes (also defined by the researcher), where the codes refer to similar issues. During theme generation, however, a different approach was taken, where the process of generating, reviewing and naming the themes is described in detail.

- *Generating, reviewing and naming the themes*

Following on from the initial stage of the thematic analysis in which interview and focus group data were coded, themes were identified by grouping the identified codes together. Braun and Clarke (2006) state that this step "minimally organises and describes your data set in (rich) detail" (p. 6). Braun and Clarke suggest clarifying the decision about what constitutes a theme. In this research, a theme is not characterised by the number of people who articulate a specific aspect. Instead, the codes generated by the researcher are grouped together on issues highlighted by the research participants, and aspects on which they expressed strong emotions (for example, feelings of being powerless).

Using the codes already identified during the initial stage of thematic analysis using open coding, the thematic analysis involved searching for themes, followed by a review of these themes in order to make sure that they were correctly allocated, and represent the views of the research participants accurately. Defining and naming the themes is a process in which the "essence" (Braun & Clarke, 2006, p. 14) of themes is captured, providing the research with a thicker description of the data and a platform for exploring and understanding the interconnectedness of the codes. As with the codes, the identified themes were defined and are available in Appendix G (interviews) and H (focus groups). The themes are described in detail in Sections 5.3.3 and 5.5.3 respectively.

Eleven themes were identified in Phase 2, Part 1. Most of them (with the exception of two) were latently coded and focused on the "underlying ideas, assumptions, and conceptualisation" (Braun & Clarke, 2006, p. 13). However, two of the 11 themes specifically grouped together particular actions in response to direct interview questions. These were coded with a semantic approach, where the researcher did not look for anything "beyond what the participant has said" (p.13) and forsaking interpretation. These are Phase 2, Part 1, Theme 2: Behaviour changes, and Theme 11: Strategies for change.

In some instances, the same codes are described as part of more than one theme. Codes were occasionally included in two themes, and they were not necessarily categorised in such a way as to keep codes that constitute a theme mutually exclusive. The conceptualisation of the themes is discussed in more detail below.

- *Conceptualisation of the themes*

Placing the themes back into the context of the research participant by exploring the interconnectedness between themes, the literature and the "wider-world" setting (Holliday, 2007, p. 80) is important for highlighting the systemic nature of energy efficiency in a residential setting. A thick description requires a more intense scrutiny of the data, exposing the codes that are obvious on the "surface" of the interview, and also looking for "interconnected meanings" (Holliday, 2007, p. 77). Braun and Clarke (2006) indicate that synthesis is the "final opportunity for analysis", where "vivid, compelling extract examples" are used to relate the analysis back to the "research question and literature, producing a scholarly report of the analysis" (p. 35). Themes were therefore tied into one another in order to reach an understanding of the system interaction between them. The extrapolation of the themes is presented in Chapter 5 and the synthesis and conceptual discussion, and they are related to the recent literature in Chapter 6.

In the next section, the analysis of the quantitative data is described.

4.5.2 Phase 2, Part 2 – Analysis of quantitative data

In this section, the analysis of the quantitative data is described. A total of 36 quantitative datasets were analysed. This consisted of 19 participants from Experimental Group 1 and 17 participants from Experimental Group 2. In Experimental Group 2 there was a loss of five participants from the original experimental group allocation (22), as indicated in Table 18. Of these five, three monitors were lost (with participants becoming unreachable after installation) and two monitors were retrieved, however problems with the data recordings occurred.

The ways in which data were prepared for analysis (the coding process) are discussed in this section, allowing insight into the ways in which the findings discussed in Chapter 5 were reached. The use of historical data is discussed and the non-parametric methods used to analyse the quantitative data are discussed in detail in Section 5.4.2. The coding process, including the calculation of the LSM and coding of household inventory, is discussed, followed by a description of the way in which the electricity consumption data were analysed.

4.5.2.1 Preparation for analysis

The collected quantitative data were captured into an Excel spread sheet. This included

- an audit number, group allocation and demographics variables;
- the LSM scores;
- the household inventory data; and
- the electricity consumption data averages per week for each household.

The characteristics of each household was coded horizontally, using the audit number as the primary identifier of the participant. The LSM was calculated in line with the method described in Section 4.4.3.3 of this chapter. Research participants were allocated to either LSM Groups 6 to 9 or LSM Group 10 (including -10 and +10 sub-segments). In total, 96 other variables from the household inventory were coded. The coding sheet contained a summary of weekly averages for electricity consumption. This coded datasheet is available in Appendix I.

In the next section, the available historical baseline data, how they were used and a justification for the chosen course of action is presented. The actual historical baseline data are discussed in Section 5.4.3.

4.5.2.2 Historical baseline data

Historical baseline data were made available to the Nova Institute by the City of Tshwane municipality and were used in this research with permission of the Nova Institute. The data consist of a monthly average of electricity consumption for the three geographical areas (Mamelodi, Garsfontein and Woodhill/Menlopark) included in the Nova pre-feasibility and pilot studies. The data are from October 2007 until August 2009 for all three areas.

Due to year-to-year variability and the fact that there was no overlap between the historical baseline data and the data for the actual year in which data were collected (2011), the historical baseline data could only be used to create a context and place the average electricity use of the households in this study in perspective. It allowed the researcher to explore the impact of the seasons on electricity consumption in households in the three geographical areas. The historical baseline data are presented in terms of geographical areas, rather than the LSM, since the LSM value for the participants in the historical baseline is not known.

The methods that were used to transform the collected and coded quantitative data into figures that accurately describe the phenomena incurred are described in the next section, in conjunction with a justification for the chosen course of action in analysing the data.

4.5.2.3 Non-parametric statistics

The quantitative sample size in the study was small (n=36), and the subsequent subdivisions (indicated in Table 23) led to samples too small to present a normal distribution. As a result of the smaller sample sizes and to confirm the suspected need to use non-parametric statistics, SPSS (IBM Corporation, 2011) was used to test the data for normality.

Table 23

Sub populations and number of participants (Exp n=19, Exp 2 n=17)

Pre-existing characteristic (Living standard)		**Investigation period**	**Season**
Group 1	LSM 6-9 (n=13)	LSM 6-9 Exp 1 (n=9)	Winter (n=7)
			Summer (n=2)
		LSM 6-9 Exp 2 (n=4)	Winter (n=1)
			Summer (n=3)
Group 2	LSM 10 (n=23)	LSM 10 Exp 1 (n=10)	Winter(n=6)
			Summer (n=4)
		LSM 10 Exp 2 (n=13)	Winter (n=7)
			Summer (n=6)

The distribution of the research participants' ages, their weekly electricity consumption and their per capita use was drawn. Figure 15 presents the distribution (by means of a distribution plot and a scatter plot) of the average daily electricity consumption of all the research participants during Week 1, and before any intervention took place with any of the households. This indicates a range of daily electricity consumption between 6.3 kWh and 52.89 kWh per day, with a standard deviation of 15.14.

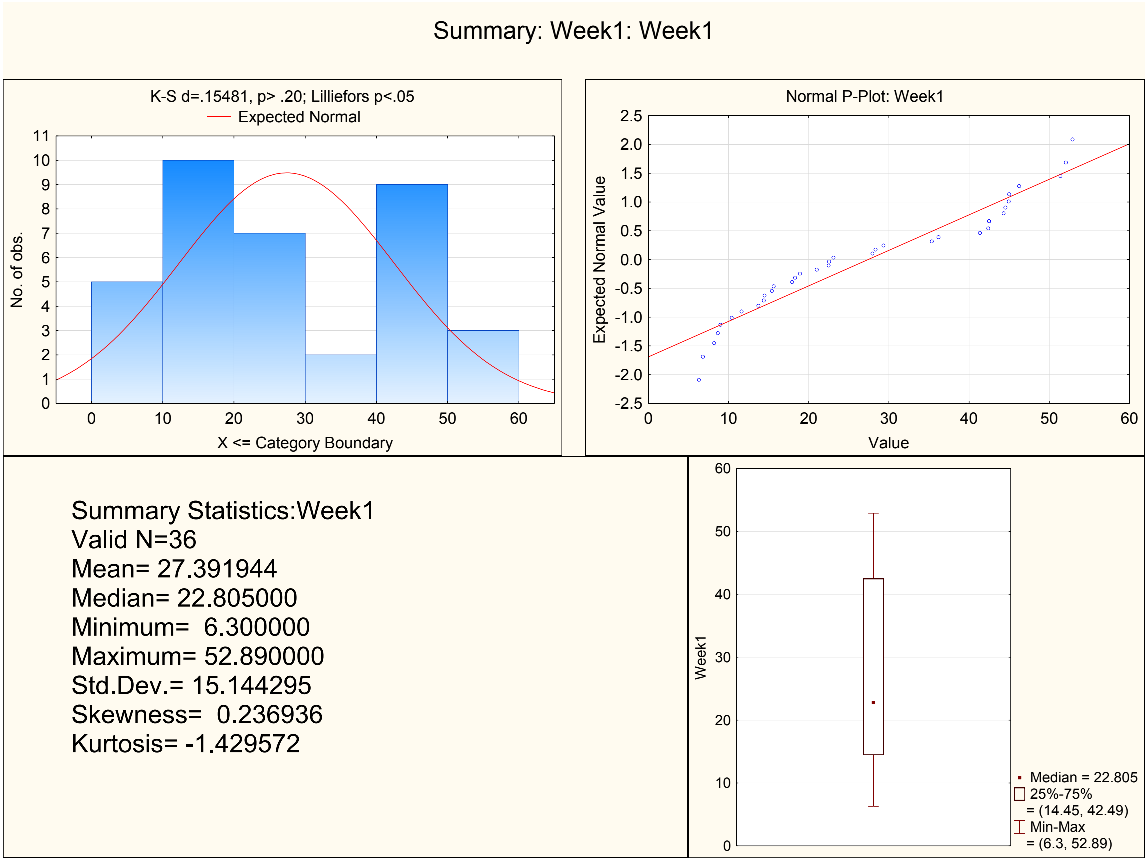

Figure 15 Distribution of electricity consumption during week one of measurement

In Figure 15, the average household electricity consumption during the baseline measurement week presents two peaks, one at an average use between 10 and 20 kWh per day, and the other at an average between 40 and 50 kWh per day. At the bottom right, the box-and-whisker plot (Mann, 2013) indicates the first and third quartile positions and a mean of 22.8 with minimum and maximum values of 6.3 and 52.89 respectively. The distribution and probability plots indicate that the electricity consumption data from participants in this study were not normally distributed (with the Kolmogorov-Smirnov test showing d=0.15481, p> 0.2 and Lilliefors p< 0.05) (IBM Corporation, 2011). Non-parametric statistics were therefore used to analyse the data further instead of parametric statistics.

Descriptive statistics such as measures of central tendency (arithmetic means) and standard deviation were calculated for the electricity consumption data, the household inventory data, and the demographics of the research participants. The following procedures were performed on the statistics:

- a means procedure and standard deviations;
- a correlation procedure; and

- electricity consumption comparisons and load profiles.

These tests were done for the research participant group as a whole, and compared on the basis of the LSM 6 to 9 and LSM 10 Groups. In Section 5.3.1, a description of the demographics of the research participants with complete quantitative data (n=36) is given, followed by a description of the amenities and appliances in each of the LSM Groups (6 to 9 and 10). Subsequently the ratio between old and new appliances was explored. This was done in order to establish whether or not new appliances assist in decreasing electricity consumption due to increased efficiency. These findings are discussed in Sections 5.4.2-5.4.6.

Detailed descriptions of the methods used to calculate the means, correlations and make comparisons are discussion in the next sections.

- *Means procedure and standard deviations*

Describing the means and standard deviations (an indication of dispersion around the mean) (Willemse, 2009) of the research group allowed the researcher to describe the data using means, standard deviations and medians as main descriptors (StatSoft, 2012). The variables that were included in this analysis were the following:

- the appliance count;
- the head count;
- the ratio of new appliances vs. old appliances;
- per capita use;
- nightly electricity use per week; and
- average electricity use over all three weeks.

In Section 5.4.4., the means, standard deviations, the minimum and maximum of each of the variables analysed are given. These were calculated for both the LSM 6 to 9 and LSM 10 groups, enabling the researcher to detect differences in the groups based on their data distributions and variability in their electricity consumption data.

- *Correlation procedure*

In order to describe the quantitative relationships between different variables, correlation calculations were done. The variables which were suspected to be related included

- the LSM and the number of people in the household (head count);
- the LSM and number of appliances in the household (appliances count);
- the LSM and the new appliances ratio;
- average electricity consumption and appliance count; and
- average electricity consumption and the new appliances ratio.

In order to explore the relationship between these variables, both Pearson and Spearman's correlations coefficients were calculated. Calculating both Pearson and Spearman correlation coefficients would provide information on the nature of the relationship between the variables. If S>P, it is indicative of monotonic rather than linear relationships, and provides further confirmation that non-parametric statistics should indeed be used (Myers & Wells, 2003). In this study, it was suspected that Spearman correlations would be more appropriate since they are based on non-normal distributed data and use ranks (depicting monotonic relationships), unlike Pearson correlations, which are based on true values and depict linear relationships (Myers & Wells, 2003); however, calculating both would serve as a confirmation. Therefore both Pearson and Spearman's correlations are reported in Section 5.4.2.

- *Electricity consumption comparisons*

Electricity consumption was compared both within households and between households. Households were compared to their own use in terms of the savings or increased consumption recorded during the three-week measurement period. Households were then in turn compared to one another in four respects:

- average daily consumption (*Adc*);
- average daily consumption per square metre (*Adcpsm*);
- average daily consumption per capita (*Adcpc*); and
- load profiles.

Below, the calculations for each of these comparisons are shown. Daily and weekly averages were established from the 24-hour consumption data collected in the households. Thereafter, for within-household comparisons, daily average savings before the intervention were compared to those following the intervention. Lastly, between-household comparisons were done and a description of the calculation of the average daily consumption per square metre and the average daily consumption per capita are given. In line with the South African National Standards (SANS 1544:2014) the electricity consumption per square meter of the house only is provided in the results. The results for all these calculations are presented in Section 5.4.4.

- *Daily consumption*

Daily consumption (*Dc*) was calculated for each complete day of measurement in each household. This was done by using the output of the E2 monitor. The output is in the form of 24 average hourly (*ah*) readings per day (one average reading per hour) in an Excel sheet. These are presented for every day of measurement across the whole measurement period. These 24 readings were added together in order to get the total daily consumption, as indicated below:

$$\sum ah01 - ah24 = Dc$$

These daily consumption results were used to calculate the daily consumption averages for three weeks. Average daily consumption for Weeks 1, 2 and 3 (*Ad1, Ad2, Ad3*) was established using the daily consumption (*Dc*) figures. These daily averages were added together (∑) and divided by the number of complete measurement days in each week (*nd1, nd2,* or *nd3*). The formula used was the following:

$$\frac{\sum(Dc1, Dc7)}{nd1} = Aw1$$

The average for Week 1 (*Aw1*), Week 2 (*Aw2*) and Week 3 (*Aw3*) was determined ensuring that the average for Week 1 was for all complete measurement days before the intervention, and what the averages for Weeks 2 and 3 were for the two weeks following the intervention (excluding the day of intervention). These averages were used to calculate the savings in each household.

- *Savings*

In order to compare a household to itself, the savings before and after the intervention were determined. As indicated in the equation below, the difference between the electricity consumption for Week 1 (*Aw1*) and Week 2 (*Aw2*) was divided by the average consumption during Week 1 (*Aw1*), multiplied by 100 (in order to get a percentage). Negative savings are indicative of an increase in electricity consumption during Week 2 compared to Week 1.

$$\frac{Aw1 - Aw2}{Aw1} * 100 = Asw12\%$$

This was also done for the difference between Weeks 1 and 3 (*Aw1-Aw3*). The average savings for Week 2 compared to Week 1 (*Asw12*) and average savings for Week 3 (*Asw13*) were then added together and divided by two to establish the average saving after the intervention (*As*), as portrayed in the equation below:

$$\frac{\left(\frac{Aw1-Aw2}{Aw1} * 100\right) + \left(\frac{Aw1-Aw3}{Aw1} * 100\right)}{2} = As$$

These average savings are presented in Tables 42, 43 and 44 (Chapter 5). Next, the electricity consumption per square metre as a means to compare household to one another on an equal basis is described.

- *Electricity consumption per square meter*

The use of electricity consumption per square metre as a concept is recommended as the best comparative method, allowing for international comparison of residential energy efficiency (Yohanis, Mondol, Wright, & Norton, 2008). These authors show that monthly consumption of European detached houses (such as those in this study) is between 3.57 and 5.17 kWh per square metre per month. Detached houses use the largest amount of electricity, while apartments and semi-detached houses use less. The American average for detached houses is around 10.7 kWh per square metre of the house per month (Silvermann, 2007). The South African averages per square metre could not be accessed by the researcher, as they are not provided by Eskom; however, these averages were calculated for the participants in this study and were used to compare the use in different households to one another in Section 5.4.4.

In this research, many of the participants did not know the exact size of their house. House sizes are usually only noted on the title deed of the property and not on the municipal accounts of each household, so it was difficult for the researcher to obtain this information. Home owners were therefore requested to give an approximation of their house size, and households were grouped into ranges during coding. These ranges (and number of households in each) are presented in Table 24.

Table 24

House size, frequency and percentage of research participants

Square Metres	Frequency	Percentage
1-80	6	17%
81-160	9	25%
161-240	8	22%
241-320	4	11%
321+	8	22%
Unknown	1	3%
	36	**100%**

In order to establish the average daily electricity consumption of a household per square metre (*Adc per Sm*), the average daily consumption (for the whole measurement period and in watt) (*Adc*) was divided by the maximum of the range in which the household was classified (*maxSqm*), as indicated in the following equation:

$$\frac{Adc}{maxSqm} = watt\ psmpd$$

This was then divided by 1 000 in order to report the electricity consumption in kilowatt:

$$\frac{Watt\ psmpd}{1000} = Adc\ per\ Sm$$

This made it possible to establish the daily electricity consumption in kilowatt per household as a function of the size of the household.

- *Electricity consumption per capita*

The same average daily consumption (*Adc*) as in the function above was used to compare electricity consumption as a function of the number of people in a household who consume the amount of electricity determined by the measurement. In this instance, the average daily consumption (*Adc*) was divided by the head count (*n*), consisting of both adults and children, in the household; the result was the average consumption per capita (*Adcpc*):

$$\frac{Adc}{n(Adults + children)} = Adcpc$$

The average daily consumption per capita allowed the researcher to understand and place into context the effect that the number of household occupants has on electricity consumption. It allowed the researcher to compare the average use per person, regardless of the number of people in a household. In the next section, the methods used in the mixed analysis are presented and discussed.

4.5.3 Phase 4: Mixed analysis

As mentioned earlier, Phase 4 presents the mixed analysis of the quantitative and qualitative data as described and discussed in this section. Results from both the qualitative and quantitative data analysis are presented together to enhance insight into various aspects which would be obscured by means of a separate analysis. The steps suggested by Creswell and Plano Clark (2011) for the analysis of mixed methods data were used here.

For an embedded design, Creswell and Plano Clark (2011) suggest analysing independently the “qualitative data set qualitatively and the quantitative data set quantitatively” (p. 215), looking at the primary data set first. This was done in Phase 2, Parts 1 and 2, and Phase 3 of the analysis, as presented in the sections above. Below, the approaches used to answer the research questions are identified and discussed. For the reader’s convenience, the research questions are repeated here:

- What is the effect of a psychological intervention, using particularization, real-time feedback, goal setting and commitment-making, with an individual in a household on the household’s electricity usage?
- What energy conservation strategies (if any) are employed by households, as perceived by the individual (participant), and why?

- How do participants from different socio-economic backgrounds attempt to save electricity?

In order to answer these questions, the aspects of the analysed data listed below are highlighted and compared to one another in a mixed analysis. These results from the mixed analysis are presented in Phase 4 in Section 5.6. The aspects that were scrutinized in the mixed analysis, and that provide answers to the research questions by means of a combined use of the analysed data sets are the following:

- quantitized qualitative themes (occurrences of qualitative themes), comparing LSM groups to one another in order to understand the similarities and differences regarding energy efficiency between these groups (if any);
- interpretation of the quantitative data based on the qualitative findings;
- the impact of the identified seasonal behaviour changes regarding electricity consumption; and
- differences between Experimental Groups 1 and 2, using qualitative data to understand perceptions of the interventions administered.

Each of these approaches is discussed in detail below.

4.5.3.1 Quantitized qualitative themes from the in-depth interviews

In this section, qualitative codes derived from the in-depth interviews were assigned a rank order in terms of the number of participants that mentioned each code. Tashakkori and Teddlie (1998) dubbed this process “quantitizing the data” (p. 126). Driscoll, Appiah-Yeboah, Salib, and Rupert (2007) describe the process as being able to indicate particularly “influential codes” (p. 22), but warn that the process could foreground utterances repeated by one particular respondent, creating the impression that a code is influential, when it is actually only important to one participant in particular. In order to avoid misidentifying these influential codes, in the current study, the *number of participants* who expressed a particular code was counted, rather than the number of times the code was mentioned.

In order to explore the differences between the two LSM groups, this process was repeated for each of the two LSM groups separately. This allowed for a comparison on the salience of issues in each group. The most salient and least salient issues for each group are indicated in Section 5.6.1 Mixed analysis involves the interpretation of quantitative data based on qualitative findings, and vice versa. During a mixed analysis, the interplay between the two data sets is explored. Data comparison is done – it is described by Johnson and Onwuegbuzie (2004) as the process of “comparing data from the qualitative and quantitative data sources” (p. 22). In this study, data collected qualitatively and quantitatively were first analysed separately.

Upon completion of the analysis of the separate sets of data (qualitative and quantitative), central aspects of each data set were identified. In the qualitative data set, this meant that often-mentioned codes, codes that highlighted high energy use behaviours by participants, or codes identified by the researcher as odd or significant, were identified. In the case of the quantitative data, irregular use and unusually high conservation percentages or consumption percentages were identified in the data set. In each case, the researcher examined the alternative data set (the quantitative data set in the case of qualitative codes, and vice versa for the quantitative use patterns) in order to explore the contributing factors in greater depth. These instances are identified, described and discussed in more detail in Sections 5.6.2-5.6.4.

4.5.3.2 Simultaneous description using qualitative and quantitative data: a case study of two participants

Data integration, where "both qualitative and quantitative data are integrated into a…coherent whole" (Johnson & Onwuegbuzie, 2004, p. 22), was done in the final stage of Phase 4. Load profiles are used to portray differences in electricity consumption between two periods (before and after the intervention) for two participants (one from each experimental group). The averages for each weekday (i.e. Mondays, Tuesdays, Wednesdays, etc.) before the intervention were compared to the averages of the weekdays following the intervention. This allowed only one average to be indicated for the electricity consumption per weekday before, and one after, the intervention.

The load profiles of two participants are presented here. These two participants were purposively selected, based on their specific knowledge (how they changed their behaviour to effectively save electricity). This sampling does not lead to generalizable results, instead it assists the researcher in exploring in-depth the interaction between the qualitative and quantitative data in cases where these are particularly distinct.

Participants selected for these descriptions, were purposefully selected because of the apparent differences in the reasoning underlying their pro-environmental behaviour changes (or lack thereof), and the fact that these are clearly visible in their energy consumption readings. Although the participants do not necessarily represent the norm, their beliefs (qualitative data) and behaviour (quantitative data) are discussed together in order to highlight the effect of the intervention, as well as their experiences during this study. The discussion during one focus group session (P20) between these two participants is also considered. In addition, each of these two participants' actual electricity consumption data and savings/increased use serve as an excellent illustration of the effect of the intervention on each of the participants, revealing new insights into electricity consumption and the psychological aspects that influence its use.

In the next section, the ethical considerations relevant to this research project are discussed.

4.6 Ethical considerations

Ethical approval for the current study was requested from the Research Ethics Committee of the Faculty of Humanities at the University of Pretoria, and was granted on 5 August 2010. In order to ensure that the rights and interests of the research participants were not impinged upon, generally accepted ethical procedures were followed in the study. This included obtaining informed consent, protecting participants from harm, respecting their the right to privacy and bearing in mind the welfare and dignity of the participants in the design of the research and during the data collection, as recommended by Babbie and Mouton (2001), Fink and Kosecoff (1998), the Health Professions Council of Southern Africa (HPCSA) (2008) and Leedy and Ormrod (2013). These aspects are outlined below.

4.6.1 Informed consent

In line with international standards, volunteers received a participation information sheet explaining the purpose and aim of the study (see Appendix B). Once volunteers had indicated their willingness to participate, an informed consent letter was presented to them to explain the different phases of the study. The participants' right to confidentially was stressed, a request was made to record their conversations and data, and an indication of who would have access to the data was given. Participants were requested to sign consent forms for each phase of the research, in other words, for the energy audit (all participants), the interview and intervention (Experimental Group 1) or just the intervention (Experimental Group 2) and the focus groups participants (all the participants who attended these sessions) (see Appendix B). By signing the consent forms, the participants acknowledged their rights and signified their agreement to participate.

4.6.2 Protection from harm

The research conducted held no threat, either physically or psychologically, to the members of the participating households. Although no psychological discomfort was anticipated, participants were encouraged to contact the researcher if at any point during the research process they felt uncomfortable or wanted to terminate their participation in this study, regardless of their reason. Participants were informed of their right to terminate their participation in the study at any time; however, none of the research participants withdrew from the study.

4.6.3 The right to privacy

Babbie and Mouton (2001) describe ensuring confidentiality as the practice of ensuring that information is accessible only to those authorized to have access. This includes a guarantee that the data will be protected throughout the lifecycle of the research. Two approaches were followed to ensure confidentiality for the participants in this study. Each participant was allocated a unique audit number that was used on all documentation and during analysis, as suggested by Leedy and

Ormrod (2013). Only the lead researcher had access to the audit numbers and information linking numbers to the participants' personal details and data. In reporting the results of this study, the audit number was used to distinguish between participants so that no personal information about the participants was made known. Furthermore, due to the sensitivity of the information gathered (such as the inventory of household contents) in this study, participants' information is kept in a locked safe to ensure privacy (and will be kept there for the 15 years following the study) (see data storage form in Appendix F) in accordance with the requirements of the University of Pretoria.

4.6.4 The welfare and dignity of research participants

The principle of justice advocated by the Health Professions Council of Southern Africa (HPCSA) (2008) states that "it is an ethical imperative that the study should leave the participant and or community better off or no worse off" (p. 3). In order to adhere to this principle of justice (HPCSA, 2008, p. 3), to "treat each person in accordance to what is right and proper", and to equally distribute the potential benefit that could be derived from this study, the same potential benefit of participation was afforded to both experimental groups. Potential benefits to the participants were explained. These benefits included gaining knowledge that could potentially save the participating household money by means of a decrease in electricity consumption, although no monetary benefits or other incentives were offered to any participants. In this study, the same electricity conservation information was provided to both groups, although in different formats (actively engaging (Experimental Group 1) vs written (Experimental Group 2)).

Upon completion of the study, all respondents were thanked, and a personalized feedback report was sent to each household. A reminder of their right to access their personal data collected in this study by requesting it from the lead researcher was included. In this section, the participants' right to informed consent, to protection from envisaged harm, their right to privacy and the welfare of the research participants was discussed. In the next section, the processes that were followed to ensure the quality of this research are outlined.

4.7 Quality of the research

Lincoln and Guba (1985) describe the quality criteria for both qualitative and quantitative research necessary to establish the trustworthiness of the data; however, Creswell and Plano Clark (2011) argue that "validity cannot be adequately addressed (or made specific) as a procedure unless the researcher conceptualizes it within a research design" (p. 239). The quality of research is usually assessed by referring to validity and reliability (Leedy & Ormrod, 2013). Validity is the measure by which the variables assessed are in fact assessed, thus increasing the validity, or truth, of the findings. Reliability is "the consistency with which a measuring instrument yields a certain, consistent result when the entity being measured hasn't changed" (Leedy & Ormrod, 2013, p. 91).

4.7.1 Validity and reliability of the research

According to Creswell and Plano Clark (2011, p. 211), “reliability plays a minor role in qualitative research and relates primarily to the reliability of multiple coders on a team to reach agreement on codes for passages of text”. They emphasise, however, that it is important to establish qualitative validity. Qualitative validity is defined as “assessing whether the information obtained through the qualitative data collection is accurate” (p. 211). Strategies include member checking, triangulation of the data, and reporting disconfirming evidence. In the next section, the reliability and validity of the quantitative instruments, data collection and analysis procedures will be discussed, followed by a discussion of the validity of the qualitative methods used in this study’s data collection and analysis.

Assessing the validity of the research implies assessing the “truth value” of the data (Leedy & Ormrod, 2013). The degree to which the variables being assessed are indeed accurately assessed is referred to as the validity of the assessment; the higher this degree, the higher the validity, or truth, of the findings consequently presented. Lincoln and Guba (1985) describe the quality criteria for both qualitative and quantitative research necessary to establish trustworthiness of the data. Creswell and Plano Clark (2011) warn that “validity cannot be adequately addressed (or made specific) as a procedure unless the researcher conceptualizes it within a research design” (p. 239). Therefore, the methods employed during the data collection phase (random allocation to experimental groups, and measurement of LSM), the data analysis phase (both qualitative and quantitative) and the data interpretation phase (in Chapter 5) are discussed separately, and as part of the research design (as suggested by Creswell & Plano Clark, 2011). The use of more than one source of data (qualitative and quantitative) focusing on the same phenomenon increased the internal validity of this study. Although many additional variables are introduced once a study is conducted in a real-life setting, it increases the external validity of the study yielding conclusions with “broader applicability to other real-world contexts” (Leedy & Ormrod, 2013, p. 103).

4.7.1.1 Random allocation to Experimental Groups 1 and 2

Random allocation was important to ensure an equal chance for all volunteers to be selected for Experimental Group 1. The assumption was made that, as recommended by Leedy and Ormrod (2013), “on average the groups were quite similar” (p. 230). This ensured the validity of the conclusions when Experimental Groups 1 and 2 are compared. In order to increase internal validity and “allow the researcher to draw accurate conclusions” (Leedy & Ormrod, 2013, p. 101), the research participants were not made aware of which experimental or LSM group they had been allocated to. This was done on the basis of the argument that a lack of knowledge of participants’ experimental group allocation decreases the probability that the research participants’ changes in behaviour were due to their expectations of the outcomes instead of the actual outcomes of the study (Leedy & Ormrod, 2013).

4.7.1.2 Phase 3: qualitative follow-up participants

Creswell and Plano Clark (2011) warn that choosing inadequate participants for the follow-up focus groups, in other words, participants who cannot help explain the significant results may have an impact on the validity of the findings. In this study, all the participants were invited to participate in the focus group discussions in the hope of including all those who had participated in the first phase of the research. Unfortunately, in many cases, participants did not attend the focus group sessions, and those who did attend, did not necessarily have reliable usage data during Phase 1 of the study. This raises some questions about the validity of the mixed analysis relating the usage data to the focus group discussions. This problem is discussed in more detail as one of the limitations to the study in Section 6.5. In the next section, the validity of the data analysis is explored.

4.7.2 The instruments

In this section, each of the instruments used during the data collection is specifically discussed in the light of its validity and reliability. During this study, validity and reliability were ensured by means of repeated interaction in the field (prolonged involvement) and establishing rapport with the participants, as suggested by Guba and Lincoln (1998). This enabled the researcher to facilitate effective collection of quantitative data and qualitative data. The instruments discussed are

- the interview guide and intervention protocol;
- the electricity consumption data collection procedure and instrument;
- the LSM;
- the household inventory; and
- the focus group discussion guide.

4.7.2.1 Interview and intervention protocol

In order to ensure the collection of valid and reliable data in the interview and intervention administered in this research, the researcher followed the same protocol during each interview and intervention session, heeding the advice of Creswell and Plano Clark (2011) that the interaction should be standardized. This ensured that any differences in the interview and intervention process were mainly introduced by the research participants, rather than the researcher.

All the interviews were conducted by the lead researcher herself (interaction in Experimental Group 1), while all interactions with participants in Experimental Group 2 were handled by a research assistant. This increased the validity and reliability of the interview and intervention, by limiting variability that could be introduced by different interviewers.

The protocol served as a checklist to assist the researcher in discussing all aspects of the intervention with each of the research participants. Appendix C contains the interview guide and intervention protocol.

4.7.2.2 The electricity consumption data

The electricity usage data was collected by means of the E2 electricity monitor described in Section 4.4.3.5. Participants had access to the consumption data, and to information and training provided by the researcher, in order to be able to verify electrical consumption on a daily basis. This allowed the research participants to alert the researcher if they suspected erroneous recording of their consumption data. Such problems arose in a few cases because of unexpected electricity blackouts for more than two days, accidental disconnection of the CT from the main feed-in cable on the distribution board, or equipment malfunction. These data sets were excluded from analysis, as only complete datasets were included. This addressed the potential effect of incomplete measurements in the data, and ensured that the measurement data were a valid and reliable reflection of the actual electricity consumption of each of the participating households.

4.7.2.3 The LSM

The LSM has been in use since the late 1980s (SAARF, 2012). The validity of the LSM has been confirmed annually since 1994: “[A] recheck each year…confirmed its continuing validity” (par. 12). The applicability of using a market segmentation tool as a means to segment people in a psychological study may be questioned. However, it can also be argued that, since the LSM is widely used and accepted as a valid segmentation tool in the South African market for those buying beer and hair care products (Lamb et al., 2008), it should also be applicable to the market buying electricity.

4.7.2.4 The household inventory

As discussed in Section 4.2.2, the household inventory was originally designed for use in audits of the household content that consumes electricity in South Africa by the engineering firm Imtech. Although the validity and reliability of this household inventory has not yet been established, some of the strategies to ensure that its quality was as high as possible included testing it during the Nova pre-feasibility study and the pilot study for the current study. After the Nova pre-feasibility and pilot studies, minor changes were made to increase readability and clear up any ambiguity in the questions asked, ensuring that the measure was applicable to the South African context. Furthermore, all the research participants were presented with the same comprehensive inventory to complete, ensuring that this aspect of the data collection was standardised.

4.7.2.5 Quality of the focus group discussions

Kitzinger and Barbour (1999) advise that it is only possible to collect rich data when participants feel comfortable with interacting in the focus group setting. In view of the vast differences between the socio-economic groups assessed in this research and the potential effect on the flow of discussions during the focus group sessions, the focus groups were kept as homogenous as possible. Meetings were organised at the original venues where the research participants were recruited. This allowed for homogeneous groups, at ease in their surroundings, enabling the researcher to eliminate some of the idiosyncratic elements that may occur in a highly heterogeneous group, in line with the recommendations of Babbie and Mouton (2001). This also helped to establish rapport between the focus group participants, as proposed by Hyden and Bulow (2003), allowing participants to "add their contributions to the common ground" (p. 305) when they perceived few differences between themselves and other members of the focus group.

4.7.3 Validity and reliability during data analysis

Validity and reliability of data is ensured by means of the transparency of the process of analysis, which is described in the three sections below, briefly considering the quality of the qualitative, quantitative and combined analysis.

4.7.3.1 Transparency by means of an audit trail (Phase 2, Part 1 and Phase 3)

Bryman, Becker, and Sempik (2008) argue that providing "sufficient information to judge the methods in the published piece" (p. 272) is imperative for transparency and the consequent trustworthiness of research data; this also applies to mixed methods research. Therefore, the data analysis stages are described in detail in the preceding sections of this chapter, and they allow the reader access to the process of analysis, along with the analysis process in the form of an audit trail.

An audit trail provides a reader with the details of the data collected from the field and allows insight into the analysis process. The audit trail for the current research was ensured by providing access to

- the interview and intervention protocol (including the interview guide) (see Appendix C); and
- for both, the analysis of the in-depth interviews (Part 2) and the focus groups (Phase 4) (see Appendix G and H respectively:
    - lists of the qualitative codes and definitions;
    - list of quotations that form part of each code;
    - the patterns (code families) identified and their definitions; and
    - a clear indication of the codes that form part of each code family, including quotations.

In the next section, the validity of the mixed analysis is discussed.

4.7.3.2 Quantitative analysis (Phase 2, Part 2)

The correct statistical methods were applied to the data by first testing for normality of distribution. Non-parametric statistics were used to analyse the data collected, because the distribution of the data was not normal. The calculations used for both within- and between-household comparisons are discussed in detail in Section 4.5.2, increasing the transparency of the conclusions reached.

Participants were compared to their own households' use, due to the great variability of household circumstances, living standards and inventories. This approach enabled the researcher to avoid comparisons between dissimilar households. Where households were compared to one another, they were grouped together according to their LSM, compared on an equal footing (use per square metre or per capita residing in the household, and compared on the basis of their allocation to a particular experimental group.

4.7.3.3 Quality of the mixed analysis (Phase 4)

Bryman et al. (2008) argue that the traditional quality criteria for quantitative and qualitative research are still applicable in assessing the quality of mixed method research, and a few additional criteria should be addressed, namely

- the relevance of using mixed methods research to the research questions;
- the integration of mixed methods findings; and
- the rationale for using a mixed methods approach in the first place.

Gaining additional insight as a result of using a mixed methods approach is one way in which to justify the use of mixed methods (Bryman et al., 2008). Therefore, in this study, the quantitative data were used to highlight the qualitative findings, and the qualitative findings were used to understand and interpret the quantitative findings, as described in Section 4.6.1. The rationale for using a mixed methods approach and its relevance to the research questions have been extensively described at the start of this chapter; transparency is discussed in more detail below.

The interpretations of the data presented in Chapters 5 and 6 are based on an analysis of both the qualitative and quantitative findings. In this analysis, the use of "thick" descriptions (Leedy & Ormrod, 2013, p. 104), where direct quotations from the research participants's responses are regularly included to highlight certain aspects of the analysis, allows readers to draw their own conclusions from the interviews, and readers are guided through the presentation of conclusions based on the analyses throughout. In addition, the coding and thematic audit trails are made available to allow readers access to the original transcribed data. In mixed method analysis, integration of the quantitative and qualitative findings is necessary and the interpretations must complement one another.

Creswell and Plano Clark (2011) advocate interpreting and analysing data in line with the research design. In order to enhance the validity in this study, this recommendation was heeded. Therefore data were analysed and interpreted in the same sequence as the data were collected, to reduce the chances of missing findings and avoiding making conclusions that cannot be substantiated. The reasons for using a mixed methods approach, the implication of the embedded design for the findings and the rationale for placing increased weight on the qualitative findings are all discussed, and substantiate the chosen course of action.

4.8 Conclusion

In this chapter, a description was presented of how the pre-feasibility study conducted by the Nova Institute provided a background to the development of the research questions. A methodological justification for the use of a mixed methodology approach was given. In this chapter, the pilot study conducted to test the research design was described. The conclusions from the pilot study informed some improvements made to the research design used in this study. The research design, a multi-phased embedded combined ex post facto and experimental design, was discussed in detail. Each phase in the data collection and analysis stages was described and discussed.

In respect of Phase 1, the unit of research, the research sites and the sampling methods used in this study were discussed. Phase 2, Part 1 dealt with the collection and analysis of the in-depth interview, and Phase 2, Part 2 with the collection and analysis of the quantitative data. Phase 3 constituted a description of the follow-up focus group sessions, how data was collected and analysed. Phase 4 was not part of the data collection, but presents the approach followed during the analysis using both the qualitative and quantitative data – the mixed analysis.

This chapter concluded with a description of the ethical implications in this study and an assessment of the quality of the research by means of a discussion of the validity and reliability of the data during the data collection, data analysis and interpretation stages of the research process. This was done using the recommendations for ensuring validity in mixed methods research made by Creswell and Plano Clark (2011). In the next chapter, the findings are presented using the same four phases used in the discussion in Chapter 4.

Chapter 5:
Qualitative, Quantitative and Mixed Analysis Findings

5.1 Introduction

In this chapter, the findings from the analysis of the collected data are presented in four phases, in line with the research phases presented in Chapter 4. Phase 1 contains a description of the demographics of all of the participants and households in this study. Phase 2, Parts 1 and 2 and Phase 3 begin with a summary of the demographics of the participants involved in those particular phases of the project. In Phase 2, the findings from the combined ex post facto and experimental research design are presented in two parts. The first part of Phase 2 consists of the interview findings (qualitative); the second part of Phase 2 focuses on the actual electricity consumption findings (quantitative).

In Phase 2, Part 1, the prominent codes and the 11 themes generated from these codes are illustrated with direct quotations from the research participants. The identified themes focus on the participants' awareness of global climate change and the issues around education and awareness creation of energy efficiency in the home; the behaviour that participants in this study engaged in before the commencement of this study, including their planned activities; the impact of financial motivations and incentives on behaviour change; the role of folk knowledge and understandings of the functioning of appliances in household behaviour; the effect of interpersonal and gender roles on household energy efficiency; the effect of the value of using resources sparingly on energy efficiency; and the existing strategies employed in households in order to motivate other household residents.

In Phase 2, Part 2, the historical baseline data obtained from the local municipality for the three geographical locations are provided from 2007 to 2009, creating a context for the interpretation of the usage data gathered in this study. Households were compared to themselves, using a baseline for comparison, and on an equal basis with one another, using per capita electricity use and monthly electricity consumption per square metre as indicators. Electricity consumption savings in the households, based on their own baseline, is presented and compared to other households on the basis of their LSM, the experimental group in which households fall, and the season of measurement. The results of the intervention (the pre- and post-intervention electricity consumption data) are then presented.

Phase 3 presents the findings from the analysis of the focus groups. Nine themes were generated, including specific attention to the changes that took place in the households; the importance of comfort in the household; the family's response to the study; the role of women in the household's managing of energy efficiency in the household; the effect of folk knowledge; the expressed need for both guidance and information; perceptions of responsibilities, both personal ones and those of the authorities; and finally, the strategies used by the research participants in order to establish changes in routines.

This chapter concludes with Phase 4. Findings from the in-depth interviews, the quantitative results from the electricity consumption data, and the focus group discussions are combined to gain insight into the interplay between the ways in which the participants talk about energy efficiency and their actual energy-saving behaviour. Four specific aspects are presented: the salience of issues in the two LSM groups, and how they differ; quantifying folk knowledge; perceptions about the impact of winter and the measured effect of winter on electricity consumption; and, finally, a comparison between two participants from each experimental group, based on their electricity consumption and the ways in which they discuss energy efficiency.

In order to answer the first research question "What is the effect of a psychological intervention, , using particularization, real-time feedback, goal setting and commitment-making, with an individual in a household on the household's electricity usage?", the effect of the intervention is discussed, and Experimental Groups 1 and 2 are primarily compared to one another in Phase 2, Part 2. In most other sections of this chapter, the LSM groupings are used as a comparative basis in order to answer the third research question, "How do participants from different socio-economic backgrounds attempt to save electricity? In answer to the second research question, "What energy conservation strategies (if any) are employed by households, as perceived by the individual (participant) and why?", the strategies are explored specifically in Phase 2, Part 1 and in Phase 3. In Phase 3, the strategies preceding participation in this research study and consequent changes in the households and the underlying reasons are explored.

These findings are then combined in Chapter 6, wherein three over-arching themes are identified and subsequently combined into a conceptual model. First, a description of the demographics of the participants is presented and discussed.

5.2 Phase 1: Demographic overview of the study participants

In this section, the demographics of the participants in this study are described, and the available data on each of the households are presented. Initially, the sample included in this study consisted of 41 households. However, some of the households did not participate in all the data collection phases for various reasons (these are discussed where relevant). Each of the sections that contain the data from the different collection phases presents a demographic breakdown of the participants and households that participated in that particular phase.

5.2.1 Demographics of all study participants

Table 25 contains a summary of the demographics of the study participants (n=41). Aspects indicated in the table include the gender, level of education and age of research participants. It also includes the number of adults and the number of children in the household and whether the home is owned or rented. The number of participants in the different LSM and experimental groups was indicated in Section 4.4.3.3 and is not indicated again.

Table 25

Overview of the demographics of the participants (n=41)

Variables	Attributes	Frequency
Gender	Female	29
	Male	12
Education	Grade 12 and below	13
	Diploma/Degree	13
	Postgraduate qualification	15
Age	<30	4
	31-40	9
	41-50	7
	51-60	16
	61+	5
Number of adults in the household	1-2	16
	3-5	22
	6+	3
Number of children in the household	0	21
	1-2	15
	3-5	4
	6+	1
Ownership of the home	Rented	3
	Owned	38

More females than males served as the primary participants in this study, possibly because of their being more available to participate in the study, as the adult female members of the households tended to be at home with their children during the day or returned from work earlier than the male of the households. The vast majority (n=36) of participants resided in freestanding single residential units. The remaining five households included two flats, two duplexes and one stand with multiple units using one electricity source. The number of children in the house was negatively correlated with the LSM – the higher the LSM score, the lower the number of children in the household, and vice versa. The correlation was (r_s=-0.42467, n=36, p=0.0098).

A number of criteria for household participation were identified before selection for participation (such as paying for electricity and living in a permanent structure), the sample lived in a broad variety of buildings types and family structures. Brandon and Lewis (1999) note that while it is possible to specify desired participant characteristics under laboratory conditions, participant characteristics in field experiments tend to vary greatly. In this study, this was also the case. This variability in households in terms of the number of people in a household and the size of the buildings predetermined the amount of electricity consumed in each household and made comparison between participating households difficult. It was therefore decided to compare households on several bases, as presented in Phase 2, Part 2 of this study:

- two groups were compared to each other, based on their living standard (discussed in detail in the previous section);
- the two experimental groups were compared to one another;
- groups were compared on the basis of the season in which their consumption was measured; and
- households were compared to themselves in terms of their electricity consumption.

This comparison was done by using the blind baseline measurement (over one week) and comparing it to the measurements following the intervention (over the next two weeks) as described in Section 4.4.4. In Phase 2, Part 1 and in Phase 3, no direct comparisons between experimental groups were made, since Experimental Group 2 did not complete interviews and cannot be compared to Group 1. Instead, the salience of issues and use of specific energy efficiency strategies of the LSM groups were explored and compared in Phase 4. In the next section, the available data for each of the 41 participants are presented.

5.2.2 The available data set

As mentioned earlier, data were not collected in all of the phases for all 41 households that participated. Table 26 presents the data available for the 41 households. In the end, the data available for analysis in Phase 2, Part 1 consisted of the transcripts of the 18 in-depth interviews with Experimental Group 1. In Phase 2, Part 2, electricity usage data from 36 participants were analysed. In Phase 3, the data from the 16 people who participated in the focus group sessions were looked at. Each household's participation in the different phases of the research (in-depth interview, usage data and focus groups) is indicated according to the household's allocation to the LSM and to the experimental groups.

Table 26

Description of participants' available data

LSM	Experimental group	Audit no.	In-depth interview (Primary doc no.)	Interview	Usage data	Focus Group	Comments
LSM 6-9 (n=16)	Experimental group (n=10)	3T12	P9: 3T12	✓	✓	×	
		3T19	P13: 3T19	✓	✓	×	
		3T20	P14: 3T20	✓	✓	×	
		3T17	P12: 3T17	✓	✓	×	
		3T4	P16: 3T4	✓	✓	×	
		3T9	P18: 3T9	✓	✓	×	
		22T1	P3: 22T1	✓	✓	×	
		21T5	P2: 21T5	✓	×	×	
		21T1	×	×	×	✓	
		21T4	P1: 21T4	✓	✓	×	
	Experimental group 2 (n=6 used 5)	3T20	×	×	✓	×	
		3K2	×	×	✓	×	
		21K1	×	×	✓	×	
		21K2	×	×	✓	×	
		21K3	×	×	×	✓	
		21K5	×	×	✓	×	
LSM 10 (n=25)	Experimental group 1 (n=10)	3T16	P11: 3T16	✓	✓	✓	Participant's husband also attended focus group
		3T14	P10: 3T14	✓	✓	×	
		3T3	P15: 3T3	✓	✓	✓	
		3T1	P8: 3T1	✓	✓	×	
		3T8	×	×	✓	×	
		3T6	P17: 3T6	✓	✓	×	
		22T4	P5: 22T4	✓	✓	✓	
		22T3	P4: 22T3	✓	✓	✓	
		23T2	P6: 23T2	✓	✓	✓	
		23T3	P7: 23T3	✓	✓	×	
	Experimental group 2 (n=15 used 13)	3K3	×	×	✓	✓	
		3K8	×	×	✓	×	
		3K12	×	×	✓	✓	Participant's wife also attended focus group
		3K19	×	×	✓	✓	
		3K15	×	×	✓	×	
		3K1	×	×	✓	×	
		3K10	×	×	✓	×	
		22K1	×	×	✓	×	
		22K7	×	×	✓	×	

LSM	Experimental group	Audit no.	In-depth interview (Primary doc no.)	Interview	Usage data	Focus Group	Comments
		31K1	×	×	✓	×	
		23K4	×	×	✓	×	
		22K4	×	×	✓	×	
		23K2	×	×	✓	✓	
		3K18	×	×	×	✓	Documentation lost but attended focus group
		Pilot 1	×	×	×	✓	Part of pilot, no data for this phase, but attended focus group

The in-depth interview findings are presented in the next section, which begins with a description of the participants in Phase 2, Part 1 of the research.

5.3 Phase 2, Part 1: In-depth interview findings

As discussed in Section 4.4.4, qualitative data were collected by means of an in-depth interview focusing on the reasons for participation, perception of the environment, interaction in the household regarding electricity use and planned future behaviour before the intervention. The demographic features of the participants who were interviewed are reported below, followed by a description of the 11 themes identified during the analysis of the in-depth interviews.

5.3.1 Demographics of the participants in the in-depth interviews

Participants from Experimental Group 1 (n=19) were requested to participate in the in-depth interviews, of which 18 were used for the analysis (the interview recording with 3T8 was inaudible, due to a technical error with the recording equipment, so this interview was excluded from the sample). Nine of the participants interviewed were from LSM Groups 6 to 9 and nine from LSM Group 10. The demographics of the participants whose interviews were included in the analysis are presented in Table 27.

Table 27
Demographic features of in-depth interview participants (n=18)

Variables	Attributes	Frequency
Gender	Male	3
	Female	15
Education	Grade 12 and below	9
	Diploma/ Degree	6
	Postgraduate	3

Variables	Attributes	Frequency
	qualification	
Age	≤30	3
	31-40	3
	41-50	3
	51-60	8
	61+	1
Number of adults in the household	1-2	6
	3-5	9
	6+	3
Number of children in the household	0	14
	1-2	2
	3-5	1
	6+	1
Ownership of the home	Rented	2
	Owned	16

The interviews were consequently analysed as described in Section 4.5.1. The next section presents the findings from the analysis of the in-depth interviews.

5.3.2 Background to participation and prominent codes

This section begins with a discussion of the participants' motivation for their participation in this study. Thereafter the most prominent codes that emerged from the data are briefly presented. This is done in order to provide the basis for the themes discussed in the next section. In this section, the findings from the initial open coding stage are presented, including a definition and description of the codes identified in the in-depth interviews.

Direct quotations from the interviews are presented in English to make the raw data accessible to a broad audience. The methodological implications of translation were discussed in Section 4.5.1. The verbatim quotations from participants' responses (typed in italics) are identified by the Primary Document number (the number allocated to each transcript in Atlas.ti), followed by the audit number of the participant and the number of the paragraph in the transcript, for example, P1:21T4:33 refers to Primary Document 1, Participant Number 21T4 and Paragraph 33 in the transcript. In some instances a spouse of the participant joined the interview; in those cases a B is added to the participant number (e.g. 21T4B) to indicate a distinction between the main participant and the comment made by his or her spouse.

In the next section, the participants' motivations for participation are presented. The motivation for participation provides a useful introduction and background for understanding a participant's reasons for volunteering in this study.

5.3.2.1 Motivation for participation

Participants mainly participated for two reasons: curiosity, and/or a desire to save on electricity costs. The reason mentioned by six participants was their curiosity in their own electricity consumption. Some participants commented specifically that they had volunteered because doing so had been suggested by friends, neighbours or colleagues residing in the vicinity of the research sites; however, ultimately, participants elected to participate out of curiosity, as is evident from the following responses:

> *Because I find it very interesting, I am on the carbon committee at work…* (P16:3T4:1)

and

> *Such things interest me* (P11:3T16:2)

Mathilda:	*Why, you know, did 3T20 come that day that we installed it, was that the first time you heard of the project?*
3T17:	*Yes.*
Mathilda:	*Okay and why did you say yes. When she said...*
3T17:	*Why?*
Mathilda:	*Yes, why?*
3T17:	*There's nothing, just just she say to me she want to check how do you use the electricity so I said yes just because I want to know.*
Mathilda:	*Okay, because you want to know as well?*
3T17:	*Yes, yes.*
Mathilda:	*And uh why do you want to know?*
3T17:	*I want to know about this electricity, why is it …eh… why is it so high.*

(P12:3T17:1-6)

Being the account holder and the increased cost of electricity, or electricity being wasted, also motivated participation:

> *It's me, because it is me that has to pay. Yes, it is me who receives the bill every month and you know every end of the month one becomes stressed when you get that envelope.* (P1:21T4:17)

> *But the financial thing is actually a big is actually a bigger thing than all the nice reasons.* (P7:23T3:6)

> *Because I am sure we waste electricity.* (P7:23T3:1)

One participant was asked by another member of the person's church congregation to participate, and was not initially filled with any enthusiasm. These comments are from the focus group discussion:

23T3:	*… and I said okay no it's fine you know, I'll do it. Yes.*
Mathilda:	*Okay, so he kind of selected you, you didn't volunteer by yourself.*

23T3: *Uhm yes he asked you know and then we said okay we'll do it ja, but it was not at that stage not really a thing you know we thought agh you know its just…*

Mathilda: *So what was it like a social obligation?*

23T3: *Yes yesyesyesyes.*

Mathilda: *Okay.*

23T3: *But after this I know it wasn't a social thing, it was shocking, so yes.*

(P19:23T3:15)

Other reasons for participation in this study included misconceptions that the researcher would solve problems between the participants and the municipality, and being in support of any research (regardless of the topic). In the next section, the codes that were generated from the raw data are highlighted and ranked, followed by an in-depth look at the themes generated in this study.

5.3.2.2 Prominent codes from the content analysis

The content analysis resulted in 155 codes. As a discussion of all of the codes would make this document very lengthy, only the most prominent codes are mentioned here. A code was considered prominent when it was mentioned by at least six of the 18 participants. In Table 28, the most prominent codes are presented, where the "Total" column indicates the number of participants who mentioned the specific code, "Code" refers to the name of the code and "Definition" provides a description of the code.

Table 28

Most prominent codes from the content analysis of interviews

Total	Code	Definition
11	Efficiency – appliance use	Behaviour change by means of specific ways in using household appliances
11	Motivation for participation – costs savings	Motivation for participation: increasing costs of electricity
10	Efficiency – geyser timing	The practice in households where the water heater system is either manually or automatically switched off in order to save electricity
9	Personal responsibility	Expression that recycling and energy efficiency is the responsibility of the person him or her self
9	Value – use resources sparingly	Expressed value: Frugality
8	Each person can make a difference	The belief that it is within the power of the individual to make a difference
8	Interaction with	Interactions with neighbours friends and family used as trusted

Total	Code	Definition
	neighbours/friends/family	sources of information
7	Conflict – electricity behaviour	Mention of conflict in the household specifically regarding electricity consumption behaviour
7	Global climate change – reality	Global climate change is a reality
7	Distrust authorities	A sense of distrust in Eskom, municipalities and “the market”
6	Female: responsible for action	Even though men in the household support the principle of energy efficiency it becomes the responsibility of the women in the households to put the systems in place and maintain them
6	Husband wife interaction	Interaction between husband and wife specifically around the use of electricity
6	Motivation for participation – curiosity	Motivation for participation: curiosity, interest
6	Non-efficient behaviour	Behaviour specifically not efficient
6	Resource efficiency – water	Resources efficiency, in particular with water
6	Shared family responsibility	The family share the responsibility to act in efficient ways
6	Strategy – authoritative instruction	Strategy to save electricity –household members act in an authoritative way to prevent high electricity consumption

These codes form the basis of the themes discussed in the next section. The full list of all codes (155) generated during the analysis of the interviews is available in Appendix G. The interplay between these codes and the LSM groupings of the interviewees is explored in more detail in Phase 4, discussed in Section 5.6. In the next section, the themes generated in Phase 2, Part 2 of this study are presented and substantiated by direct quotations from the in-depth interviews.

5.3.3 Themes emerging from codes

In all, 11 themes were generated, encompassing the 155 codes. Sub-themes are used where sufficient numbers of codes justified separate discussions. The number of contributory codes and quotations are indicated in the third column; the themes are presented in the sections that follow, Table 29.

Table 29

Themes generated from the in-depth interviews

Themes and Sub-themes (S-T)	Definition	Codes from Table 28
Theme 1: **Environmental Awareness** *S-T 1.1: The (non)threat of global climate change* *S-T 1.2: Small things like "being aware" is enough* *S-T 1.3: Education*	References to the importance of awareness of global climate change and possible behaviour options	**37 codes, 138 quotations** • Global Climate Change-reality • Interaction with family and friends • Shared family responsibility
Theme 2: **Behaviour changes** *S-T 2.1: Energy efficiency in the use of appliances and geysers* *S-T 2.2: Changing of routine behaviour*	References to changes in behaviour, routine behaviour, automated behaviour and energy efficiency practices	**17 codes, 97 quotations** • Efficiency – appliance use • Efficiency – geyser timers • Non-efficient behaviour
Theme 3: **Efficiency planning**	Planning in terms of energy efficiency, also a possible indicator of the unreachable, since it has not been implemented already	**8 codes, 26 quotations** (none from Table 28)
Theme 4: **Financial motivation and incentives**	Mentions of the financial drivers and incentives for energy efficiency	**15 codes, 57 quotations** • Motivation for participation – cost savings
Theme 5: **Folk knowledge**	Folk knowledge generally accepted amongst the interviewees, but scientifically disproven	**6 codes, 6 quotations** (none from Table 28)
Theme 6: **Gender roles interaction** *S-T 6.1: Support for energy efficiency in the household* S-T 6.2: *Conflict about energy consumption in the household*	Identification and definition of roles within a household, defined by the interviewees in terms of gender roles.	**8 codes, 52 quotations** • Conflict – electricity behaviour • Female responsible for action • Husband and wife interaction
Theme 7: **Comfort** *S-T 7.1: Comfort needs to be convenient* *S-T 7.2: Comfort is important*	Comfort and lifestyle choices: including the importance of comfort and the need for convenience	**12 codes, 61 quotations** (none from Table 28)
Theme 8: **Need: information-based feedback and support**	Expressed need for information, based on facts and providing a basis for action, including guidance from authorities, municipal staff and sales people	**16 codes, 61 quotations** • Distrust authorities • Motivation for participation – curiosity
Theme 9: **Role player identification**	The identification of the roles that should be played by different role players including government, the	**18 codes, 80 quotations** • Distrust authorities

Themes and Sub-themes (S-T)	Definition	Codes from Table 28
	municipalities, Eskom, the civil society and individuals	
Theme 10: **Self and values**	Aspects that the person him or herself worked through, ideas that still challenge the concept of self in energy efficiency and self-reported values	**19 codes, 102 quotations** • Each person can make a difference • Personal responsibility • Resource efficiency – water • Value – using resources sparingly
Theme 11: **Strategies currently in use**	Specific strategies employed by the participants in this research to coerce/convince family members to participate in energy efficiency behaviour in the household.	**16 codes, 47 quotations** • Strategy – authoritative

Responses about behaviour change and planning (Themes 2 and 3), personal values (Theme 10) and strategies (Theme 11) were primarily elicited by questions in the interview guide. Discussions on these topics were expected. By contrast, discussions on Themes 5 (Folk knowledge), 6 (Gender roles) and 8 (Need: information-based feedback and support) were conspicuous, in that they represent themes introduced by the participants themselves, without any prompting. All 11 themes are discussed in detail below.

5.3.3.1 Theme 1: Environmental awareness

The participants' awareness of global climate change, and their perceptions of the potential risks and mitigation strategies available are explored in this theme. This theme focused on several issues; these are divided into three sub-themes, namely the (non)threat of global climate change, personal awareness levels and those of others, and ways in which awareness could be raised.

- *Sub-theme 1.1: The (non)threat of global climate change*

Some participants regarded themselves as pro-environmental and aware of ecological issues, citing their "*conscience*" as the main motivator for environmentally responsible behaviour in an attempt to address global climate change, as exemplified by the following comment:

> *But it is obviously good if one can also save on your account, so my husband will be happy with any savings on our electricity and water account, so no it is still part of it, I think the most important motivation is the conscience.* (P5:22T4:32)

However, to some, global climate change remains a lofty ideal:

Mathilda: *But, why do you want to save electricity?*

23T3: *Oh, okay, several reasons, uhm the right reason is to lower your carbon footprint and all those things, But the financial thing is actually a big… is actually a bigger thing than all the nice reasons.* (P7:23T3:6)

While exploring the perceptions of global climate change, responses were reserved in terms of the possible impact of global climate change. Doubt about whether global climate change was real was expressed in several ways. In limited instances, participants displayed their doubt by emphasising either the impact of natural occurrences rather than the human impact on the global climate, or cited studies that disprove the human element in global climate change:

> *When you look at Al Gore's video then it worries you but then you hear another guy say to you, listen these things run in cycles, and one volcano does more harm...* (P6:23T2B:54)

> *I don't know how green this is, or how serious this global warming stuff is, some say it is true, some sources say it is not true, but in any case, I feel one must live responsibly.* (P17:3T6:23)

The tendency to prefer a personal approach to global climate change and motivate behaviour by means of personal values and personal responsibility is discussed in more detail in Theme 11. The importance of awareness in energy efficiency (and any resource for that matter) is explored below.

- *Sub-theme 1.2: Small things like "being aware" is enough*

Across the board, participants suggested that creating awareness around pro-environmental behaviour is important, and it is felt that "being aware" is enough. In the light of the general perception amongst participants that there is no real, immediate and nearby (or local) threat to the environment, it is not surprising that a "mild" approach to "going green" is also exhibited by the participants:

> *But I know that if everyone takes just that one small extra step, it is going to make a difference.* (P3:22T1:7)

> *Well, I think we all realise how valuable the earth for us you…if everyone does not contribute doesn't matter how small the contribution is and how unimportant you think it is, it is where you start you know. So and I feel here at work one had to create an awareness especially with people who are not literate.* (P16:3T4:15-18)

It is clear that there are no perceptions of imminent danger or of a need for drastic steps to eradicate the problem of global climate change. Solutions and proposed actions for curbing the global climate change issues bordered on the insignificant:

> *…exhaust gases and the planes must fly uh cars must drive, our economy would simply not allow, I mean the society, the need to live wouldn't allow us to change certain things, uhh but there are still small things that we could work on…* (P15:3T3:19:12)

Again, there is a link here between the perceived risk of global climate change and the need to change behaviour accordingly as discussed previously. To several participants, awareness-making and education presents the solution to the (non-existent) problem of climate change.

- *Sub-theme 1.3: Education*

Participants' discussions around awareness creation included suggestions for specific education programmes in households for young children:

> *But we quickly send them back, especially the grandchildren, we send them back and say go put off the light.* (P15:3T3:31)

in schools for older children:

> *I worked at the botanical garden for 12 years and I sort of got the idea that you have to turn the heads of the children…* (P4:22T3:28)

and less formal education for adults by means of community projects:

> *…literally have no idea, in the first place they can't understand how electricity works, not that I understand it, but I have an idea, so you have such a big job you know to start working with those people.* (P16:3T4:18-21)

In this section, participants' views on global climate change, the value of being aware of these changes and the role of education were presented. In the next section, participants' discussions on behaviour changes that they had implemented in their households before the intervention are reported.

5.3.3.2 Theme 2: Behaviour changes

Behaviour changes made by research participants prior to the intervention include efficient use of appliances and geysers, mainly as a result of advice in magazines and television advertisements. This theme focuses on physical changes made by members of the participating households. First, energy efficiency practices are reported, followed by a discussion of routine pro-environmental behaviour, which includes recycling, rain water harvesting and water conservation. Routine behaviour is included in this section because it is considered one way in which to increase efficient use of electricity. It is presented separately from other practices reported here which the participants do not necessarily consider habitual.

- *Sub-theme 2.1: Energy efficiency in the use of appliances and geysers*

Participants mentioned efficiency measures relating to small appliances most, as indicated in Table 30 (prominent codes). Discussions revolved around the specific use of appliances such as heaters, kettles, television sets, fridges, washing machines, ovens and stoves, irons, dishwashers, air-conditioning, underfloor heating, switching off appliances at the wall sockets, switching off "stand by", and lights. Specific issues relating to efficiency in the use of fridges, freezers and geyser timers are subsequently discussed.

Table 30

Energy efficiency practices with appliances (Code: Efficiency – appliance use)

Appliance	Strategies employed	Participant's comment
Heaters	• No use of heater • Heat only one room • Use alternatives (gas)	*I say this winter we didn't put the heater on for one day.* (P1:21T4:22)
Kettles	• Boil more water at a time and keep warm • Use immediately after boiling • Everybody drinks tea together	Mathilda: *So you boil less water at a time?* 3T19: *More water, in order to when I boil water, everyone can come and drink tea*. (P13:3T19:3) 3T4: *… yes what I do, I put my when I boil my water in the morning, it is more out of fear that there wouldn't be water when I get home, but I pour the water into a thermos flask and this afternoon when I get home, I pour it back into the kettle and boil it.* (P16:3T4:6) *Yes, for example we boil water and pour it into a thermos flask.* (P17:3T6:2)
Television sets	• Switch off when sleeping • Switch off stand by	*I'd I'd I'd sit in my room and I'd watch TV until I fell asleep but now I actually take time to switch it off.* (P2:21T5:4)
Fridges and freezers	• Switch off when empty	*23T2: Yes, definitely, I thought I will put off a couple of the fridges.* Mathilda: *Okay*? 22T3: *Yes, yes.* Mathilda: *Have you already done that?* 23T2: *Yes I did, no when you told me that the fridges don't get, you know that nothing would really, after someone else told me I shouldn't put them off… then I thought I will put them off because I don't really need it.* (P7:23T3:17)
Washing machine	• Wash at 40 degrees • Wash only a full load	*No, it's the small things when I adjust my washing machine to 40 degrees for the simple reason that colder than that it doesn't really clean the clothes and warmer it damages the material, so it is set on that and I load it, I don't wash if I don't have a*

Appliance	Strategies employed	Participant's comment
		full load (P15:3T3:29)
Stoves	• Use smaller appliances like a hotplate instead of a stove • Cook for more than one day at a time • Use oven less • Using alternatives (LP gas)	*Maybe, I don't know because even the stove, I'm not using the stove, I'm using the hot plate. When I'm cooking I always use the hotplate. I'm using it not not every time but regularly, not regularly, sometimes.* (P9:3T12:13) *…and try to cook for two days and spare the other day.* (P18:3T9:6) *I am using my oven today, but I used it very seldom, because it is a big oven and used a lot of electricity. So I do this very seldom. I used to bake a lot but now I also do that seldom.* (P17:3T6:2-3) *You see I'm cooking samp and I know samp takes long. I've got a gas. I'm cooking with the gas, now when it's start to soak and then I'm going to use the stove.* (P18:3T9:25)
Standby		*…and then also we must switch off the plugs.* (P12:3T17:7)
Geyser	• Using less hot water • Switch off geysers	3T12: *I uh we didn't use the geyser anymore, so…* Mathilda: *Okay, so you stopped using the geyser…* 3T12: *Ja, stopped using they geyser and we're not using a heater, so that changed.* (P9:3T12:8)

Energy efficiency practices in some households are quite harsh. In some instances, participants chose not to use a heater at all during winter, or to use physically smaller appliances, in order to save electricity. For instance, a hotplate is used instead of the stove, and a smaller old television set is used instead of the larger flat screen television. The participants thus perceived the physical size of the appliance to be an indication of the amount of electricity it consumed.

During the Nova pre-feasibility study and the pilot study, described in Section 4.2.2, cooling by means of fridges and freezers was pointed out to be a major contributor to electricity consumption. This was especially true in more affluent areas, where people sometimes have five or six refrigerators in their homes. These are often additional or special use fridges, such as bar fridges, caravan fridges and garage freezers. In Table 30, quotes from two participants illustrated their savings relating to fridges and freezers.

It is well known that space and water heating use most energy in the household (www.eskomdsm.co.za). Since the geyser is the largest known contributor to residential electricity consumption, discussions on the efficient use of the geyser were separately coded (Code: Efficiency – geyser use).

Geyser management was mentioned by ten of the 18 participants interviewed. The pilot study and the Nova pre-feasibility study showed that geysers are often not overtly managed because they are traditionally installed out of sight, they are fairly inaccessible and the average home owner is not sure of how to adjust temperature settings. Timing geyser use (albeit manually or automatically) by switching it off at the distribution board therefore presented the strategy most frequently adopted by participants to effect efficiency in the home.

In this study, it was found that manually switching off geysers was the main method participants used to schedule geyser use. This method works well when people remember to switch the geyser on in time for use, but sometimes it results in conflict with other family members when it is forgotten:

> *We are going to forget to put it on, then there will be drama... and it is going to come down on me, I am going to forget to put it on, I know it already.* (P10:3T14:14-16)

Participants mentioned that they switch their geysers off for large parts of the day or night, depending on their routines, as is evident from the following comment:

> *You see, every morning I switch it off, it is off the whole day.* (P1:21T4:15)
>
> *…in the morning, and switch it on during the night before sleeping* (P12:3T17:6)

Strategies that the participants used to remind themselves to switch the geyser on and off included the use of cell phone alarms, and even written reminder cards on door posts:

> *Yes, it works for me, when I walk in I immediately see the red card is on top so the geyser is still off and I quickly put it on...oh, I I just have it against against the door post...and when I have put it on, then you just turn it around [to show the green].* (P16:3T4:10-14)

These manual methods of scheduling use and managing equipment were used most often by the participants in this study, but the geyser is usually still on for about 12 hours of the day (either during the day or during the night) and the timing is influenced by the participants' daily routine. Routine changes people make in order to become more energy efficient are discussed in the next sub-theme.

- *Sub-theme 2.2: Changing of routine behaviour*

In this sub-theme, participants spoke about changing their routine behaviour in using electricity in order to increase energy efficiency. This predominantly includes changing bath-time and morning routines, to allow for switching the geyser on and off manually. Participants say that it has become part of their routine, but that it influences their routine:

> *And then I switch my geyser off if I remember, but I do not always want to switch it off because I don't want to when I walk in [switch it on], sometimes I want to take a warm bath immediately.* (P16:3T4:8)

It is clear that manual switching the geyser on has a large impact on the routine and small comforts in the household. In some cases, however, the consequences of the change in routine are not so mild and are expected to create discomfort:

> *We've never switched the geyser off, we've spoken about it, we've had to do it, but we're so inconsistent, and then like and then you wake up in the morning and there is no hot water and you thinking okay, I don't think I'm going to be able to keep up, so maybe we should start having the note and put it on the fridge. (*P2:21T5:18)

It can even create conflict:

> *We are going to forget to put it back on, and then there will be drama. Yes, and it will come down on me, I will forget to put it on, I know it already.* (P10:3T14:16)

Routine behaviour changes that have been implemented by the respondents vary. Most respondents commented that making the initial changes in their households was difficult, but that subsequently people in the household got into the habit. Routine environmental behaviour was described like this:

> *Just to take that decision, I want to do it, it is quite, it's a mind challenge.* (P11:3T16:35)

Establishing and maintaining new behavioural habits in the household were influenced by several strategies employed by the research participants to convey information about the desired behaviour regarding energy efficiency in their households. The strategies employed by the research participants before the in-depth interview were diverse (see Theme 12).

In Theme 3, below, the planned energy efficiency changes in the households are described.

5.3.3.3 Theme 3: Efficiency planning

Participants' comments around the planning of efficiency measures in the household are indicative of the strength of their behavioural intentions. In many instances, participants were not able to identify energy efficiency options themselves. During the intervention in this study, several options for energy efficiency in participants' households were pointed out to them; however, to some participants the suggestions did not hold any appeal and they relegated these ideas to "planning for the distant future". Such planning did not contain any concrete steps to attain the stated goal:

> *No not really, oh, one talks about one day you know, the the uhm solar panels and things like that, but it really is not in the near future.* (P5:22T4:20)

Future plans, in some instances, focus on the unreachable. One household did not have any hot water, since the geyser broke some months before. When asked whether the household plans any energy efficiency measures for the future, this was the response:

> *In future I think of changing the TV because you told me that one use more electricity than this one so I have to repair this one and use this one...and then I don't know maybe the fridge also because it's the old one, the old model*. (P9:3T12:10-11)

In the light of the need for hot water, the likelihood of implementing these changes was slim. Even minor changes, like using CFL light bulbs instead of incandescent light bulbs (CFL bulbs are widely available and can be obtained free of charge when swopped for the incandescent light bulbs through Eskom) may seem impossible to make if the motivation is lacking:

> *I don't know, I personally think one should start changing [to CFLs] I don't know how much it is going to save, but uh you know, change to these lights.* (P10:3T14:12)

From the comments above, it is clear that the planned measures will probably not occur. In some instances, participants suggested financial and other incentives to drive change. Theme 4 presents the discussion on financial motivation for energy efficiency and the use of incentives.

5.3.3.4 Theme 4: Financial motivation and incentives

Many participants argued that saving money (by reducing their electricity bill) was a motivational factor for their participation in this research study, as discussed in Section 5.3.2. Cost is a much more tangible aspect than global climate change. In some instances, the participants were not personally responsible for paying the electricity bill, but they perceived the account holders (in cases where they were not the same person) to be motivated by the cost of electricity:

> *With him it is more from a financial point of view.* (P4:22T3:17)
>
> *So yes, my husband will be happy with any saving on the water and electricity account,* (P5:22T4:8)
>
> *He's the one; he's the one because he's the one who is paying.* (P14:3T20:7)

The rand value on an electricity bill serves as the main feedback consumers receive about their electricity consumption, usually at least one month after use. Feedback on responsible use is lacking, and participants comment on their inability to assess whether they have managed to save electricity or not:

> *You don't know whether it will make a difference in the end.* (P4:22T3:12)
>
> Mathilda: *And do you feel that it makes an impact?*

3T9: *No...I don't use… you see I'm having what type of heater I'm doing also that, but it doesn't have an impact.* (P18:3T9:10)

One participant suggested the use of incentives to encourage energy efficiency:

I think the municipality or someone gives you a rebate. (P3:23T2:6)

However, the motivation behind the provision of rebates and incentives by government is sometimes viewed with suspicion, as is explained by the same participant:

I think the motive around, around the rebate [for installing solar water heaters] was to help Eskom to provide electricity in in times when they had a shortage, so I don't think it was ever driven by a green agenda, it was because of the need, because they didn't have enough power stations. And this thing will fade when they have, they are busy building their power stations and when they are done they will ten to one let these things slide because they have the capacity, and it's a business so they need to sell. (P6:23T2:36-40)

This comment is an indication of the distrust some participants displayed of large corporations and government. (This is discussed in more detail in Theme 10.) In the next theme, the impact of erroneous beliefs on the functioning of certain appliances is explored in more detail.

5.3.3.5 Theme 5: Folk knowledge

Folk knowledge is defined in this study as generally accepted facts about appliance operation held by participants, but not been confirmed by the results of the measurement of energy use by appliances in the pre-feasibility and pilot studies described in Section 4.2.2. and 4.4.2. Nye and Hargreaves (2010) show that "'folk knowledge' about what it means to live a green lifestyle, how to use surrounding systems in greener ways, and why it is desirable to do so" (p. 146) is often dispelled or enforced within a person's close social system. In other words, beliefs are preserved and even promoted by means of normative beliefs, via family and friends. The savings that could be achieved in households through altering this folk knowledge about energy use by appliances are potentially large. Some examples of this folk knowledge are listed in Table 31 and are illustrated by quotations from the in-depth interview transcripts.

Table 31

Examples of folk knowledge

Folk knowledge	Quote
Fridges/freezers have to be switched on in order to avoid damage (even when they are empty)	*When you came to see me, I thought that the fridges is not really necessary...after somebody said one shouldn't put it off because of the gas and blah blah blah, then I thought I will put it off because I don't need it.* (P7:23T3:19)
Geysers are too old to put on a	*And a geyser, so I tried to find out and it sounds to me like… I can't really remember, it was too expensive to put a switch*

Folk knowledge	Quote
timer switch	*on the old geyser and I would have to get a new geyser in order to put a timer on it.* (P16:3T4:9)
Geyser timers do not make a difference	*… she is right here at home and she doesn't use anything, but the electricity just flies. Other people told me I should put off the geyser but it doesn't help.* (P1:21T4:31)
Smaller appliances use less electricity	*…maybe, I don't know because even the stove, I'm not using the stove, I'm using the hot plate.* (P9:3T12:13)
Downlighters do not use a lot of electricity	*She … wanted these ridiculous lights you know the, the round the small round ones, the multiple ones.* (P2:21T5:26)

The participants' folk knowledge about the functioning of household appliances potentially contributes to higher electricity consumption, so changing these beliefs provides great savings potential. The interactions in households also contribute to the uptake in the household of the energy efficiency practices suggested. These interactions may have a large impact on energy efficiency practices in the home, as described in the next section.

5.3.3.6 Theme 6: Gender role interactions

This theme describes the perceptions and role definitions with regard to managing electricity in the home. Questions about the interaction between men and women in households were not included in the interview guide, since this was not identified as a contributing matter in either Nova's pre-feasibility study or the pilot study, or the literature reviewed. However, it was one of the most prominent codes identified in the content analysis, as presented in Table 28.

In most instances in literature, it was argued that it did not matter who reported the household electricity findings, since household behaviour is thought to be understood by all members of the household (Abrahamse et al., 2005; Gatersleben et al., 2002; Staats et al., 2004). Carlsson-Kanyama and Lindén (2007) argue, however, that "traditional surveys where one household member answers about the overall household behaviour cannot capture the intricate pattern of how household chores are divided between men, women and children" (p. 2171). The exploratory nature of this study encouraged interaction in the household among its members (by means of the intervention) and provided an opportunity to discuss the effects of the interactions that took place in the home at a later stage (during the focus group sessions). The intervention combined with the focus group sessions later on provided some insight into the interpersonal interactions between household members regarding energy efficiency, although a more in-depth study on this is recommended in Section 6.6.1 and 2.

The perceptions of gender roles were explored during the in-depth interviews and are presented in two sub-themes: the support for energy efficiency in the household among its members, and aspects where conflict arises due to perceived excessive electricity consumption.

- *Sub-theme 6.1: Support for energy efficiency in the household*

The interaction between household members focused on the establishment and maintenance of a routine in the household suitable to everyone, and the expectation that household members would uphold the established routine. Interestingly, the female participant in a household often identified herself, or the male participant described his female partner, as the main actor in establishing change in the household:

Mathilda: *Oh okay, so who in the household drives the change, sounds like you?*

22T4: *Yes it would be me. He will maybe sometimes put of the light or not water the garden every day, but no, I think it is actually me, yes.* (P5:22T4:30)

So uhm but I am the one that does it recently, you know he leaves early and comes home after me, so I am the one that opens the windows, switches on the lights, switch off the lights and those kinds of things, but he is in it with me. (P11:3T16:10-14)

Usually my wife is the one who takes the newspapers to the church [for recycling]. (P10:3T14:19)

In the comments quoted above, the adult female in the household is often the one who takes responsibility for change, along with the expectation of behaviour in accordance with the established routines. Although an individual in the household (often a female) puts a desired routine in place, the behaviour of other members of the household does not always comply with expectations. This example focuses on recycling practices:

When I catch him he is throwing something into the dustbin again, then I take it out and I rinse it, but no he really tries hard. He is getting better with it. (P5:22T4:9)

From time to time, non-conformity with the desired behaviour stated in the household led to conflict, which is discussed in more detail in the next sub-theme.

- *Sub-theme 6.2: Conflict about energy consumption in the household*

In instances where members of the household have different priorities or little communication about a common aim such as saving electricity, conflict may arise. This is particularly visible in the following comments:

There is constantly conflict in the house because of the electricity consumption. (P4:22T3:2)

He is very strict with us. (P6:23T2:23)

We are going to forget to put it [the geyser] back on, and then there will be drama. Yes, and it will come down on me, I will forget to put it on, I know it already. (P10:3T14:16)

Conflict is sometimes avoided by not addressing energy efficiency and recycling issues at all. In some households it became clear that no overt discussions about electricity use in the household and household aims regarding electricity has ever occurred, as illustrated here:

Mathilda: *Is there someone in the household who is more pedantic about switching the lights off that the others, or not really?*

3T14: *Uh, I think I switch off more than the rest of the household.*

Mathilda: *Okay and uhm your wife doesn't switch it off as often as you would have wanted?*

3T14: *No, no.*

Mathilda: *What do you do to get her to switch it off?*

3T14: *Ag uh, I don't really do anything, I just switch it off. Just switch it off behind her.*

Mathilda: *Lead by example?*

3T14: *Yes, and the kids aren't bothered you know.*

Mathilda: *Have you talked about it?*

3t14: *Not really.* (P10:3T14:27-29)

A lack of discussion between household members on energy efficiency is evident. (This lack of communication is explored in more detail in Theme 11.) In the next section, the need for comfort and convenience is discussed in more detail.

5.3.3.7 Theme 7: Comfort

Comfort was discussed in two ways; the first was that pro-environmental behaviour (whether it related to energy efficiency, recycling or water management) had to be convenient in order to sustainable; the second was the need for comfort (and electricity is used to fulfil that need) at whatever the cost may be.

- *Sub-theme 7.1: Pre-environmental behaviour needs to be convenient*

In terms of energy efficiency measures, participants expressed the need for recycling, water management and energy efficiency to be convenient, otherwise they would not implement it. Inefficient but convenient measures included drying washing in the tumble dryer and not recycling at all:

No, we just take the garbage out and then the truck comes picks it up and it's done. (P2:21T5:53)

Mathilda: *Okay, and do you recycle, you know, do you put glass on the side and throw that away separately, or how does it work?*

3T17: *Uhm m, I don't do that.*

Mathilda: *Just one bin?*

3T17: *Mm.*

Mathilda: *Okay, do they pick it up here?*

3T17: *They pick it up here, mm*. (P12:3T17:12)

I don't know how it [recycling] it going to work, but I think it would have been nice if they did it like overseas where you put your different containers out and put it on the street and the guys pick it up for you… (P4:22T3:41)

I sometimes think it is just plain effort, and we are lazy, it's just easier not to do it, but it doesn't take a lot out of you. (P5:22T4:38)

From these quotes it is clear that the convenient practices for efficiency need to be in place, as in the case of this participant:

…and he has two drums in the area that is closed off and then I just threw it away over there because you can throw it away at any time, and I drive in that direction in any way. (P5:22T4:5)

- *Sub-theme 7.2: Comfort is important*

Even though participants may be very conscious of the possible impacts of their behaviour, they indicate a perceived dichotomy between comfort and efficiency. They also recognize the need for balance between the two:

But the thing with with energy efficiency and with saving anything is later on it borders on stinginess. (P4:22T3:19)

…What we could do and sometimes one doesn't know whether you could have done something extra that doesn't create a great disruption…. (P15:3T3:5)

But what we need to use we could minimize without creating a total inconvenience. (P15:3T3:15)

Feeling suffocated by dos and don'ts in energy efficiency, recycling and the consumption of food and drink was mentioned especially by participants from the more affluent areas. This is discussed in more detail in the themes generated from the focus group analysis in Phase 3. Several (nine) of the research participants emphasized the need for guidance and more information on establishing new strategies for efficiency in their households. In the next theme the need for information-based feedback is emphasized.

5.3.3.8 Theme 8: Need: information-based feedback and support

In this section, discussion centred around the need for information-based feedback and adequate support from the electricity suppliers. Participants expressed a need for guidance as a desire to understand electricity better, and the need for municipal staff to provide guidance and advice on energy efficiency to participants in a friendly manner, as expressed here:

> *…their attitude [municipal staff] because we just found somebody saying that they don't know that and that, you never come out satisfied after an encounter with them. You are still the problem that you had you still come back with it at home.* (P18:3T9, 22:20)

The need for personal interaction was expressed as follows

> *…when you told me that the fridges is not really necessary...after somebody said one shouldn't put it off because of the gas and blah blah blah, then I thought I will put it off because I don't need it.* (P6:23T3, 7:19)

The need for personalized advice was emphasised by this expression of the need for guidance:

> *And there is such a lot of nonsense on the market, every guy who talks to you about efficiency is trying to sell you something, there is nobody that objectively says 'This is the best'. The guy that hawks always wants to sell you a geyser or the guy who sells you a solar panel doesn't even know the difference between a heat pump and a solar panel or whether it should be in parallel or serial. It is just an extortion market.* (P6:23T2:50-52)

A need for better feedback and information regarding energy efficiency was also expressed. Participants stated their curiosity about coming to understand the consumption of electricity in their households as their motivation for participation in this study (refer to Section 5.3.2), because currently feedback is limited. The lack of timeous feedback was cited by participants in this study as a barrier to changing behaviour with regard to electricity use, since the impact of the behaviour change is unclear from the current billing system:

> *Yes, I think there's something about not being…not having access to the information. Yes, definitely is a bit handicapped.* (P2:21T5:28)

> Mathilda: I*s it important for you to see that there are financial savings on your bill at the end of the month or don't you expect...*
>
> 3T6: *OBVIOUSLY!* (P17:3T6:16)

Participants specifically expressed the need to receive consistent billing, as explained here:

> *Even before the account comes when you go and check that last month it was this and adds this. I can't even because it makes it difficult for you as a house owner to be able to balance your things that I'm expecting to be charged. You come back [with an] exorbitant amount and then you are inconvenienced in other accounts.* (P18:3T9:14)

Participants sometimes resort to alternative measures in order to attain the desired feedback, such as installing pre-paid meters in their homes:

> *Yes, I think that if you can see how much you are using you would definitely [save] that is way we talked the other night about installing a pre-paid meter.* (P4:22T3:25)

These responses from the research participants were provided before the electricity consumption data was made available to them (before the blind measurement was unveiled). The consequent impact of the real-time feedback monitor and its impact in the household are discussed in relation to the findings on the focus groups and are reported in Section 5.5.3.

5.3.3.9 Theme 9: Role players in energy efficiency

The participants expressed a need for clear identification of the role players in efforts against climate change. This entails the argument that authorities, civil organizations, community groups and individuals need to declare their interest and act in accordance with their declared aims. A great sense of distrust in government, the municipalities and the national energy provider (Eskom) was found:

> *I think those of us who pay, pay for the whole lot who doesn't pay.* (P17:3T6:20)

The participants also expressed a need for a holistic approach, in other words, for all spheres of one's life, including the authorities, work and personal, to be on board. The perception that authorities do not exhibit pro-environmental behaviour undermines the commitment of individuals:

> *You know what can make one really negative is when your streetlights outside are on and you phone and you tell them and you phone a week later and you tell them and it keeps on burning day and night you know …and then you realize you know what, the people feel that they try, but the bigger institutions ha-ha feel nothing...yes your effort means nothing.* (P7:23T3:26-29)

Another participant sees government as potentially playing a positive role:

> *So I think if government did it and then cause also like if gov...I think people are more prone to listen to government as opposed to listen to uhm a private stakeholder because you I mean with with a lot of people it's always oh no they're trying to make money off of me why why can't I just do this myself so if it's government it's it's seen more as mandatory as opposed to optional.* (P2:21T5:34-37)

It is clear that this participant prefers messages coming from government and being regulated and is in stark contrast with the previous quote where the participant distrusts government completely. Nevertheless, it seems essential to participants that role players specifically in authoritative positions show integrity in energy efficiency management. The interplay between the integrity of the leaders and the perceptions of people about the message of those messages will need to be explored in more detail in future research. In the following section, the values and perceptions and statements by the participants about themselves are highlighted.

5.3.3.10 Theme 10: Self and values

In this research, using resources sparingly was considered a value, a personal attitude that is not hereditary and an indication that the person is "grounded"; with several participants indicating that they were "brought up that way":

> *Because I uhm grew up in the Karoo where we were frugal with everything, and it is absolutely my attitude.* (P3:22T1:1)
>
> *I just want to tell you uhm uhm littering and things is so uh uh to to to no do that and to pick it up is so ingrained [sigh] since school days already.* (P15:3T3:58)

Participants who said that they grew up using resources sparingly also had a very strong sense that it is their personal responsibility to act environmentally responsibly. Interestingly, the value of using resources sparingly was only mentioned by the more affluent participants. This raises some interesting questions, which are discussed in more detail in the discussion of Phase 4 in Section 5.6.1.

Comments made by participants on their values and how they perceive their own level of environmentalism included several different aspects:

- a sense that the earth is valuable;
- each person can make a difference;
- one has to listen to one's conscience;
- acting environmentally responsibly is a spiritual thing;
- it is their personal responsibility; and
- expressing the need to display consistent pro-environmental behaviour.

Comments that illustrate values as the driving force behind participants' behaviour and show that it comes down to a personal and spiritual responsibility to change consumption behaviour are presented below:

> *True, stay true to myself.* (P3:22T1:5)
>
> *I think the most important in motivation is the conscience*. (P5:22T4:29)
>
> *Yes, no, what I often think it is like religion, you must, that little thing you think is right, you must do that. (P6:23T3:35)*

These quotations all highlight the personal motivation factors such as values, listening to one's conscience and understanding one's role in nature. Although it might seem as though moral norms are being laid down by the participants, it depends on the way in which the individual sees the task that would determine its effectiveness. A discussion on the effect of morals versus social norms on personal behaviour is presented in Section 6.2.1.

5.3.3.11 Theme 11: Strategies currently used (i.e. before the intervention)

The strategies employed by the research participants in their households before the commencement of this research are discussed in this section. The researcher is aware that no household is a *tabula rasa,* and that several had possibly already introduced some pro-environmental practices in their households before the commencement of this study. The participants' management of the behaviour of family members' use of electricity ranged from using discussions to coercion. Several different strategies were used to motivate behaviour change in the household. These are subdivided and illustrated by means of comments in Table 32, and are discussed in more detail after the table.

Table 32
Household strategies already in use as reported by the participants

Strategy	Quote
Authoritative verbal instructions	*Why do they do it? Because I said so.* (P9:3T12:4) *We will easily send them, especially the grandchildren, we easily send them and say go switch off that light.* (P15:3T3:31)
Communication • Reminders • Family discussions • Shared responsibilities • Request understanding/pity • Spreading the word	**Reminders** *I'm always nagging him to switch stuff off.* (P2:21T5:10) **Family discussions** *And we discuss it with them...in general.* (P15:3T3:32) *Uh everybody knows because my husband is the last to go off, he knows that all the switches shall be off except for the light switch there.* (P18:3T9:15) **Request for understanding/pity** *I always tell him: "Look at my rent, can't you have pity for me, whenever you're here this is the amount that I get".* (P18:3T9:23) **Spreading the word** *Yes, I told everybody about this meter and you don't want to know, but it works and I tested it with all the you know appliances switching it on or whatever.* (P11:3T16:41)
Physical changes • Reminders • Lead by example • Plan/schedule use	**Reminders** *At this stage we are using the cell phone.* (P11:3T16:85) *…but now I have this system, a red card and a green card, yes it works for me when I walk in the door I immediately see*

Strategy	Quote
• Pre-paid meters • Provide meter-readings	*the red card above that...* (P16:3T4:20) **Plan/Schedule use** *…in order to when I boil water, everyone can come and drink tea.* (P13:3T19:3) **Pre-paid meters** *I am going to get a prepaid meter, because I am almost certain that I use less power than what they say I am using.* (P9:3T12:22) **Provide meter readings** *My husband takes the readings and phones it through.* (P17:3T6:17)
Become active in the work place • Open forums • Translate recycling information	*…but we have somebody on the committee for example that uhm who can translate well and when we talk at the personnel forum to people we to tell them to switch off your appliances.* (P16:3T4:23)

The strategies employed by people in their households include using authoritative instruction by means of written and spoken instructions to family members; verbal communication, including requests, family discussions and nagging; physical reminders by means of cell phone alarms and reminder cards. Other physical interventions, such as phoning through the meter readings to the municipality and requesting pre-paid electricity meters from the municipality may increase a perception of control over a situation otherwise construed as unmanageable (Theme 8: Availability of information based feedback and support). Especially in instances where participants lived alone, they discussed the study with friends and colleagues, and those participants started to become more involved in energy efficiency measures at their places of work, applying energy efficient practices more broadly. These strategies provide some insight into the ways in which participants try to motivate energy efficient practices in the home.

5.3.4 Conclusion on Phase 2, Part 1

From the analysis of the in-depth interview data, it became clear that the participants believe that although global climate change is not an immediate threat, each person has a responsibility to act in accordance with his or her own conscience in order to effect a change for the better. Awareness around global climate change is not high, and participants in this study could not identify their role in eradicating global climate change clearly at an individual level. Participants tended to indicate that awareness campaigns and education should be used to increase awareness of global climate change.

Planning for efficiency is lacking, as participants were unable to indicate clear plans and how these would be pursued. Even though some energy efficiency strategies were employed in some households before the commencement of this study, there are and will probably always be inertia toward behaviour change due to the perceived uncomfortable impact of these changes, especially in the home. In order to avoid conflict in the household, changes in routine practices are often not implemented. If changes are made, they are more likely to be instituted and applied by the female members of the household.

A need for information-based feedback and support was expressed, along with a clear indication that role players in energy efficiency are difficult to identify, and that there are not enough strong leaders with integrity. Strategies for addressing change in the household vary from authoritative commands to energy efficiency's becoming a lifestyle where people lead by example and engage colleagues and family on discussions about energy efficiency.

In the next section, the results from Phase 2, Part 2 of the analysis, the quantitative findings and the effectiveness of the intervention, are reported.

5.4 Phase 2: Part 2 – Quantitative results: electricity usage data

This section starts with the demographics of the research participants regarding the electrical usage data. Historical baseline data from 2007, 2008 and 2009 in the same geographic areas used in this study are then presented, followed by a description of seasonal differences in the electricity consumption figures collected in this research. Subsequently, the household consumption, and the daily, per capita and per square meter electricity use of the households that were observed are given. This section concludes with an assessment of the effectiveness of the intervention.

5.4.1 Demographics of the participants regarding the quantitative data

The number of participants with available electricity usage data was 36. The mean age of the research participants was 48 (the youngest was 27 and the oldest participant 69). The mean number of people in a household was four (with a standard deviation of two). The demographics are presented in Table 33.

Table 33

Overview of the demographic features of research participants and households (n=36)

Variables	Attributes	Frequency
Gender	Female	27
	Male	9
Education	Grade 12 and below	11
	Diploma/Degree	13
	Postgraduate qualification	12
Age	-30	3

Variables	Attributes	Frequency
	31-40	7
	41-50	8
	51-60	13
	61+	5
Number of adults in the household	1-2	15
	3-5	18
	6+	3
Number of children in the household	0	18
	1-2	13
	3-5	4
	6+	1
Ownership of the home	Rented	4
	Owned	32

The Pearson correlation coefficient was computed in order to explore the relationship between the LSM and the number of people residing in participating households. Not surprisingly, a negative correlation was found (r_s=-0.42467, n=36, p=0.0098) – the more people in the household, the lower the LSM score and vice versa.

The LSM grouping is used as the basis for comparison throughout this chapter, except in Section 5.4.6, where the effect of the intervention is discussed. In Sections 5.4.4 and 5.4.5, Experimental Groups 1 and 2 are compared in order to illustrate the effect of the intervention.

5.4.2 Household inventory

As discussed in Section 4.4.4, a household inventory was completed by each of the participating households. The inventory lists 96 variables, including pools, gardens, lights (one count per room for all lights, i.e. yes or no in the living room, bedroom or kitchen for example), television sets, HiFi/DVD players, computers, heaters, air conditioners, fridge/freezers, washing machines, dryers, dishwashers, microwaves, kettles and geysers. Detailed results from the inventory are set out in Appendix I. In this section, an overview is given of the type and number of amenities and appliances recorded, and differences between the two LSM groups are presented. The ratio of old appliances versus new appliances is also discussed.

5.4.2.1 Amenities and appliances

In Table 34, a summary of the amenities and appliances in the measured households is provided. Some interesting phenomena are pointed out after the table.

Table 34

Amenities and appliances for LSM 6-9 and LSM 10 (n=36)

Amenities and appliances	Amount	LSM 6-9 (n=13)	LSM 10 (n=23)
Garden (yes)		7	22
Pool (yes)		0	11
Number of bathrooms	0	1	0
	1	10	3
	2	2	10
	3+	0	10
Number of bedrooms	1	0	0
	2	5	3
	3	5	8
	4	1	6
	5	1	3
	6	1	2
Number of television sets	1	10	11
	2	2	10
	3+	1	2
Number of Hi-Fi sets	1	4	1
	2	9	12
	3	0	5
	4+	0	5
Number of computer(s)/laptop (s)	0	10	1
	1	3	15
	2	0	5
	3	0	1
	4+	0	1
Number of heater(s)	1	11	14
	2	2	6
	3+	0	3
Combined fridge/freezer(s)		10	22
Fridge(s)		3	9
Freezer(s)		2	17
Stove			
- Ceramic		1	2
- Steel		12	18
- Spiral		0	2
Washing machine			0
	No	5	1
	Yes	8	22
Dishwasher			
	No	12	6

Amenities and appliances	Amount	LSM 6-9 (n=13)	LSM 10 (n=23)
	Yes	1	17
Tumble dryer			
	No	11	9
	Yes	2	14
Microwave			
	No	1	23
	Yes	12	
Kettle		13	23
Geyser	0	3	0
	1	9	11
	2	1	10
	3	0	2

Every household has a kettle, and all have a microwave, except one household. Other than that, the differences between the households in the LSM 6 to 9 and the LSM 10 Groups are vast. About half of the LSM 10 Group have swimming pools and most have two or more bathrooms, while in the LSM 6 to 9 Group, the majority have one bathroom per household. It is interesting to note that in cases where the LSM 6 to 9 Group have several bedrooms, the number of people in the household is also high.

Although the LSM uses the presence of certain appliances as part of its criteria, this description of the differences between the LSM 6 to 9 and LSM 10 Groups provides a detailed picture of the different circumstances these two groups of people experience as part of their socio-economic realities every day. Table 35 indicates the mean, standard deviation and median of the main amenities and appliances in all 36 households.

Table 35

Mean, standard deviation and median of household appliances

Variable	Mean		StdDev		Minimum		Maximum	
	LSM 6-9 (n=13)	LSM 10 (n=23)	LSM 6-9 (n=13)	LSM 10 (n=23)	LSM 6-9 (n=13)	LSM 10 (n=23)	LSM 6-9 (n=13)	LSM 10 (n=23)
Age	44.6	50	11	10	28	27	62	69
Adults	3.5	3	1.7	1	1	1	7	7
Children	2	0.8	2.5	1	0	0	9	3
Living rooms	1.3	2.2	0.5	0.6	1	1	2	3
Bedrooms	3	3.8	1.2	1.2	2	2	6	6
Bathrooms	1	2.3	0.5	0.7	0	1	2	4
TVs	1.3	1.6	0.7	0.7	1	1	3	4
Hifi/DVD	0.7	1.8	0.5	1.4	0	0	1	5

Variable	Mean		StdDev		Minimum		Maximum	
Computers	0.2	1.4	0.4	0.8	0	0	1	4
Heaters	0.1	1	0.4	1.7	0	0	1	6
Geysers	0.8	1.6	0.5	0.7	0	1	2	3

Determining the electricity consumption of individual appliances, as was done in the Nova pre-feasibility study was not possible with the Efergy E2 metering system used in this study. However, the collective effect of using more (or fewer) appliances, and whether or not they are new may have an effect. This is discussed in the next section.

5.4.2.2 Ratio of new appliances to older appliances

In the LSM 6 to 9 Group, the number of appliances owned ranged between six and 11 appliances with an average of eight appliances in the home. New appliances (less than five years old) constituted 35% of the appliances. In the LSM 10 Group, the average appliance ownership ranged between ten and 27 appliances, with an average of 16 appliances in a household. An average of 45% of the appliances in the LSM 10 households was less than five years old. As expected, there is a significant and strong correlation (r=0.849) between the number of appliances in the household and the LSM, since the LSM is based on household content.

As discussed in Section 4.5.2.3, both Pearson and Spearman's correlation coefficients were used to examine the relationships between several variables. Both Pearson (r) and Spearman correlation coefficient scores (r_s) and the statistical significance of each score is given in Table 36.

Table 36

Correlations between LSM group, average consumption and appliances owned

	Pearson's correlation coefficient (r) (n=36)	Statistical significance (p) (n=36)	Spearman's correlation Coefficient (r_s) (n=36)	Statistical significance (p) (n=36)
LSM and head count	-0.42	0.0098	-0.19	0.2539
LSM and appliance count	0.73	<0.0001	0.85	<0.0001
LSM and new appliance ratio	0.26	0.133	0.11	0.5072
Average use and appliance count	0.54	0.0006	0.56	0.0003
Average use and appliance ratio	0.06	0.722	0.02	0.9041

From the information in Table 36, several conclusions can be drawn, some of which were anticipated. The living standard score indicated a moderate negative relationship with the number of people in the home (headcount) (r=-0.42, n=36, p=0.0098), signalling that having fewer people in the household correlates with a higher living standard. Also, the living standard of the participants' households showed a significantly strong positive relationship with the number of appliances in the household ($r=0.73$, $n=36$, $p=<0.0001$). This was to be expected, since the LSM measurement focuses on participants' access to appliances in their homes. No correlation between LSM and the number of new appliances in the household ($r=0.26$, $n=36$, $p=0.133$) was found, indicating that regardless of their LSM level, various participants owned new appliances.

It was initially thought that owning newer appliances (less than five years old) would correlate with lower electricity consumption in a household due to the appliances' improved efficiency. The mean ratio of new/old appliances in this sample, however, was 0.41 (with a median of 0.46). This means that in this sample, most households had an average of 40% new appliances and 60% old appliances. No correlation between the ratio of new appliances to old appliances and average electricity use could be found; a very weak correlation between the number of new appliances and electricity consumption ($r=0.06$, $n=36$, $p=0.722$) was calculated. In other words, owning new appliances did not contribute significantly to electricity savings in this sample. This could have been caused by the rather low new/old appliance ratio. The more appliances in a home, however, the higher the average electricity consumption, as is clear from the significantly moderate correlation ($r_s=0.54$, $n=36$, $p=0.0006$) between the average electricity consumption and the appliance count in the households.

In the next section, the historical baseline data obtained for the three geographical areas included in this study are discussed. This enables an overview of the average use per geographical area over a period of two years between 2007 and 2009.

5.4.3 Historical baseline data

Please refer to Appendix J for the full list of average monthly consumption figures for the three areas from 2007 to 2009. The baseline data enabled the researcher to compare participating households in the same area of measurement to previous usage patterns. The historical baseline findings are discussed in more detail, followed by the averages from the current study, putting both the historical baseline data and this study's results into perspective. The historical baseline data for Mamelodi, Garsfontein and Woodhill are presented in Figure 16.

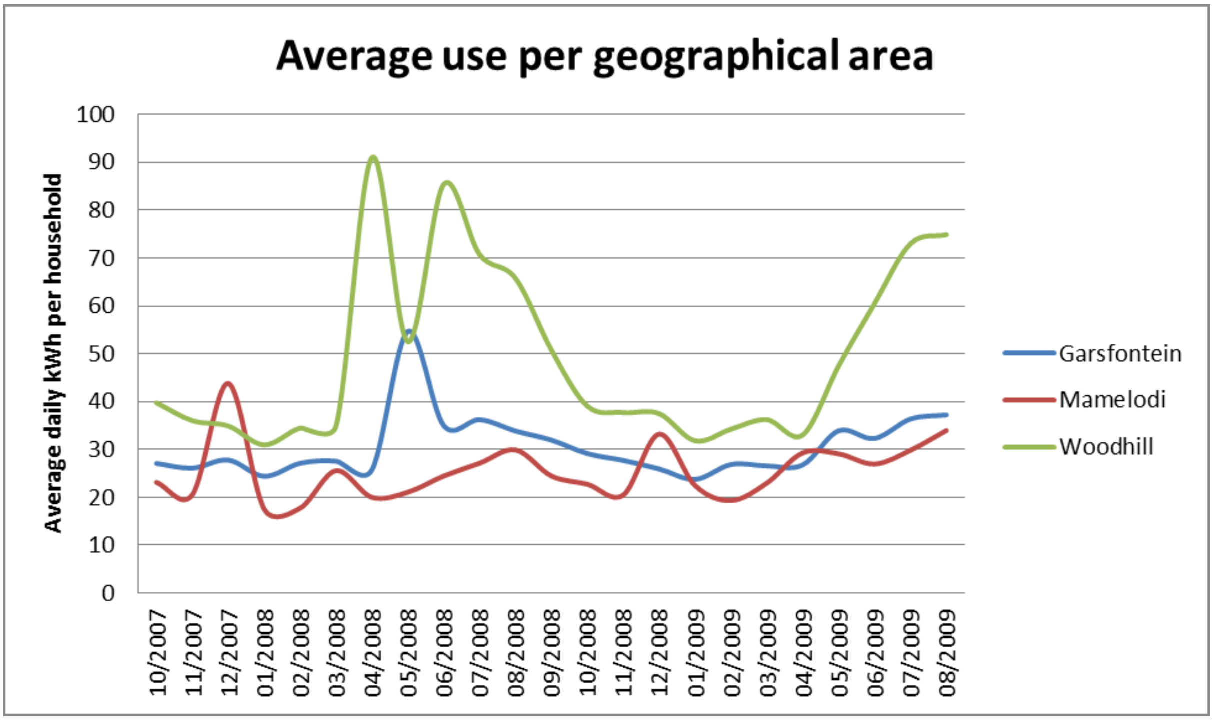

Figure 16 The three geographical areas' use compared, October 2007 to August 2009

Figure 16 shows that the three areas have distinctly different usage patterns. The climate or the weather could not be used as an explanation, since these areas are within a 20 km radius of each other. It is interesting to note that during the December 2007 and 2008 holiday season, with an average maximum temperature of 27.51°C and an average minimum temperature of 15.91°C (data made available by the Agricultural Research Council of South Africa, 2012, and presented in Appendix J), the electricity use in Mamelodi spiked, while in the more affluent areas, it dropped. Higher electricity use during this time may be due to more people (and possibly visitors) being on vacation in their homes. In the more affluent areas, however, the electricity consumption drops considerably during the same holiday season, possibly due to residents' being away on vacation.

During winter, electricity consumption in Mamelodi, Garsfontein and Woodhill increases, probably due to the cold weather (an average maximum temperature of 19.89°C and a minimum temperature of 4.4°C during July 2008, for example). However, the rate at which the very affluent (Woodhill) consume electricity in winter is astounding. This could be an indication of a high need for comfort at any cost (in the form of heat), while the less affluent may resort to other methods of keeping warm in winter (such as using gas heaters and blankets).

The last observation from the historic data is that the impact of the global economic problems may have played a role in the actual use of electricity in households. It is clear that the spike in Woodhill during a cold winter in 2009 (with an average maximum temperature of 17.97°C and a minimum temperature of 2.38°C) is quite a bit lower, comparatively, than that in a warmer 2008 winter (with an average maximum temperature of 19.51°C and a minimum temperature of 3.85° C). In Mamelodi, it seems as if the average use increased in 2009, but was still lower than the use in

2007. Both of these trends may be due to the global economic situation and the various incidents of load shedding that occurred in South Africa in 2007 and 2008, which consequently increased awareness of energy efficiency during 2009. Although electricity price increases occur at the end of June each year (during winter), it was not assumed to have an effect in this study, as participants in both Experimental Groups 1 and 2 were affected by the change.

In Table 37 average daily electricity use from the historical baseline (in the three geographic areas) is compared to the averages for the two LSM groups that participated in this study. Although this comparison is useful for placing electricity consumption in perspective, it is not necessarily very accurate, due to the non-probability sampling method used in this study (which implies that the sample may not be representative of the geographical areas presented in the baselines). However, from Table 37, it is evident that the baseline average kWh use per household per day is very similar in Mamelodi and the LSM 6 to 9 Group, while the LSM 10 Group represent the exact average between the Garsfontein and Woodhill/Menlopark geographical measurement.

Table 37

Historical baseline use compared to participating households in this study

	Historical baseline averages (2007-2009)			**Research participants' averages from each geographical area (2011)**		
	Mamelodi	**Garsfontein**	**Woodhill/ Menlopark**	**Mamelodi**	**Garsfontein**	**Woodhill/ Menlopark**
Average kWh use per household	18.5 kWh	28.3 kWh	36.8 kWh	20.52 kWh	31.8 kWh	29.3 kWh

The averages presented from the historical baseline data in Table 37 represent a daily average taking the full period of available data into consideration (2007 to 2009). The data collection period in this study was fairly short, so averages presented from this study are not necessarily a generalizable representation of average use.

In the next section, the electricity consumption of the participants in this study is described.

5.4.4 Daily kWh average, per capita and per square metre use in households

In this section, the daily averages and per capita use in the participating households are presented. The daily average is a useful measure, in that it corresponds with the baseline measurements per area, as discussed in Section 4.5.2, and presents a single unit of measurement, while per capita use is useful for comparison, since it encompasses not only the appliances in the household, but also provides an indication of the extent to which one person in the household contributes to the total households' electricity consumption, enabling the researcher to look at the per person usage rate.

In this study's sample, the average monthly kWh use per household measured monthly was 3.8kWh per square metre in the LSM 6 to 9 Group, and 3.7kWh per square metre in the LSM 10 Group. The LSM 10 Group seems to use slightly less electricity per square metre; however, the number of people served by that consumption is far fewer, the houses much larger and the efficiency in these households is far lower than that of the LSM 6 to 9 Group.

In Table 38 below, daily use of kWh per household is provided, and in the last column for each group, the monthly electricity consumption (based on the average daily consumption during the measurement period multiplied by 30) is given. The average use per household and the per capita use in both the LSM 6 to 9 (n=13), and LSM 10 Groups (n=23) are presented in Table 38.

Table 38

Average household, per capita and per square metre use in the LSM 6 to 9 and LSM 10 Groups

LSM 6-9 (n=13)				LSM 10 (n=23)			
Audit number	**Ave kWh use (daily) per household**	**kWh Per capita (daily)**	**kWh Per m^2 (daily)**	**Audit number**	**Ave kWh use (daily) per household**	**kWh Per capita (daily)**	**kWh Per m^2 (daily)**
3T2	14.1	1.6	1.8	**22K1**	6.31	6.3	0.4
3T12	13.88	1.7	1.7	**22K7**	27.01	4.5	1.1
3T19	33.37	2.1	2.1	**3T16**	12.17	6.1	0.5
3T20	17.66	8.8	1.1	**3T14**	39.75	13.2	1.7
21K5	5.92	0.7	0.2	**3K4**	50.89	8.5	1.6
3T17	23.82	7.9	3.0	**3K3**	48.45	12.1	1.2
21K2	10.73	2.7	1.3	**3K8**	43.91	7.3	1.1
21K1	15.15	3.0	0.9	**3K12**	44.48	14.8	1.4
22T1	7.77	7.8	0.5	**3K19**	41.91	10.5	1.0
3K2	61.03	10.2	7.6	**31K1**	11.42	5.7	0.7
21T4	21.75	5.4	1.4	**23K4**	43.29	10.8	1.1
3T4	7.21	7.2	0.5	**22K4**	55.81	11.2	1.4
3T9	8.45	1.7	0.5	**23K2**	27.75	6.9	0.7
				3K15	38.96	19.5	1.2
				3K1	27.04	13.5	1.7
				3K10	26.00	13.0	1.6
				22T4	13.81	2.3	0.3
				22T3	16.77	4.2	0.4
				23T2	43.50	6.2	1.1

LSM 6-9 (n=13)				LSM 10 (n=23)			
				23T3	42.62	10.7	1.3
				3T3	25.34	12.7	1.6
				3T1	19.82	9.9	2.5
				3T8	**48.12**	**9.6**	3.0
Average	**14.98**	**4.2**	**1.7**		**32.8**	**9.5**	**1.2**

From Table 38, it is clear that the average per capita use in LSM 6-9 is 4.2 kWh per person per day, 14.98 kWh per household per day and 1.7 kWh per square metre per day. In the more affluent areas (LSM10) the consumption is 9.5 kWh per person per day, 32.8 kWh average consumption in a household per day and 1.2 kWh per square metre daily. The electricity consumption per square metre for LSM 10 users was less than for those in LSM 6-9, presumably due to the higher number of square metres in their homes. It is clear, however, that the LSM 10 users consume, per person (and as a household), more than double the amount of electricity used by their LSM 6-9 counterparts (LSM 10 per capita = 9.5 kWh per day, while LSM 6-9 per capita = 4.2 kWh per day). This can be attributed to the higher number of appliances and the larger space in the LSM 10 homes, which requires more heating than the space occupied by the LSM 6-9 participants in this study. Other aspects such as the time of the year (winter or summer) may also affect electricity use. Seasonal differences in temperatures have a specific impact on household electricity consumption. These are explored in more detail below.

5.4.5 Seasonal differences

The current study was conducted over two different seasons (winter and summer). As explained in Section 5.4.3, this was due to equipment and human resource restrictions, and a note was made on the participants' appliance survey on whether the household was tested in summer or in winter. The seasonal differences in the households are presented in Table 39.

Table 39

Seasonal differences in the electricity consumption of households

Group	Season	Average electricity consumption per day	Difference
LSM 6-9	Summer	12.26 kWh	10.7 kWh
LSM 6-9	Winter	22.43kWh	
LSM 10	Summer	28.83 kWh	8.65 kWh
LSM 10	Winter	37.48 kWh	

In line with the historical baseline data, there is additional use during the colder months. It should be noted that this comparison is between different LSM groupings (not individual households) and ideally summer and winter measurements in the same households should be taken in order to get a clear picture of the impact of the season, which was not done in this study and is further discussed in Section 6.5.3. The LSM winter and summer savings are presented below.

The need for comfort in the winter months leads to increased electricity consumption in most houses, probably due to an increased use of hot water, stoves and ovens and space heating. The average savings during the winter months were much lower than during the summer months, as depicted in Table 40. The difference in savings between summer and winter is evident, with an average increase during winter of nearly 10%, and an average saving during summer to a similar degree, again showing a 10% decrease in electricity consumption during summer.

Table 40

Winter and summer savings

	Winter	Summer	Average saving per LSM group
LSM 6-9	-11.5%	13%	0.75%
LSM 10	-8%	5.5%	-1.25%
Average	-9.75%	9.25%	

The negative savings (increased consumption) during winter in LSM 10 and the very small saving (0.75%) in LSM 6-9 is indicative of the need for heat comfort (substantiated by the qualitative notes made by participants on their data logging sheets). When one looks at the LSM groups, it seems that the intervention did not effectively change the electricity consumption of participants in terms of actual use, especially in winter, but that it had some effect on individual households in summer. In specific instances, individual participants were much more aware of their electricity consumption and saved as much as 30% of electricity by means of behaviour change. This is described in more detail in the next section.

5.4.6 The effect of the intervention

During the intervention, several aspects contributed towards decreases or increases in electricity consumption in each household. Seasonal effects, such as a cold spell or changes in the household (a visitor, a child away on a camp) had an effect on a household's electricity consumption. These causes were inferred by the participants and were reported during discussions with the researcher upon removal of the monitors (captured in the researcher's field notes), or on the data logging worksheets provided by the researcher at the start of the intervention (see Appendix D). These comments are presented in the comments section of Tables 42, 43 and 44. In some cases, substantial changes in electricity usage took place in Experimental Group 2 (for example, in the case of 21K1 and 3K2), but the reasons for these changes were not captured, since these participants had limited contact with the researcher.

In this section, the LSM and experimental group allocation, as well as the season of measurement are indicated in order to understand the effect of the intervention in the context of the participants' living standard, the intervention they received and the seasonal impact. Tables 42, 43 and 44 indicate that several households saved a significant amount of electricity (more than 10%), while others did not, the minus (-) sign indicating negative savings (increased consumption). On average (ignoring the seasonal effect), neither of the groups increased use, and savings were marginal with 0.75% in the LSM 6 to 9 Group and 1.25% in the LSM 10 Group. The average savings in the two experimental groups in each of the LSM groups, however, paints a slightly different picture and necessitates an in-depth look at the various factors influencing electricity consumption, discussed in Section 5.6.

5.4.6.1 Electricity consumption results

In Table 41, the average savings during the second and third week of consumption (averaged and compared to the baseline week) are reported for LSM 6-9 and LSM10 separately. Experimental Groups 1 and 2 are reported separately and the season in which the measurement was taken is presented with some comments regarding the use as indicated by the participants on the data logging worksheets.

Table 41

LSM 6-9 savings in Experimental Groups 1 and 2 during winter and summer

	LSM 6-9 (n=13)												
	Experimental Group 1 (n=9)									**Experimental Group 2 (n=4)**			
	Winter (n=7)							**Summer (n=2)**		**Winter (n=1)**	**Summer (n=3)**		
ID	3T2	3T12	3T19	3T20	3T17	3T4	3T9	22T1	21T4	3K2	21K1	21K2	21K5
Average saving (kWh per day)	4%	-2%	12%	10%	-9%	18%	4%	21%	5%	-28%	26%	-5%	19%
Average for all household in the same LSM, experimental group and season	5%							13%		-28%	13%		
Comments		Used stove instead of hotplate after the second week of measurement	Participant reported more conscientious use of electricity	Switched geyser off manually during the day		Switched geyser off manually during the day		Switched off an unused, extra geyser, and switched the one in use off during the day					

Table 42

LSM10 savings in Experimental Group 1 during winter and summer

		LSM 10								
		Experimental Group 1 (n=10)								
	Winter (n=6)						**Summer (n=4)**			
ID	3T16	3T14	3T3	3T1	3T8	3T6	22T4	22T3	23T2	23T3
Average household savings	31%	10%	-15%	8%	-20%	6%	7%	10%	5%	12%
Average	3%						9%			
Comments	Started switching off the geyser manually, consistent saving is clear		Visitors and sickly infant at home, heater on during the night		Tenant used the heater excessively			Participant reported more conscientious use of electricity		Large savings after the first week due to additional fridges and freezers being shut off

Table 43

LSM 10 savings in Experimental Group 2 during winter and summer

	LSM 10												
	Experimental Group 2 (n=13)												
	Winter (n=7)							**Summer (n=6)**					
ID	3K3	3K8	3K12	3K19	3K15	3K1	3K10	22K1	22K7	31K1	23K4	22K4	23K2
Average household savings	-12%	2%	-11%	-28%	12%	5%	-100%	0%	7%	3%	3%	-11%	8%
Average	-19%							2%					
Comments	Used under floor heating						Heater was left on during every night for the elderly dog		Saving despite new infant in the home				

From Table 41, Table 42 and Table 43, the impact of winter is clear. Table 43 shows that when respondents used heaters during the night (as with participants 3K3, 3K10, 3T8 and 3T3), the electricity consumption rose between 12% (3K3) and 100% (3K10). Participants who indicated on the reporting sheets that they used their electricity more conscientiously after the intervention saved between 10% (22T3) and 12% (3T19). Participants who started switching their geysers off at least during the day following the intervention improved their energy efficiency by 10% (3T20), 18% (3T4), 21% (22T1) and 31% (3T16) respectively. One participant (23T3), who switched off several unused fridges and freezers, saved 22% during the first week after the intervention, but switched them back on a week later. In the next section, the savings (or lack thereof) is compared on the basis of the LSM group allocation, the seasons and the experimental groups.

5.4.6.2 Group-by-group comparison

Although mentioned in Table 40, Table 44 highlights the electricity consumption data on the basis of LSM group allocation, the season and the experimental groups. The two LSM groups were compared in order to allow the researcher to understand the impact of the pre-existing characteristic of the living standard on the effectiveness of the intervention.

Table 44

LSM group savings

Groups	Average savings (kWh)
LSM 6-9	0.75%
LSM 10	-1.25%

A very small difference between the two LSM groups is evident, although the LSM 6 to 9 Group did better than LSM 10 in saving electricity. This indicates that the pre-existing characteristic of living standard did not interact with the intervention in any specific way. The impact of the season in which the households were measured is indicated in Table 45.

Table 45

Average seasonal savings

Group	Average savings (kWh)
Winter	-9.75 %
Summer	9.25 %

Not surprisingly, more electricity was consumed during winter than during summer (presumably due to weather conditions). This is in line with the historical baseline increases during winter. By contrast, the savings from the two experimental groups are presented in Table 46.

Table 46

Experimental group savings

Groups	Average savings (kWh)
Experimental Group 1	7.5 %
Experimental Group 2	-8 %

Clearly, the intervention applied in this study yielded some changes in behaviour, resulting in an average saving of 7.5%, where the comparison group increased their use by 8%. However, in each of these comparisons, the other aspects (LSM and season in the case of the experimental group comparison) dulled the true effect of the intervention, because only one aspect could be highlighted in each instance. In the next section, Table 47 presents the effect of each of these elements had on electricity savings.

First, from Table 47, below, it is clear that both LSM groups and both experimental groups managed to save electricity during summer (LSM 6-9, Experimental Group 1 = 13%; LSM 6-9 Experimental Group 2= 13%; LSM 10 Experimental Group 1=9% and LSM 10 Experimental Group 2=2%). This highlights the need to consider winter time savings in particular, where larger differences were recorded. The average savings per experimental and LSM group are presented in Table 47.

Table 47

Average savings per experimental and LSM group

Pre-existing characteristic (Living standard)	Experimental Groups	Average savings	Season	Saving
LSM 6-9 (n=13)	LSM 6-9 Exp 1 (n=9)	9%	Winter (n=7)	5%
			Summer (n=2)	13%
	LSM 6-9 Exp 2 (n=4)	-7.5%	Winter (n=1)	-28%
			Summer (n=3)	13%
LSM 10 (n=23)	LSM 10 Exp 1 (n=10)	6%	Winter (n=6)	3%
			Summer (n=4)	9%
	LSM 10 Exp 2 (n=13)	-8.5%	Winter (n=7)	-18%
			Summer (n=6)	2%

During winter and in LSM 6-9, the Experimental Group 1 (n=7) managed to save 5% on their electricity consumption, while the electricity consumption in Experimental Group 2 (n=1) increased by 28%. When considering LSM 10, the participants in Experimental Group 1 (n=6) managed to save 3%, while the electricity consumption in Experimental Group 2 (n=7) increased by 18%. Thus in Experimental Group 2 in both LSM 6-9 and LSM 10, the increase in winter electricity consumption (-28% and -18% respectively) was substantial. These same increases were not measured in Experimental Group 1 during the same winter measurement time. The conclusion is therefore drawn that even though the Experimental group 1 savings in both LSM 6-9 and LSM 10 groups (presented in Table 47) was not substantial the intervention was effective in preventing the common winter increase in electricity consumption in Experimental Group 1 compared to Experimental Group 2.

In the next section, individual load profiles of four participants are presented, allowing for an in-depth look at some individual households. These participants were purposively selected in order to serve as a case study type exploration of the data. These were all measured during the same winter period.

5.4.6.3 Load profiles of selected individual households

Load profiles for two of the research participants are presented in Figure 17 and Figure 18 to demonstrate the difference between their electricity consumption before and after the intervention. The profile presents a 24-hour load profile. The hourly averages (for example, the average of the baseline week at 10:00-11:00) for each hour during the baseline measurement are compared to the averages following the intervention (average of the following two weeks at 10:00-11:00). The load profiles presented here compare each household's baseline consumption to its own post-implementation consumption. The load profiles of participating households presented here were all measured during the same winter period, since winter elicits an exaggerated reaction to the elements and circumstances in the households (Littleford et al., 2012). These participants were selected on the basis of their clear increases or decreases during the measurement periods. The load profiles below include participants from the LSM 6 to 9 Group, one from Experimental Group 1 and one from Experimental Group 2.

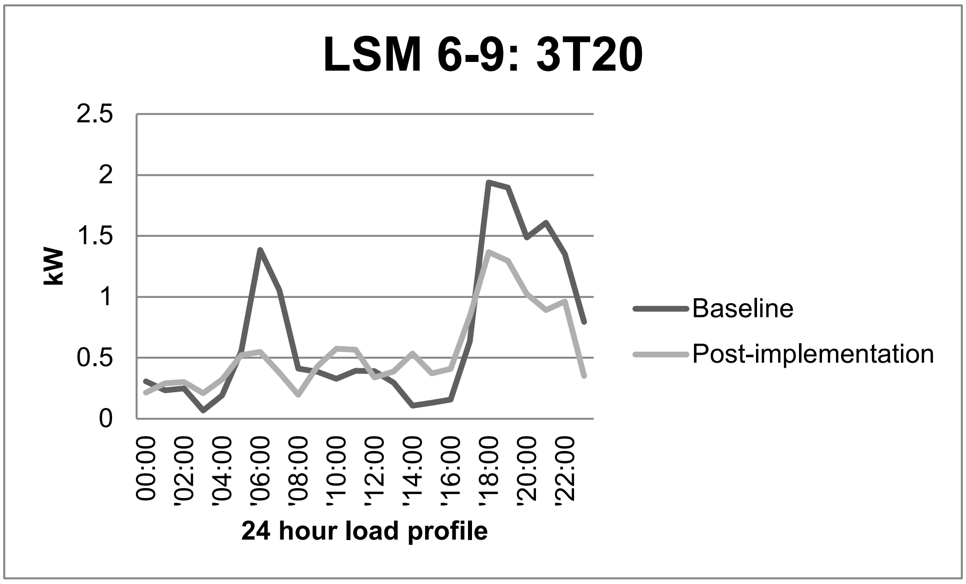

Figure 17 Baseline and post-implementation load profiles of 3T20 from LSM 6-9 (Experimental Group 1)

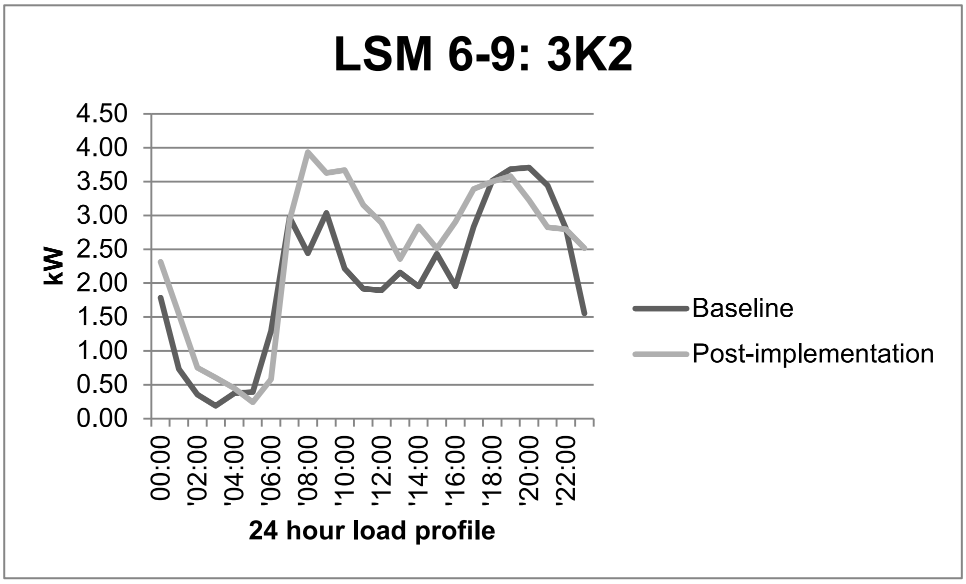

Figure 18 Baseline and post-implementation load profiles of 3K2 from LSM 6-9 (Experimental Group 2)

Energy efficiency improved in the home of the participant from Experimental Group 1, compared to the increased consumption of the participant in Experimental Group 2. Participant 3K2 had an average increase in electricity consumption of 28% in the two weeks following the intervention, while 3T20 saved an average of 10% following the intervention. The saving made by Household 3T20 from Experimental Group 1 was reportedly due to manually switching off the geyser during the day.

Next, load profiles for two participants from LSM 10 (again, one from Experimental Group 1 and one from Experimental Group 2) are presented in Figure 19 and Figure 20.

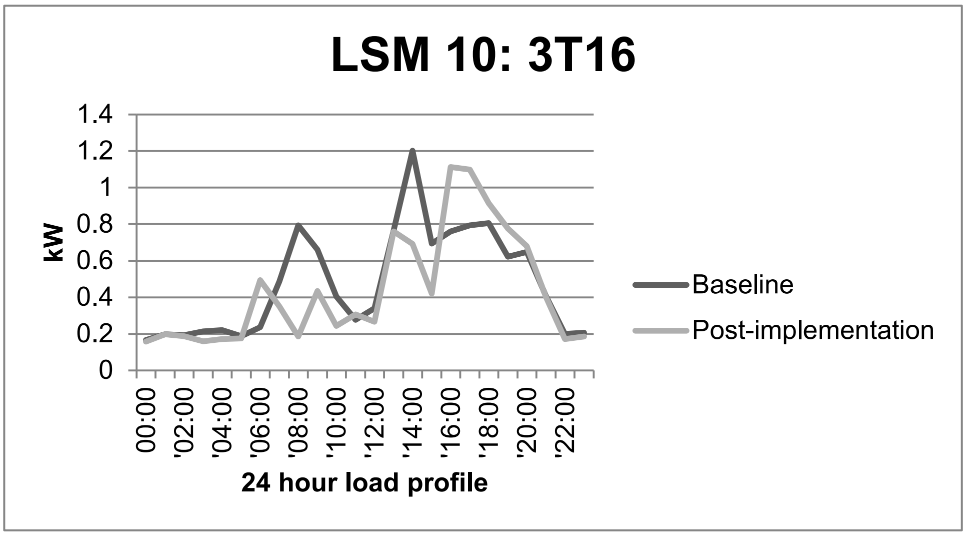

Figure 19 LSM 10: from Experimental Group 1

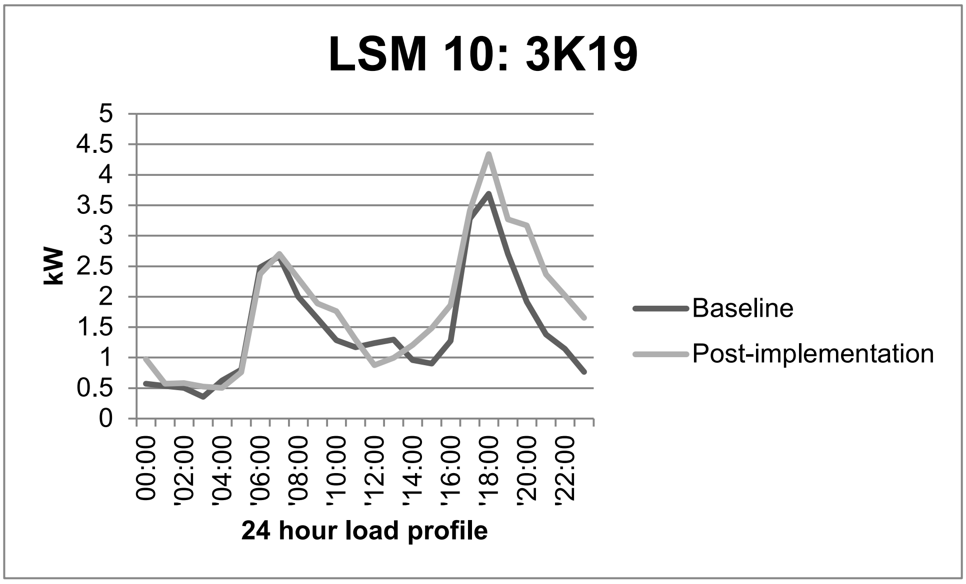

Figure 20 LSM 10 from Experimental Group 2

Participant 3K19 in Experimental Group 2 also had an average increase in electricity consumption of 28% in the two weeks following the intervention, while 3T16 saved an average of 31% following the intervention. Again the change in the household from Experimental Group 1 was reportedly due to manually switching off the geyser, but both during the day and again after use at night.

From the load profiles and the accompanying notes made by the participants on the data logging sheets, the intervention applied in this study effected some change in behaviour, primarily encouraging people to switch off their geysers during the day.

5.4.7 Conclusion on Phase 2, Part 2

In Section 5.4, the results on the actual electricity consumption of the participating households were presented. Per capita use in the LSM 6 to 9 Group was 4.2 kWh per person per day, while it was 9.5 kWh per person per day in the more affluent areas (LSM 10). Household use in LSM 6-9 was 14.98 kWh per day, and 32.8 kWh per day in LSM 10, while the kWh per square metre in both areas was the same, although the more affluent group had more square metres for fewer people.

The importance of the qualitative data (comments on the data logging worksheets), as presented in Table 41, Table 42 and Table 43 became evident. These comments pinpointed the exact changes in behaviour that the participants assumed had led to changes in their electricity consumption.

The differences in consumption based on the LSM groups were admittedly not outstanding. Differences in consumption as a result of the seasons were more pronounced with more than a 10% average increase of consumption during winter. This is in line with the results from the historical baseline data. It is concluded that the intervention was successful in motivating behaviour change and improving energy efficiency in both LSM groups, especially during winter, which has been identified as the best time of the year for intervention, increasing awareness and commitment toward electricity savings, when use normally tends to increase, as was evident from Experimental Group 2, and the baseline figures. Although winter has been identified as the best time to intervene, no definite conclusions can be drawn from only one participant's increased consumption, and this finding needs to be confirmed in further research. The findings from the qualitative data collected during the focus groups after the intervention are discussed in the next section.

5.5 Phase 3: Focus group discussion findings

As discussed in Section 4.4.5, six focus groups were planned (two in the vicinity of each research site) after the completion of measurement. Although the focus groups were well organized and people received reminders and were encouraged to attend, only five of the six planned focus groups were realized and the attendance in each group was very poor. Below, a description of the 16 focus group participants is provided, followed by a summary of the ten themes identified in the analysis of the focus group discussions.

5.5.1 Demographics of the focus group participants

Table 48 indicates the primary document name and number (as in Atlas.ti), and the audit numbers of the focus group participants. In some instances, where both spouses from one household attended the focus group, the spouse of the original research participant is indicated using the name audit number with a B at the end, in order to help the researcher to discern between the focus group participants. This pattern was also adopted in the transcriptions of the focus group discussions.

Table 48
Document numbers, names and audit numbers of participants in the five focus groups

Primary document name	Primary document number	Participants
Garsfontein FG Phase 1	P19	23T2 and 23K2
Garsfontein FG Phase 2	P20	3T16, 3T16B, 3K19
Mamelodi FG Phase 1	P21	M1 and M2
Woodhill/Menlopark FG Phase 1	P22	22T1, 22T3 and 22T4
Woodhill/Menlopark FG Phase 2	P23	3K3, 3T3, Pilot 1, 3K12, 3K12B, 3K18

Both of the participants from the Mamelodi group were from Experimental Group 2, so they had not participated in an in-depth interview (Phase 2, Part 1). They both also experienced problems with the electricity monitor (intermittent measuring or accidental erasure of data after collection) which means they did not have usage data that could be analysed. However, the discussions with these participants during the focus group session highlighted issues very different from those raised by the other focus groups, and their insights are discussed in Theme 6 (see Section 5.5.3.6) in particular. The demographic features of the focus group participants are presented in Table 49.

Table 49

Demographic features of focus group participants

Focus group session	Attendees	Male	Female	Ages
Garsfontein 1 (P19)	2	1	1	51 and 52
Garsfontein 2 (P20)	3	2	1	39, 52 and 54
Mamelodi 1 (P21)	2	1	1	33 and 54
Menlo 1 (P22)	3	0	3	33, 55 and 60
Menlo 2 (P23)	6	3	3	45, 47, 48, 52, 53 and 58

In the analysis of the focus groups, the direct quotations are labelled in the following way: P20:10-12, where P20 indicated the primary document number (and also the specific focus group), and 10-12 indicates the paragraph number in the primary document. The individual speakers are identified in the text by means of their audit numbers. Below section, prominent codes from the focus group data are identified and discussed.

5.5.2 Prominent codes from focus group data

During the content analysis of the focus groups, 117 codes were identified. As with the content analysis of the in-depth interviews an overview of the most prominent codes is presented before the themes are discussed in more detail. Table 50 presents codes mentioned at least eight times during the focus group sessions.

Table 50

Codes mentioned at least eight times during focus group sessions

Total	Code	Definition
31	Efficient appliance use	Behaviour change by means of specific ways in using household appliances
18	Educate children	Discussions on the value of educating children in environmentally responsible behaviour
17	Husband and wife interaction	Interaction between husband and wife specifically around the use of electricity
15	Distrust authorities	A sense of distrust in Eskom, municipalities and “the market”
15	Efficiency – geyser use	Method of employing energy efficiency through geyser management
14	Value – use resources sparingly	Expressed value: Frugality
14	Comfort – important	Comfort in the home is emphasised
12	Feedback – interesting	Feedback was interesting
11	Feedback – monitor complicated	The feedback monitor was complicated

Total	Code	Definition
11	Feedback – behaviour changed	Feedback led to changes in behaviour in the household
10	Motivation for participation – curiosity	Motivation for participation: curiosity, interest
10	Perception – most people are ignorant	Perceptions expressed that most other people are ignorant
9	Female: responsible for action	Often, males in the household support the principle of energy efficiency, however, it comes down to the women in the households to put the systems in place and maintain them
8	Routine environmental behaviour	Routine environmental behaviour identified in the households
8	Individual efforts vs. authorities' efforts	The efforts of the individual are undermined by a lack of display of commitment from authorities
8	Desire for personalized energy advice	The need is expressed for personalized and specific energy efficiency advice
8	Awareness increase is important	Awareness increase is important

In the next section, the themes that emerged from the codes are presented.

5.5.3 Themes emerging from codes in Phase 3

The qualitative findings from the thematic analysis of the focus groups are presented in this section in themes and sub-themes. Direct quotations from the transcripts are used to explore and describe the participants' points of view and illuminate the reasons behind certain behaviours. Table 51 provides an overview of the themes, definitions and numbers of codes and quotations that constitute each theme.

Table 51

Focus group themes and sub-themes

Themes and Sub-themes (S-T)	Definition	Codes from Table 50
Theme 1: **Behaviour changes and planning** ***S-T 1.1: Changes in behaviour since the intervention*** ***S-T 1.2: Automation*** ***S-T 1.3: Efficiency planning***	References to changes in behaviour, routine behaviour, automated behaviour and energy efficiency practices and planned changes	Codes: 21, Quotations: 97 • Efficient appliance use • Efficiency – geyser use • Feedback – behaviour changed • Routine environmental behaviour
Theme 2: **Comfort**	Lifestyle choices and the need for comfort including consumption patterns and recycling behaviour	Codes: 9, Quotations: 50 • Comfort – important • Routine environmental behaviour

Themes and Sub-themes (S-T)	Definition	Codes from Table 50
Theme 3: **Family response** ***S-T 3.1: Feedback and increased awareness*** ***S-T 3.2: Education of children***	References to the responses of the family (and broader) as perceived by the research participant	Codes: 31, Quotations: 139 • Educate children • Perception – most people are ignorant • Feedback – interesting awareness increase is important
Theme 4: **Folk knowledge**	Folk knowledge generally accepted amongst the interviewees, but scientifically disproven	Codes: 3, Quotations: 7
Theme 5: **Female as implementer**	Identification and definition of roles within a household, as defined by the interviewees in terms of gender roles	Codes: 7, Quotations: 37 • Husband and wife interaction • Female: responsible for action
Theme 6: **Need for guidance**	Expressed need for guidance and a sense of leadership, not necessarily information-focused	Codes: 14, Quotations: 37 • Feedback – monitor complicated • Desire for personalized energy advice
Theme 7: **Need for information**	Expressed need for information, based on facts and providing a basis for action, including monetary information, price-based information, and recognition for electricity savings achieved	Codes: 12, Quotations: 38 • Feedback – interesting • Feedback – monitor complicated • Feedback – behaviour changed • Motivation for participation – curiosity
Theme 8: **Perceived responsibility: from individual to authorities** ***S-T 8.1: The role of the individual*** ***S-T 8.2: The role of the authorities***	Participants' perceptions around responsibility ranging from the individual and the household to societal structures and governmental structures.	Codes: 19, Quotations: 76 • Distrust authorities • Individual efforts vs authorities' efforts • Perception – most people are ignorant • Value – use resources sparingly
Theme 9: **Strategies**	Specific strategies employed by the participants in this research to coerce family members to participate in energy efficiency behaviour in the household.	Codes: 9, Quotations: 27

5.5.3.1 Theme 1: Behaviour changes and planning

The changes in behaviour mentioned by the participants in the focus groups are discussed in three sub-themes. The first theme focuses on behaviour changes that took place in the household once the intervention was completed, the second focuses on the value of automating certain behaviours in the household. Third, the planned activities in the household are considered.

- *Sub-Theme 1.1: Changes in behaviour since the intervention*

In this section, the changes in households following the intervention are discussed and presented (see Table 52).

Table 52

Changes in behaviour following the intervention

Appliance	Behaviour change	Quotation
Fridges	• Switch additional fridges/freezers off • Defrost more regularly • Re-think need for additional fridge/freezers • Sell unnecessary fridges/freezers	Pilot 1: *Let me tell you what what shocked me the most was … the cooling side, not the air-conditioning, not space cooling, the … fridges, I had like six fridges if not more, and there's one in the garage with not much in it and the bar fridge is running with next to nothing in it, and your caravan fridge is running, the 4x4 fridge is running and you got two plus an extra one, and that was seventy per.. I could get a seventy per cent saving on that.* (P23:35) 23T3: *I put off all the extra uh uhm fridges and things like that as you know we are using, there was four uh uh fridges and three deep freezers so ja, I put some of them off and it's still off.* (P20:4)
Washing machine	• Wash a full load • Wash at a lower temperature	22T3: *What what was interesting to me, that I didn't realize, was that uh I put my washing machine on a warm cycle, that made a big difference.* (P22:48)
Ovens, stoves and microwaves	• Limited oven use • Increased microwave use • Cook for two days	23K2: . *We use the microwave much more often than the stove.* (P19:37) 21K3: *I minimize the use of those some of those appliances ironing every day ironing and you*

Appliance	Behaviour change	Quotation
	• Don't cook for lunch • Cook everything in the oven or everything on the stove • Use alternatives (wood/gas) • Buy cooked food	*know cooking the whole day so in the house now we had uhm uh uh cooking cooking time table schedule.* (P21:15) 3K12: *There was something very interesting on Sundays when I cooked and I invited people, then the electricity uhm was much more So ja it actually showed me that it uhm ja to to invite people if that meal also means that I should pay much more.* (P23:15) 3T3: *I when I cook in the oven, I cook everything in the oven. When I cook on the stove, I cook everything on the stove.* (P23:43) 3K12: *…you know maybe I should just go, there's that little place in Hazelwood where you can just buy the foods. So I've checked that so buying the food sometimes now is cheaper than to make the food.* (P23:16)
Air-conditioning	• Limit use to really hot days	3T3: *…how long we can go for not putting on the air-con in the shop, and we saved between two thousand and three thousand rands a month, without suffering a lot of discomfort…. you can't put off the computers, obviously everything gets put off in the evening, even the screen savers and everything. But just not doing the air-con.* (P23:29) 3T3: *But if it's very very very hot, for those little times we just put on the air-con for that… time to cool down the shop.* (P23:30)
Lights	• Switch off when not in use • Use energy efficient bulbs • Use day light sensors • Use solar lights • Use timer switches	3T3: *…you put off lights when you're not busy there and we don't really sort of sit in the dark with a little candle.* (P23:44) 3T16: *So now I switched all the globes.* (P20:4) Pilot 1: *…it's semi-automated, so if you put on a light and it's light enough, it just doesn't come on.* (P23:89)

Appliance	Behaviour change	Quotation
		Pilot 1: *Ja, and then everything else is day/nights and timers and your standby lights are all timed or solar, something like that, so it's fairly automated, there was very little we had to change.* (P23:91)
Iron	• Iron all in one go, instead of everyday	21K3: *I minimize the use of … some of those appliances ironing every day….* (P21:15)
Standby		3T16: *And then I also switch off the most things at the wall, instead of just switching the machine itself off, I am talking about the TV and those kinds of appliances.* (P20:5) 3T32: *… we've got nothing on standby.* (P23:48)
Kettle		3T16: *I don't fill to kettle completely anymore, it was something I used to do.* (P20:15)

Automation was an issue that was not discussed during the in-depth interviews. By installing and using automatic timers with their geysers and lights, some participants improved their energy efficiency even more. Below, the installation and management of automated efficiency is discussed in more detail.

- *Sub-Theme 1.2: Automation*

Automated energy efficiency behaviour refers to certain strategies implemented by participants to automate energy efficiency behaviour in the household. This is done by means of timers for geysers, pools and outside lights, daylight sensors in the home for lights and motion sensors for air-conditioning systems. Sometimes, the routines in the household are so varied that automation are thought to have little effect:

23K2: *…we experiment with putting the geyser off during the day and so on eventually it didn't work that very well because we don't have a fixed routine so we decided not to do it*. (P19:31-32)

3K19: *…it's also a function of how the household works, right.* (P20:75)

For some participants, the household routine had to be adjusted slightly in order to become more efficient, and not without an effect on the household. One participant describes what they did:

22T4: *…that is interesting. We don't continuously have hot water, that's one thing since I have, don't have the geyser on in the mornings anymore, but uhm we* *use the dishwasher instead of washing so one does not actually need it.* (P22:62)

True automation requires a certain amount of technical ability that research participants did not seem to possess. In the one case where the technical ability and interest of the homeowner overlapped, it contributed to an interesting array of gadgetry to manage residential electricity consumption:

Pilot 1: *Ja, first of all we were living that way [efficiently with the use of timers and sensors], and secondly it's semi-automated, so if you put on a light and it's light enough, it just doesn't come on. No, it is, we live in a thatch house which is fairly dark and the inclination is to walk down and switch on lights, you can switch them on, but if it's light enough, they just don't come on.*

3K12: *Okay, ja I'm also in a thatch.*

Pilot 1: *Ja, and then everything else is day/nights and timers and your standby lights are all timed or solar, something like that, so it's fairly automated, there was very little we had to change.* (P23:39)

This particular participant's home is already fully automated and he took it upon himself to make changes at his place of work:

Pilot 1: *What we did at the office was to, and we're talking Rands now, the electricity bill came down by exactly R5000 a month. And all we did was, it's simple, you're at work, just rough figures, you're at work eight hours a day. The other sixteen hours a day there is nobody at work and on weekends neither. And all we did, was put an intelligent system to do the geysers, we've got ten, eleven geysers so they're off when you're not there, and on when you're there. And that brought down R5000 already. And that's proven, because I do that meter reading myself.* (P23:41)

Automation was not used by most participants because of the technical skills necessary for implementation. Another aspect that influenced behaviour change in the household was the perception of the need to plan for residential energy efficiency. Below, the need to plan for energy efficiency and the methods considered by participants is presented.

- *Sub-Theme 1.3: Efficiency planning*

For many participants, energy efficiency seems to be a temporary problem. Perceptions are that once the construction of new electricity generation plants is completed, energy efficiency would stop being important. Other participants however managed to identify possibilities for continually improving their energy efficiency, regardless of the possible level of supply:

3K19: *The more independent one can be from an infrastructure that is not, well I don't want to sound too negative, uhm at this stage of the fight is struggling. I* *think eventually the infrastructure will pick up, and will start to produce enough for the demand in the country, but I think it is going to be at least twenty or thirty years, I don't think it is going to happen soon. So in areas where one has the ability to provide for oneself, I think that is good.*

3T16B: *Yes, I think if one wants to change it one has to change it now, I mean we don't even have any control, if Eskom or the municipality says they are raising the price of electricity…it's something we cannot control, but you can do something else.*

3T16: *Especially here where we have so many resources.*

3T16B: *Yes.*

3K19: *…and power failures. Yes the frustration with the power failures, it is very frustrating and really leads to being uncomfortable and you know just simply stress.* (P20:24-27)

The interaction between these participants indicates the ability to identify future possibilities through viewing energy efficiency in different ways. Another factor that has an impact on the effectiveness of planning energy efficiency measures is that it really is not possible, expected or required as part of the social norm:

3K19: *Many people get on the bandwagon, they make a quick buck on the side, and you just really never have that certainty that it will work. And you know there are websites and like with your project, everything is there to educate people and so forth but I don't know, it just isn't part of our society yet. I think it is only starting to come into our society because we have that problem on the national grid.* (P20:82-84)

The perceived levels of discomfort that will be caused by changing behaviour and routines are discussed in more detail in the next section.

5.5.3.2 Theme 2: Comfort

The expected impact on comfort in the household of implementation of energy efficiency measures was indicated by participants. Changes in the household routine or to the equipment in the household are perceived to have an impact on comfort. Two participants discussed the use of energy efficient globes in very different ways, illustrating the arguments before and reasoning after these participants accepted a new technology:

3K19: *It's never as bright as you want it to be. It is always vague and takes a long time to heat up or you get there [in the shop] and you see R 15 or R 75, then you think, you must be nuts. You don't immediately think this one is going to last longer than the other.* (P20:61)

3K3: *You would seem better off if you go and pay a hell of a lot of money for these fancy globes, and I do it. Globe is broken; okay buy another one, R 199, for one globe, but it helps, because it uses four watts instead of sixty watts.* (P23:127)

Physical comfort when switching appliances on and off was also discussed:

23T3: *…me who works with the electricity, I don't want to struggle and think, uhm I have to put this off here and put that off there, because I am busy here. I just want to finish my work…* (P19:16)

When switches are in uncomfortable places they are simply not switched off:

22T3: *…because when you get up in the morning, you just quickly want to switch on your computer, you don't want to have to crawl under the table to switch on the plugs and things...* (P22:40)

The following statement highlights the argumentation underlying behaviour change that had a real impact on daily routines:

22T4: *…that is interesting. We don't continuously have hot water, that's one thing since I have, don't have the geyser on in the mornings anymore, but uhm we use the dishwasher instead of washing so one does not actually need it.* (P22:62)

From the comments quoted above, it is clear that both physical and psychological expected discomfort dissuade participants from developing and maintaining efficient routines. However, it is also clear that once changes have taken place they are not perceived to have such a big impact after all. The next theme explores the household member's responses to the changes in the household as perceived by the individual research participant.

5.5.3.3 Theme 3: Family response

During the focus group discussions, the responses of family members as perceived by the research participants were discussed. This included the family's reaction to the real-time feedback provided by the electricity monitor as part of the intervention a few months earlier. Although feedback is discussed in detail in Theme 6: Need for information, the real-time feedback increased general awareness of electricity consumption in the household. In Sub-theme 3.1, awareness through feedback is discussed. In Sub-theme 3.2, the importance of education and the use of the monitor as an educational tool is discussed.

- *Sub-theme 3.1: Feedback and increased awareness*

The monitor used for feedback during the three-week measurement period allowed electricity consumers insight into their electricity consumption otherwise inaccessible to homeowners, including the cost of electricity and kilograms of carbon emitted. This influenced the research participants' awareness of their use of electricity, as they reported:

> *And the result was that just the fact that you can see when the kettle is on and there goes the little figures and then you already have that awareness, I have the tendency to switch the kettle on and then I work hard and then you have to go back and put the kettle on and use the electricity, the use is just incredible for those types of appliances and so there it sharpens the insight and the discipline.* (P20:3K19:10-12)
>
> *You think twice before you switch something on you know, is it really necessary or not.* (P20:3T16B:14)

For others, the feedback was empowering:

> *So I'm conscious now, I'm aware, I'm clever now.* (P21:21K3:27)

For still others, it confirmed their careful use of electricity:

> Mathilda: *What was their response to the study was it useful in a way, or not really, did it add value in some way?*
>
> 23K2: *It in some way it made us a little more sensitive although we were already.*
>
> (P19:23K2:43)

For some, being part of this research posed an opportunity for educating their children about electricity conservation. This is presented in Sub-theme 3.2, below.

- *Sub-theme 3.2: Education of children*

Participants mentioned that education about energy efficiency, amongst other pro-environmental behaviours, should start at an early age. The real-time feedback monitor allowed for an opportunity to engage other family members in concretely observing the electricity consumption in the household. Engaging other family members was done by the participant and not the researcher, but it allows the researcher insight into the strategies employed by the research participants in their households. Here, the value of receiving real-time feedback on actual electricity consumption is highlighted along with the fact that the feedback concretized electricity consumption and can be used for educational purposes in the household.

> 3K18: *I think uhm, once again I think uhm education is a very big thing in it and one should start early, uhm, then this meter helps a lot when it's in your face.*
>
> (P23:31)

The more concrete display of an otherwise abstract concept of electricity could have been used to support learning, linking it to much of the work dealt with in schools:

> 3K19: *…there are actually often discussions about it because the 13 year old boy has a lot of these types of things they do at school, projects, physical sciences*

and life sciences then they deal with many of these things such as the dangers of electricity, or you know how it is generated and such kinds of things, so they are very aware of the dangers and the costs and so forth.

(P20:36)

These observations and early education opportunities were instrumental in changing behaviour in this household, as is evident from this comment:

3K12B: *Ja it was the same with us, it was, you can tell them, it was the kid the kids also they saw the meter going and they, actually just went back and put the lights off, somebody taking a shower now or whatever and the geysers off and saw the difference and it made them put the geysers off more often so.*

(P23:18)

Even adult children (over the age of 18) were educated by parents who participated in this study:

3T3: *Well both my husband and myself [drive the change] it's not either or but what is interesting is that my three boys who have their own places they live in, and we sort of discussed this whole thing while they were visiting or if we were over there for the day or so. And they said that wow, but we can save on electricity back home and they asked us you know what do we do, what do we put off, what etcetera, so…* (P23:87)

General making aware and education, sometimes by means of the electricity monitor itself, and in other instances (as in 3T3 above) by means of discussions, were used to inform and instruct in the participating households. Some of the folk knowledge identified during the in-depth interviews was mentioned in the focus groups as well, these are discussed in the next section.

5.5.3.4 Theme 4: Folk knowledge

Interestingly, in the quotes below, these erroneous beliefs were mostly displayed by the participants from Experimental Group 2. These participants have been purposively selected in order to illustrate what happened in some cases, when considering the impact of erroneous beliefs on intention and behaviour. Although it is not necessarily representative of all changes in behaviour by all participants, it is still valuable in higlighling the extent to which erroneous beliefs have been changed in participants in Experimental Group 1 (3T16), and not to the same extent in Experimental Group 2 (3K19):

3T16: *You know what, I was in the hardware store one day and I tried to find out about this geyser blanket…and the guy there completely junked the idea. He said he doesn't know if it is worth the money, and he doesn't think that it will make a big difference one can rather manage it in another way. And then there are obviously many people who say don't put off your geyser you know, the instant there is something wrong with your geyser they say it is because* *you put it on and off. Wow! All the people in the whole country is doing it, so I really don't know how safe it is, but I just think any geyser will go at one time or another.*

3K19: *For me the most important is to know the costs and to be frugal, you know switch off the lights and such things, I think there lay the biggest savings. I am not one to switch off the geyser in the morning before I leave. I think when we go away for a long weekend or on holiday then I will switch it off, but from a safety perspective not necessarily because of the savings. Because, oh there are so many people's opinions about these things and if you use the same amount of electricity that you save when you put it off to heat it up again…in a specific time period, so you know there are so many opinions about it.*

(P20:57-61)

3K19: *But is there really a positive effect on your use? Meaning is your use lower; looking at it scientifically it should be, but that on off on off, I don't know. Do you see it in your account?*

Mathilda: *Yes.*

3T16B: *We definitely see it in our account.* (P20:77-78)

This highlights some important erroneous beliefs that have been changed in the case of Participant 3T16 (Experimental Group 1), but that are still held by Participant 3K19 (Experimental Group 2). This serves as an indication of the effectiveness of the intervention. Moreover, the usage data and savings in each of these households provide more background and are discussed in Phase 4 (see Section 5.6). The next theme is the role of females in the household.

5.5.3.5 Theme 5: The role of females in the household

Although the interaction between various household members formed part of the interview questions, different gender roles were not originally considered to be of importance, because the effect of gender roles on energy efficiency behaviour was not stresses in the literature. From the discussions below, however, it became clear that gender roles may be more important than originally expected. In this section, two aspects are discussed: Sub-theme 5.1 is the interaction in the household between family members, and Sub-theme 5.2 looks at the way in which female partners are portrayed as the implementers of change in the household.

- *Sub-theme 5.1: Intervention encouraged interaction about energy efficiency*

In several of the households, the intervention encouraged interaction around electricity in the participating households. Interaction between family members ranged from conflict focused on the excessive use of electricity and the role allocation of those responsible for managing electricity in the household. The comment below illustrates the first type of interaction (conflict about electricity consumption):

22T3: *Yes, as I said, when [husband] opens that account then we are in trouble.* (P22:37)

The role allocation for management of electricity in the home came under the spotlight. In the discussion with the participants, some said that the decision to participate in the research project was made by the male spouse in the household, while it was the female spouse who actually participated in the interview, intervention and focus groups discussions:

3T3: *Okay my name is 3T3 and I didn't volunteer my husband volunteered for us.* (P23:1)

Even though the husband volunteered for the household to participate, this particular volunteer participated with great enthusiasm, and the researcher never met the husband.

One male participant described the household interaction during the focus group discussion as follows:

3K19: *Well, the interaction was mostly around me and my wife, and we were continuously aware, so she was introduced, she attended the initial information session and she explained it to me and to tell you the truth, she also downloaded the data so that she could see, see the pattern of the electricity.* (P20:33)

Clearly, here the interaction during the intervention was with the wife, even though the husband was in full support of her participation as is clear in his choice of the pronoun "we". This was the case in several of the households, and the importance of addressing the "implementer" of the energy efficient practices in the home became apparent.

- *Sub-theme 5.2: Female as implementer*

Female participants were often indicated as those who structure and plan routines in the household, as this female participant states:

22T4: *No, ag uhm, I am the one at home who creates the structure so I think it is depends more on me, he… it is not going to take too much effort from him to fall in with that, so…* (P22:26)

This participant took on the day-to-day management of the household electricity consumption and other conservation activities such as recycling, in a sense shielding her husband from the responsibility of implementation, but at the same time expecting compliance. Another participant illustrates his wife's knack for managing the electricity consumption:

3T16: *She constantly reminds me, put off here, put off there. She was really the one who kept her finger on the button the whole time, so.* (P20:39)

Implementation and enthusiasm for maintaining the desired behaviour seems to be important in establishing household routines managed in the household by a particular person, even when others in the household do not really comply:

3K3B: *She [their daughter] gets cross with her brothers, she gets them by the hair and say, put off the lights, she is very aware. Perhaps that is her personality and she wants to be controlling us, but that's one way for her, she gets furious when they leave it on. Ja, but the brothers are…*

3K3: *But her brothers can't be bothered.* (P23:78)

It seems that those who put household routines in place are best at maintaining the routines and motivating other members of the household to act in accordance with the strategy. In the next section, the need for guidance (as expressed during the focus group sessions) is explored.

5.5.3.6 Theme 6: Need for guidance

The need for guidance and the need for information were treated as two different themes in the analysis of the focus group discussions, because they represent two distinct requirements expressed by the participants. Guidance indicates the involvement of a knowledgeable person, the need to talk about the information to discuss findings and confer strategies, whereas the need for information is focused on billing practices, information dissemination and real-time and comparative feedback. The need for information is discussed in Theme 7, below.

The need for personalised electricity advice in the home was expressed by participants in the focus groups, especially those who were not part of Experimental Group 1 and therefore received limited interaction with the researcher. The comments below illustrate the participants' need:

21T1: *…when we open it you are there with us and you explaining each and every thing and then the next time when I'm opening it alone I know what to check. Because I didn't get a chance to be with you ja, I didn't know what to look for even if I open the the box what to check.* (P21:59)

21K3: *…is that you know this new this new technology cuts things you know we are old you know sometimes it takes time to to understand you know. And you'll find illiterate people who do not understand like we do so now they are of no use to them you know that's why 21T1 suggest that if you you come and do it yourself.* (P21:44)

Both these quotations are from the same focus group (P21 – Mamelodi) and emphasise the need for adequate guidance.

The effectiveness of the research project was also discussed by participants, especially in Mamelodi (where problems with actual electricity monitoring occurred in the only two focus group attendees' households). Many of their comments expressed a desire for better guidance during the research project (especially for those assigned to Experimental Group 2):

21T1: *I didn't learn anything.* (P21:1)

From the following comment, it is evident that the purpose of the baseline measurement and the subsequent explanation of the use of the electricity monitor were not sufficiently clearly communicated to the participant:

21T1: *You… just closed it the day you closed it maybe I thought you were coming back again so that because that's what I told you maybe if you can get time, you can come back so that you can explain to me what to expect or what to check because I didn't even know when I check what I could find there.* (P21:8-9)

Participants' own time constraints also afffected the effectiveness of the energy audit and intervention:

21T1: *So I was interested because I wanted to see uh maybe we can determine which appliances take more electricity than the others but maybe it's because of my busy schedule or whatever because I didn't get that even to read those things.*

Mathilda: *Okay you didn't…*

21T1: *…even…those … papers like this one I didn't get the chance to go through them.* (P21:2)

Here, the ineffectiveness of leaving information for people to read in their own time is illustrated. Moreover, the effectiveness of the real-time feedback by means of the electricity monitor also greatly depended on the research participants' level of confidence working with electronics:

21K3: *Ja no uh I must confess that really was, I was ignorant of the use of that thing.* (P21:41)

21K3: *…is that you know this new this new technology cuts things you know we are old you know sometimes it takes time to …*

21T1: *…to understand…*

21K3: *…to understand you know…* (P21:44)

21T1: *I have to say I really did not relate well to the monitor, I was really not in tune with it.*

Mathilda: *Did you have a look at it or did you just leave it in one place?*

21T1: *No, I uhm actually I just left it.* (P21:50)

From the above comments, it seems that very clear and personal communication strategies should be used in order to attain the true goals of research of this kind. It is evident that increased support and perhaps guidance from a community representative would be beneficial in areas where computer literacy and the use of electronics are still limited. This is not only true for the participants from Mamelodi, but also for participants from the other focus groups who often requested their children to deal with the electricity monitor installed by the researcher:

Mathilda: *…and you understood what was on it and how to change.*

23T3: *Now that … is [son's name] baby.*

Mathilda: *Okay.*

23T3: *I was born before computers and things like that so…* (P19:57)

However, other participants liked the real-time feedback provided by means of the monitor:

23K2: *Ja that it helped me a lot but to see that little meter going up and down the whole time and to know like when I've put down the elec… uhm the floor heating, under floor heating.* (P23:17)

The feedback provided by the electricity monitor was missed after completion of the study:

3K19: *I miss my monitor*. (P20:47)

Mathilda: *Okay, so it was a learning experience.*

3K18: *So aside from but I unfortunately when the meter was gone, it was gone.*

3K12: *Ja*.

3K18: *Because it's not visible, I think uh,…*

3T3: *For children it needs to be visible.* (P23:61-62)

Participants did not all have the same experience of using the monitor. The need for clear communication was expressed. In some instances, however, the intervention was well received and the technology was understood quite well.

The next theme focuses on the informational requirements of the research participants.

5.5.3.7 Theme 7: Need for information

The existing billing system used by the City of Tshwane (the local municipality in the region) was expressly criticised by one of the participants. The current system uses estimation and monthly bills indicating previous use (or estimates).

3K18: *…I mean those graphs at the back is worth nothing because of the periods that are different when they read it, then its estimation. It doesn't tell me anything. If they would correct it prior, afterward they would correct it then I would say all right, at least that helps because those graphs are actually something I would have like to see correct ones.* (P23:76)

The real-time feedback provided during the intervention in the form of the monitor installed in the households in the study provided an opportunity for the research participants to see their actual household electricity consumption. Comments on the impact of the real-time feedback were as follows:

3K12: *Ja that it helped me a lot but to see that little meter going up and down the whole time and to know like when I've put down the elec… uhm the floor heating, under floor heating.* (P23:16)

22T4: *And sometimes, even if it is not necessarily the geyser, because we put it on and off, but it is a lot of other things and suddenly it goes sky high and then you really realise how all the small things contribute, we have really, it [the feedback] was very nice.* (P22:46)

3T16B: *Yes, really it was an eye-opener to see you know for example just a kettle you switch on; you know suddenly the electricity flies.* (P20:40)

The ability to access actual electricity usage data in one's own house was empowering to some participants, enabling decision-making and giving them a sense of control over a situation normally perceived as inaccessible and uncontrollable. This form of feedback on responsible behaviour may in itself be an incentive for behaviour change, as indicated when this participant described her working environment:

3K12: *And every month I check because they need to report on things like do they put off the lights, the aircon, saving paper, recycling, ag there's a lot of other things in that but it's about the commitment and dedication of people. If you don't have that I'm sure that's what your research is all about, are you committed, how do you change behaviour, because it's only if you change the people's behaviour and get a commitment. And then there is rewarded recognition for that, obviously, and actually that's how you do it, that's how we try to do it and like on our recognition functions, those people whose really doing something extra about it, are rewarded for it.* (P23:95)

The value of real-time feedback and a form of reward for responsible use of resources were stressed in this section and may possibly pose a sustainable motivation for change in behaviour. This is discussed in more detail in Section 6.2.3.

5.5.3.8 Theme 8: Responsibility: from individual to authorities

This theme presents the personal values and responsibilities related to energy efficiency, as reported by the participants. It expands on the exploration of these responsibilities by taking society and authorities perceived to be in control of energy efficiency into consideration.

- *Sub-Theme 8.1: The role of the individual*

Even though participants indicated that pro-environmental behaviour depends on an external locus of control, they experience frustration in their attempts to conserve the environment due to a lack of commitment, infrastructure and organization from authorities, and then they argue that their behaviour is driven by an internal locus of control:

23K2: *I teach it to my children and my wife is frugal, we actually grew up like that so it wasn't something that we had to learn I grew up that way.* (P19:21)

3K19: *It's just a generally good approach in life to be frugal in any case.* (P20:34)

3K12: *…and actually it's just part of us now to save and not to waste any energy, electricity, water.* (P23:7)

3T3: *I think that people will only save and if they do it. Let me put it differently. People who save, do it holistically. Because you're not going to get people who just save on electricity. If you get people who save on electricity, they will save on water, they will do the paper recycling, they will do plastic recycling, they will do glass recycling, they would think about it holistically.*

Pilot 1: *Even the money side will be a saving side. They'll even work different with their money.*

3T3: *Ja, but people don't save because they save money; they save because they've realized if we do not all bring our bit and become the drop in the bucket, my drop, …*(P23:96-100)

Participants also linked the values in their life to spiritual motivations:

23K2: *…uhm well uh uh okay uh the the the church uh should participate because it is a public issue it concerns all human life, it concerns Gods creations so that's why the church should be involved and the the church uhm probably has many different roles to fulfil uhm in uh uh promoting the awareness, making people sensitive, motivate members to live sober and so on and uh to uh think again about their lifestyles and consumerism and all those things, so I think it's a very important uhm biblical theme to live in a certain way and in that way also express your gratitude towards God and what He has made and what He has given to us.* (P19:8-13)

The personal values, motivation and spiritual reasoning of research participants were presented above and serve as the basis for their interaction with other household members in their own attempts to motivate change in the behaviour of their fellow household occupants. In the next sub-theme, perceptions about the role played by authorities in energy efficiency are explored.

- *Sub-Theme 8.2: The role of the authorities*

The ability of the individual to contribute positively to energy efficiency is often undermined by a perceived lack of commitment by large corporations, the country's electricity generator (Eskom), local municipalities and the government:

3T16: *So you know the argument I have, anything flows from management as if it is at the top, from the government and they can shut off the power at night in their huge buildings, and then from there the whole process would be easier than trying to achieve something from the bottom.* (P20:106)

3T3: *And uhm, then you feel but why but why are these things not really seriously considered by the municipality.* (P23:106)

3K19: *We need formal policies in large corporations.* (P20:107)

3K18: *I think very often what it needs, it needs a driver behind it, now whether it's in a small family, somebody that drives it in that family, or whether it's in a bigger organization, but I think that government needs to jump in more aggressively, not just making advertising stories about the footprint and all those kinds of things which is actually too big for us to understand, for the normal people to understand what the impact of that is, and must make it in small chunks so that the people understand, make it easy for them to save, you know, like you said if I want to get rid of the old motor oil, I don't have to travel ten kilometres to get rid of it*. (P23:104)

The discussions with participants in this study revealed a lack of trust in the authorities. One research participant noted a deep sense of mistrust:

3K12: *There's another thing I want to say about the bracket [categorization] and it's got nothing to do with racism. The other day someone said to me that there's a code on the white people's account, and that we do pay more. I want to know if it is true.*

3K18: *But is it the electricity, or the overall bill?*

3K12: *The overall bill.*

3K18: *I think the overall bill I tend to agree with you.*

3K12: *It's the overall bill.*

3K18: *Yes, because if you stay in Waterkloof, you pay more than people say, Sinoville or those kinds of things*

3K12: *That's compared to someone. Not just that, it was someone living in Moreleta Park, this is my broker actually who told me this, and she had to go to this client of hers in Moreleta, and she's also staying in Moreleta and these were from another race and they paid almost half less and, okay you can't compare it just like that, but then they said to her there's code on your account. Ja it's*

> *a very contentious matter I'm raising now, you know what, I really just want to know that, because why on this earth still…you know. How long are we going to pay?* (P23:71-74)

Here it is clear that the mistrust in the authorities is shared amongst the research participants, and that racial tension and the divide between the affluent and the poor are emphasized. A lack of leadership, transparency and available information encourage this lack of trust and increase confusion around who is responsible for energy efficiency and how they are expected to fulfil this mandate.

In the next section, the strategies employed in households in order to effect change in these households are discussed. These strategies refer to the ways in which the nominated participants guided discussions about energy efficiency in their households, including how behaviour was changed, as discussed in the focus groups.

5.5.3.9 Theme 9: Strategies used by participants to effect change in their households

This theme deals with the strategies employed by the research participants to effect change in their particular households. The strategies employed range from authoritative instructions and other communication strategies in the household, to making physical changes at work and aligning values between work and home. Table 53 presents the strategies used, including some comments illustrating the participants' chosen course of action.

Table 53

Strategies employed by research participants in their households

Strategy	Quote
• Authoritative instruction: • Written instructions • Verbal instructions	**Written instructions** 21K3: *It work with me I didn't there was no need for me to explain, I just wrote the principles in the house ne because I'm the head of the house né. so I'll wrote there you know the order in the house about the use of this you know.* (P21:68) 21K3: *Ja so now it's it's helpful so the the sooner we minimize the use of electricity not wasting the better shall it be for us. So it's it's it's just like that.* Mathilda: *Did you write that and that's what you stuck to the wall?* 21K3: *Ja so they all comply to the regulations in the house.* (P21:78) **Verbal instructions**

Strategy	Quote
	3K18: *Yes, I would call them back. They would walk up to their rooms and I'll wait till they're there, call them back, those kinds of things, that's how I do it. I wouldn't call them back before they're there.* (P23:83)
Communication • Reminders • Family discussions • Shared responsibilities • Spreading the word	**Communicating reminders** 3T16B: *She constantly reminds me switch off here, switch off there*. (P20:38) **Family discussions** 23K2: *I showed them how it works and I showed them the difference when you put something on and so on and I think that increased the awareness*. (P19:51) 3K19: *…actually we often have discussions about it because especially with the 13-year old boy, a lot of the things that they do at school, projects, and natural sciences and life sciences they deal with stuff like the dangers of electricity, or the generation of electricity and the costs and so on.* (P20:36) **Spreading the word** 3T16: *Yes, I told everybody about this meter and you don't want to know, but it works and I tested it with all the you know appliances switching it on or whatever.* (P20:41)
Physical changes • Reminders • Lead by example • Plan/schedule use • Pre-paid meters • Provide meter readings	**Physical reminders** 3T16: *At this stage we are using the cell phone.* (P20:85) **Plan/Schedule use** 21K3: *…so in the house now we had uhm uh uh cooking cooking time table schedule.* (P21:17)
Become more active in the work place • Align values at work and home • Change physical set-up at work	**Align values** 3K12: *…then I'm working for a company who's the deep green place and um we really try to be seen as people who try to save this planet and to save energy, water, electricity, and actually it's just part of us now to save and not to waste any energy, electricity, water.* (P23:6) 3K12: *Your values have got to be aligned with the company's values. Otherwise it will be very difficult for you, if you don't have honesty or integrity or respect or things like that, you can't work there.* (P23:130)

Strategy	Quote
	Make physical changes at work Pilot 1: *What we did at the office was to and we're talking Rands now, the electricity bill came down by exactly five thousand Rand a month. And all we did was, it's simple, you're at work, just rough figures, you're at work eight hours a day. The other sixteen hours a day there is nobody at work and on weekends neither. And all we did, was put an intelligent system to do the geysers, we've got ten, eleven geysers so they're off when you're not there, and on when you're there. And that brought down five thousand rand already. And that's proven, because I do that meter reading myself.* (P23:42)

These strategies are discussed in detail in Section 6.2.5, where they are linked to the literature and conceptually discussed.

5.5.4 Conclusion on Phase 3

The themes generated in the analysis of the focus group discussions focused on several aspects, including the behaviour of the research participants in their use of their household appliances. The most common changes were achieved by means of geyser timing (automatic or manual) and changes in the use of fridges and freezers. The changes implemented were constrained by the expected levels of discomfort these changes would cause in participants' homes and the responses from the families of the participants to such perceptions.

Participants' comments revealed the role of erroneous beliefs about energy efficiency in changing behaviour, as well as the role of the person (often female) creating specific structures and routines in the household to address energy efficiency. They also mentioned a need for guidance and the need for specific information regarding feedback on responsible use in order to enable planning for efficiency. The strategies the participants employed in their families were also explored. These themes are conceptually discussed in Chapter 6. In the next section, the combined findings are presented and provide a comprehensive description of the link between environmental perceptions, actual electricity consumption and the perceived value of the feedback provided by means of the real-time feedback monitor.

5.6 Phase 4: Findings from the mixed methods analysis

In this section, the findings from the mixed analysis of the data from the various collection methods are presented. First, quantitizing the qualitative data from the in-depth interviews by means of ranking allowed the researcher to develop an understanding of the salience of different issues. The outcome of the ranking exercise is interpreted by means of the qualitative data from the interviews, in combination with the LSM data. Secondly, the energy consumption as a direct result of folk knowledge is quantified using the actual electricity consumption data and qualitative data from one specific household, where misconceptions on the functioning of appliances were apparent. In the third section, the electricity consumption of participants assessed in winter is related to the issues they highlighted during the qualitative data collection opportunities, taking an in-depth look at the comfort derived from heating/warmth in particular. Lastly, the electricity consumption data and comments of an Experimental Group 1 participant are compared to those of a participant from Experimental Group 2.

5.6.1 Quantitizing the data (LSM 6-9 talk vs LSM 10 talk)

In order to explore the salience of specific issues in the two LSM groups, the qualitative data from both the in-depth interview and the focus group discussions were combined and quantitized (as discussed in Section 4.5.3). The identified codes are compared by LSM, by ranking qualitative codes according to the ones mentioned most often by the research participants in each group. This provides a picture of the issues mentioned by most interviewees, and highlights the effect of the participants' living standard on the prominence of certain issues. The codes that were most salient in the LSM 6 to 9 and LSM 10 Groups respectively are presented in Table 54.

Table 54

Quantitized codes on salient issues in both LSM 6-9 and LSM 10

Salient issues	**LSM 6-9 (n=16)**	**LSM 10 (n=25)**
Eff – appliance use	10 (62.5%)	14 (56%)
Eff – geyser timer	8 (50%)	15 (60%)
Husband and wife interaction	5 (31%)	11 (44%)
Personal responsibility	5 (31%)	11 (44%)
Interaction with family and friends	7 (43%)	7 (28%)

From the number of times each of these codes was mentioned during either the in-depth interviews or the focus group sessions, it is clear that appliance and geyser use and the methods applied in households to consume electricity efficiently were discussed by the largest number of participants. This should come as no surprise as a large section of the in-depth interview focused on the actual changes made in the households before the commencement of the study. The interaction between husband and wife, however, was not among the questions in the interview guide or the focus group discussion guides, but was identified by both LSM groups as an important issue. Participants from the LSM 10 Group felt that taking personal responsibility for actions was important, and participants discussed the role of personal responsibility, or expressed the need for people to take personal responsibility, while the issue was less prominent amongst those in the LSM 6 to 9 Group.

Interaction with family, friends and neighbours with regard to energy efficiency was mentioned by seven participants in the LSM 6 to 9 Group and seven in the LSM 10 Group indicating an overarching importance accorded to interaction between social companions about issues that affect participants.

The differences in the emphasis and the number of times an aspect was mentioned by people from the two LSM groups are indicated in Table 55.

Table 55

Quantitized codes on the difference in salient issues in LSM 6-9 and LSM 10

Differences	LSM 6-9 (n=13)	LSM 10 (n=23)
Strategy – authoritative instruction	7	4
Each person can make a difference	2	14
Recycling needs to be more structured	0	9
Values discussion	0	15
Comfort – important	0	12

Authoritative instruction seems to be more often used in the LSM 6 to 9 Group as a strategy to convince family members to change their behaviour than in the LSM 10 Group. In LSM 6-9, very few participants referred to the belief that each person can make a difference, whereas this was quite an important aspect addressed by the LSM 10 participants.

The need for pro-environmental behaviour to be convenient and structured, and the importance of comfort was especially emphasized by the LSM 10 participants. In the LSM 10 Group, many participants mentioned the value of frugality, which was not mentioned outright by any of the LSM 6-9 participants. This omission by the LSM 6-9 group may perhaps, albeit counterintuitively, imply that to this group frugality is a way of life, which does not need citing as a value. There might be no other option available to people in this LSM group than to live in a frugal manner, using resources as best they can.

5.6.2 Interpretation of quantitative data based on qualitative findings and vice versa

The interplay between the qualitative and quantitative data sets is explored in this section. Both the qualitative and quantitative data sets were discussed in the previous sections. During analysis, the researcher identified frequently mentioned codes (in the qualitative data analysis), codes that reflected high energy use behaviours by participants, and odd or significant codes (according to the researcher) that warranted further investigation. This impelled the researcher to re-assess the quantitative use, paying specific attention to the issues highlighted in the qualitative data (where possible).

Similarly, unusually high savings or use, and irregular use, were identified in the quantitative data set, and the researcher used the qualitative data set to gain new insights contained in a different type of data about the same household. In this section, folk knowledge, which was identified during qualitative discussions as a possible cause of higher electricity consumption is discussed, using quantitative data. In turn, qualitative data are used to highlight a participant's reasoning and justifications for higher use or savings recorded during winter. In each case, the researcher examined the alternative data set (the quantitative data set in the case of qualitative codes, and vice versa for the quantitative use patterns) in order to explore the contributing factors further. These are discussed in the next section.

5.6.2.1 The consumption of folk knowledge

The identification of erroneous beliefs in the in-depth interviews led the researcher to explore the extent to which these beliefs contributed to actual electricity consumption. This led the researcher to re-examine the quantitative data, particularly relating to the erroneous beliefs identified in the qualitative data.

In the household of 23T3, there were seven fridges/freezers. Most of them had previously been used for catering, and they had been kept in case the children in the household (who were students at the time) might need them when they moved out of the house in a year or two. After the baseline measurement, where the daily average was 46.24 kWh, the participant was requested to switch the unused freezers and fridges off as part of the intervention. From the quote below, the influence of advice from "credible" sources are clear:

> *…when you told me that the fridges are not really necessary...after somebody said one shouldn't put it off because of the gas and blah blah blah, then I thought I will put it off because I don't need it.* (P7:23T3:19)

In the second week after the intervention was implemented, the household's daily average use was 36.13 kWh, representing a saving of 22% per day. This is a significant saving, attributed almost solely to discarding folk knowledge and thereby changing behaviour, as the participant declared that not much else had changed during the second week of measurement. During Week 3, when the freezers were switched back on, but lights and appliances were switched off more conscientiously, the savings were quite insignificant, with a daily average use of 45.5 kWh, a saving of only 1.6%.

It is not enough to identify erroneous beliefs around the functioning of household appliances in interviews. In the example above, the actual electricity consumption measurements provided the necessary support for a strong argument to identify such beliefs and change the identified beliefs. This is an example of why both qualitative and quantitative data are needed in order to make a specific, logically founded recommendation about electricity consumption.

In the next section, winter as a specific season of change is explored in more detail using both the qualitative and quantitative data.

5.6.3 Winter use vs winter talk

From the analysis in Phase 2, Part 2, it is clear that winter poses a very specific opportunity in South Africa to address energy efficiency for two reasons. First, the annual electricity price increase is usually implemented on 1 July (winter), therefore people paying for electricity may be more focused on their consumption due to the increase in cost. Second, the cold weather is the main reason for increases in electricity consumption (in all households), as the data indicate.

The quantitative findings presented in Table 56 indicate the electricity consumption increases and savings in both LSM and experimental groups during winter, where the effectiveness of the intervention in curbing the normal winter-time increase in Experimental Group 1 was shown.

Table 56

Electricity savings during winter

LSM group	Experimental group (winter)	Winter savings/losses (average kWh per day)
LSM 6-9 (n=13)	Exp1 (n=7)	5%
	Exp 2 (n=1)	-28%
LSM 10 (n=23)	Exp 1 (n=6)	3%
	Exp 2 (n=7)	-19%

From the discussion in Section 5.4.6, it is clear that the living standard of the participants in this study did not have an impact on the effectiveness of the intervention. Therefore, the winter electricity use of Experimental Groups 1 and 2 is used in this section, regardless of the participants' LSM group allocation. The savings and increased use during winter in the two experimental groups are presented in Table 57.

Table 57

Winter savings and losses per experimental group

Winter experimental group	Savings/Losses during winter (average kWh per day)
Experimental Group 1 (n=13)	4%
Experimental Group 2 (n=8)	-23.5%

During cold spells, the electricity consumption went up considerably, and participants often noted using their heater more often. This encouraged the researcher to look at specific references to heat and comfort during the in-depth interviews and focus group discussions again. The importance of comfort after a day's work was mentioned and highly regarded, as one participant noted:

> *…one specifically wants to spend money on comforts*. (P20:3K19:16)

This illustrates the need to have certain comforts, and displays a willingness to pay for those comforts.

Warm water, food and drinks and the comfort these create are highly valued. Discussions on the comfort found in being able to take a hot bath, drinking a hot cup of tea or coffee and heating one's home was mentioned quite often.

> *In the winter months we uh, instead of trying to heat the whole house, or to heat every room in it, we only heat the bedroom where the television is as well, so it is comfortable for us to do.* (P23:3T3:25)

> *…and then I switch my geyser off when I remember, but I am not always in the mood to switch it off because I don't want to switch it on when I come back, I want to be able to take a hot bath immediately.* (P16:3T4:7)

During the in-depth interviews almost all participants noted their frugality when using heaters. The usage data and the corresponding data logging sheets indicated a lower use of heaters during cold spells in Experimental Group 1 than in Experimental Group 2. During the in-depth interviews, one of the participants noted:

> *I say, this winter that is past, we haven't put on the heater once.* (P1:P21T4:22)

Participants from Experimental Group 2 did not participate in the in-depth interviews, nor did they participate in an interactive evaluation of their electricity use. Qualitative comments from Experimental Group 2 participants were captured on the data logging sheets, and represent the only qualitative comments available to the researcher. These comments are highlighted here:

> 3T8: *Tenant used heater excessively.*
>
> 3K10: *Heater was left on during every night for the elderly dog.*
>
> 3K3: *Used under floor heating.*

Participants from Experimental Group 1 (who completed both an interview and the intervention) noted during the focus group session that they had been more conscientious about not using their heaters and mentioned a change in routine in order to compensate for the cold:

> 3T3: *But what we do do is we if it's like in the winter and it's cold, we heat the one room where the two of us would sit watch television, it's in the bedroom, it's a schlepp it's far from the kitchen, but we've got the light, we've got everything.* (P23:47)

In the next section, a closer look at two participants, one from Experimental Group 1 and the other from Experimental Group 2, is presented.

5.6.4 Simultaneous description: A case study of two participants

In this section, changes that took place in an Experimental Group 1 household are compared to the lack of changes that took place in an Experimental Group 2 household. These differences emerged clearly in the focus group discussion (P20), leading the researcher to re-examine the quantitative data for each participant. Although this section focuses only on the changes in two households, which were purposefully selected to illustrate these changes, it is believed to be an apt illustration of the possibilities of a successful intervention.

These participants had the same LSM score (LSM10), and both participated during the same season (winter). Participant 3K19 was in Experimental Group 2 and Participant 3T16 was in Experimental Group 1. During the focus group session Participant 3K19 noted a reason for not changing certain aspects in the household:

> 3K19: *Because, oh there are so many people's opinions about these things and if you use the same amount of electricity that you save when you put it off to heat it up again…in a specific time period, so you know there are so many opinions about it.* (P20:57)

Actual electricity consumption during the whole measurement period for this participant's household is indicated in Table 58. An average increase of 27% compared to his or her own baseline week, is shown.

Table 58

Average consumption and savings for 3K19

Average per day: Week 1 (kWh)	Average per day: Week 2 (kWh)	Average per day: Week 3 (kWh)	Savings Week 1 – Week 2 (%kWh)	Savings Week 1 – Week 3 (%kWh)	Average saving
35.36	43.36	47	-22.6%	-32.9%	-27.75%

The other participant (3T16, from Experimental Group 1) noted that his or her electricity use might increase in future because of an increased use of heaters:

> 3T16: *There is going to be a big difference, even last year August I saw the difference. I think we had a cold winter or maybe one is colder as one gets older, so one may see a difference because, the heaters and things was on.* (P20:6)

However, the use in the household of 3T16 went down, as indicated in Table 59.

Table 59

Average consumption and savings for 3T16

Average per day: Week 1 (kWh)	Average per day: Week 2 (kWh)	Average per day: Week 3 (kWh)	Savings Week 1 – Week 2 (%kWh)	Savings Week 1 – Week 3 (%kWh)	Average saving
15.4	10.8	10.3	29.8%	33%	31%

The decrease was mainly due to the changes in their geyser use, with Participant 3K19 finding the results difficult to believe:

3T16: *You know, wait just a minute, because with our geyser that we switch on and off, you have to take a bath when it was on, otherwise either morning or evening or whatever you know. You know, other friends of ours, what did they say is their setting [on their geyser timer]? Thirty or forty minutes a day?*

3K19: *But is there really a positive effect on your use? Meaning is your use lower; looking at it scientifically it should be, but that on off on off, I don't know. Do you see it in your account?*

Mathilda: *Yes.*

3T16B: *We definitely see it in our account*. (P20:72-78)

Electricity consumption decreased by 31% in 3T16's household, mainly due to switching the geyser off for large portions of the day. In 3K19's household, where no changes were encouraged, the electricity consumption increased by a daily average of 27%. The impact of participation in the intervention is highlighted both in the actual electricity consumption and the qualitative data. In this instance, the qualitative data serve a supportive role in explaining the trends in the electricity consumption data that would not otherwise have been explained.

5.6.5 Conclusion on Phase 4

From the analysis in Phase 4, it became clear that in both LSM 6-9 and LSM 10, interaction between husband and wife and interaction with family and friends regarding energy efficiency are important. However, for participants in LSM 10, comfort and convenience are very important. Arguing that each person has a personal responsibility is something everybody agrees on; however, the LSM 10 group frequently mentioned that each person has the ability to make a difference. The LSM 10 group also mentioned that values are the guiding principle for acting in a frugal manner with all resources, including electricity. In LSM 6-9 households, the possibility of saving money by means of energy efficiency was emphasised.

The actual electricity consumption associated with erroneous beliefs about the functioning of household appliances was highlighted by means of an example. This placed the emphasis not only on the need to identify such beliefs, but substantiated the argument for doing so by means of usage data. The impact of these beliefs has not been identified qualitatively and substantiated quantitatively in the literature before.

Once again, winter was indicated as a specifically vulnerable time for increased electricity consumption due to the comfort people derive from space heating. It is therefore a good time for intervention. The differences in electricity consumption and the importance of heat comfort during winter were illustrated by means of electricity use figures. Lastly, the differences between two participants from Focus Group P20 were explored in detail, providing both their arguments and their usage data. The intervention clearly encouraged the participant from Experimental Group 1 to overcome the expected psychological discomfort still expected by the participant in Experimental Group 2.

5.7 Conclusion

In this chapter, the findings from the analysis were presented in four phases. In Phase 1 an overview of the demographics of the research participants and their available data was provided. In Phase 2, Part 1, the findings from the in-depth interviews in the form of the most frequently occurring codes and themes generated from the analysis were presented. In summary, global climate change was not perceived to be an immediate threat, but most participants argued that their personal values and social norms should be the driving force behind motivating more responsible pro-environmental behaviour.

Efficiency planning is not clear enough, and although various strategies are employed, inertia was still perceived even in several of the households that had completed an interview. In some instances, where changes have been made, conflict sometimes arose. Preliminary indications were that it was largely females who were responsible for changing household routines. A need for support in managing energy efficiency and feedback based on information was expressed.

In Phase 2, Part 2, electricity consumption data were compared between LSM 6-9 and LSM 10 households, on a per capita basis, and the data were compared to the baseline measurements. There was no clear indication that a person or household's living standard (LSM) affects the impact of the intervention, but the allocation to one or the other experimental group appeared to be related to a difference in the electricity consumption, as did the season in which the household was measured. The conclusion from Phase 2, Part 2 was that the intervention was effective in limiting the winter use increase in Experimental Group 1 that was unmitigated in Experimental Group 2.

In Phase 3, the nine themes generated from the focus groups were once again shown to focus on the changes in behaviour and the strategies employed by the participants following the intervention (for those in Experimental Group 1). It became evident that women are considered the main implementers of energy efficiency and other pro-environmental strategies in households. Communication strategies and strategies where values are intentionally aligned with self-concepts and even employers' values were adopted. The benefits of real-time feedback were emphasised, but simultaneously highlighted the need for clear, unambiguous and accessible instructions and guidance, especially in areas where literacy levels are lower and computers are used less often.

In Phase 4, the different data sets were explored in conjunction with one another. The salience of issues in the two LSM groups were explored, revealing that LSM 10 households were much more concerned with comfort and convenience than the households in LSM 6-9. To those in LSM 10, the value of using resources sparingly was more salient. High electricity consumption as a result of erroneous folk knowledge was indicated by means of a case study, and the effect of the need for heat comfort on electricity consumption was explored. Finally, two participants' discussions from Focus Group P20 were explored in detail, and were re-examined using their individual electricity consumption figures in order to highlight the effect the intervention had on these individual households' routines and electricity use.

In the next chapter, the identified themes in this chapter along with the findings from the combined analysis are presented in three over-arching themes and are conceptually contextualised in the literature. These over-arching themes focus, first, on environmental concern, looking at the environment in general, and at energy efficiency in particular, second, the search for information and, third, practices, both in terms of communication and behaviour relating to establishing energy efficiency in participants' homes. These themes are used in the conceptual model that will be presented. The model makes use of the ecological dimensions and provides a basis for understanding and interpreting residential energy efficiency in South Africa.

Chapter 6:
Conceptual Discussion

6.1 Introduction

In the previous chapter, the findings from the research process were presented in four phases. In this chapter, the findings from these four phases are discussed in the light of the literature presented in Chapters 2 and 3. This will be done in the form of three over-arching themes, which encompass the 11 themes reported on in Phase 2, Part 2 (resulting from the in-depth interviews) and the nine themes generated in Phase 3 that were presented in Section 5.5. These are discussed conceptually and presented in this chapter, linking the data in this study to the literature, culminating in the presentation of a conceptual model of residential energy efficiency in South Africa.

At this point, it is important to reiterate the research questions to remind the reader of the purpose of the study and how these questions have been addressed in support of the development of a conceptual model of residential energy efficiency:

- What is the effect of a psychological intervention, using particularization, real-time feedback, goal setting and commitment-making, with an individual in a household on the household's electricity usage
- What energy conservation strategies (if any) are employed by households, as perceived by the individual (participant) and why?
- How do participants from different socio-economic backgrounds attempt to save electricity?

In the sections below, the research findings are conceptualised in three over-arching themes: environmental concern, finding out about energy efficiency and energy efficiency behaviour, and communication strategies. Each is discussed using the ecological context of energy efficiency. Findings suggest that environmental concern, curiosity and behaviour are all important in instigating changes in pro-environmental behaviour.

In Over-arching Theme 1, the micro (personal values), meso (gender roles and the community) and exo (leadership) levels of exhibiting environmental concern are discussed. Given that, at the exo level, distrust amongst the participants of institutions advocating energy efficiency was highlighted, the micro level (personal norms) play an important role in motivating change in their households. At a meso level, gender roles are explored in more detail and their importance for energy efficiency in the household are highlighted in Over-arching Theme 1.

In Over-arching Theme 2, the need for guidance and information is emphasised. The need for and the goal of feedback are presented; the need to provide unbiased and understandable information to household owners regardless of their socio-economic background is emphasised; and the challenges particularly applicable to lower income households are discussed.

In Over-arching Theme 3, behaviour (both physical behaviour and communication strategies employed in this project) is addressed. The need to re-think some of the behaviours identified in this study is discussed. Strategies preferred by participants are identified, followed by a detailed description of the communication strategies employed, along with their level of application in the micro, meso and exo level contexts. The conceptual model of residential energy efficiency is developed and discussed throughout the three over-arching theme discussions, with descriptions of interaction between the ecological levels within each over arching theme and the resultant interaction.

In Section 6.3, the outcomes of this study and recommendations for similar projects in future are presented. These include recommendations for improvement of home energy audits and for refining the type of interaction between researchers and research participants – especially in low income households.

Limitations to this study are subsequently discussed in Section 6.4. These tend to cluster around the benefits and problems normally associated with field research, as opposed to laboratory research. The limitations are discussed with specific reference to the chosen unit of research, the implementation of the intervention design, and the research design adopted in this study.

Recommendations for future research are made in Section 6.6, looking at micro level and meso level research questions that emerged from this study, followed by a discussion of two policy implications of this study in Section 6.7. These policy implications relate to the provision of normative and personalized feedback on a daily basis and the need to enforce this with regulation. Moreover, the measurement yardstick for the success of energy efficiency projects in low income households needs to be clarified and standards or guidelines must be developed and implemented.

6.2 Over-arching themes: A conceptual discussion

The research findings in Chapter 5 highlighted important aspects identified in the data, and in this section, the description is taken further by discussing these findings in conjunction with the literature in the form of three over-arching themes. This is done in-line with Boyatzis's (1998) encouragement of further description:

> Moving to higher levels of cognitive complexity, we could place pattern recognition, or the inductive process of identifying themes or patterns in seemingly unrelated information, as the next highest cognitive capability. It would be impossible to perceive

> patterns inherent in complex data or seemingly unrelated data without the ability to build, perceive and think in terms of multiple causal relationships. Pattern invention, which could be called theory building, could be placed at the highest level of such a hierarchy. (p. 139).

The over-arching themes in this section are classified according to the empowerment spiral of Mehlmann et al. (2010) discussed in Section 3.4.2. Three over-arching themes have been generated by identifying patterns in the themes discussed in Chapter 5. These focus on aspects of concern for the environment, finding information when looking for it, and acting on the information. For each over-arching theme, the themes and findings that constitute that particular over-arching theme are presented in a table format. The first over-arching theme looks at personal values and social norms (environmental concern), the second focuses on the impact of feedback on the motivational loop in the individual and family (find out), and the third on actual and planned behaviour and communication strategies. It is important to note that these over-arching themes are not presented in a hierarchical way; the empowerment spiral can start at any point and does not end after one circle/iteration, but continues to spiral. Mehlmann et al. (2010) emphasise that “[e]ach step – ‘acting’, ‘caring’, ‘informing’ – prompts the next. It does not matter where you start; and the cycle is potentially self-reinforcing: a positive feedback loop” (p. 178). The over-arching themes (OATs) discussed in this section are:

- OAT 1: Norms in the ecological framework (Environmental concern);
- OAT 2: Information and feedback (Find out and provide feedback); and
- OAT 3: Behaviour and communication strategies (Behaviour and strategies).

In each over-arching theme, the ecological levels are discussed, that is, the micro, meso and exo levels of that particular over-arching theme. This is done by first highlighting the applicable aspect of the empowerment spiral, along with a description of the characteristics of this particular over-arching theme. Then a table is presented, highlighting the contributory themes and findings identified in Chapter 5. This is followed by a discussion of the literature on the theme. Finally, a conceptual placement in the ecological model specific to energy efficiency is undertaken. The micro, meso and exo levels of the ecological approach are used throughout to discuss the empowerment spiral action. It is important to note that, although an attempt is made to discuss the identified over-arching themes using each of the ecological levels in detail, this study looked mainly at the individual and the individual’s perception of his or her impact on the actions of family, neighbours and authorities. Therefore, this conceptual discussion examines the data collected at an individual level and presents an ecological interpretation of those individuals’ viewpoints (the micro and meso levels, with some context at the exo level, placing this study in a South African context). The macro level in Bronfenbrenner’s (1977) ecological approach is defined as “the overarching institutional and ideological patterns of the culture or subculture as they affect human development” (p. 527) and does not fall into the ambit of this study. Figure 21 presents the conceptual model in which the over-arching themes fit and interact, adapted from Mehlmann et al.'s (2010) empowerment spiral.

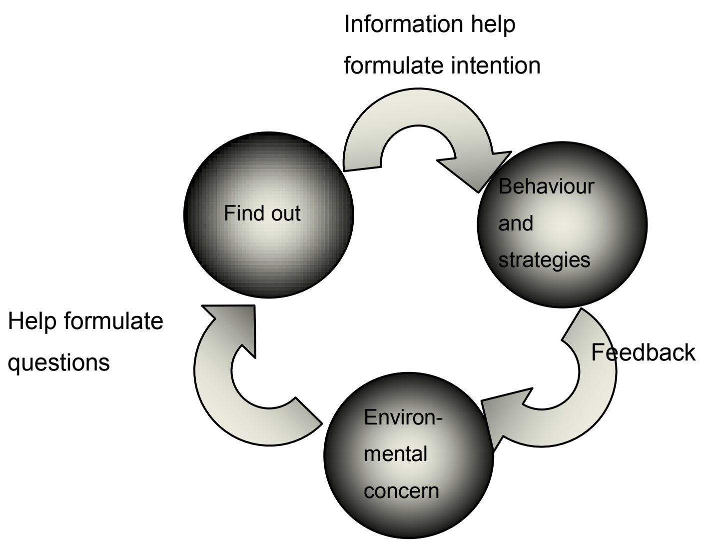

Figure 21 Mehlmann et al.'s (2010) empowerment spiral as adapted for this study

In the sections that follow, each over-arching theme is discussed in detail; the first of which describes the ecological framework of norms in more detail.

6.2.1 Over-arching Theme 1: Ecological framework of norms (Environmental concern)

The first over-arching theme deals with the ecological framework of norms (environmental concern). In this over-arching theme, the interplay between awareness of global climate change and the need for energy efficiency at a personal level, and the perceived social norms and self-efficacy in addressing these issues are investigated. The exploration of the perceived and expressed social and personal norms enable a description of the extent to which the research participants themselves (and their perceptions of those around them) are concerned about the environment in general and energy efficiency in particular. This over-arching theme answers the questions: "*Do I care about energy efficiency?"* (exploring personal values and norms) and *"Do I see others caring about energy efficiency?"* (focusing on perceived social norms); and finally *"Am I supposed to care about energy efficiency?*" (focusing on the normative goals communicated by the exo level, such as schools, communities, municipalities etc.).

First, the "Environmental concern" aspect of the empowerment spiral is identified and discussed, followed by a table highlighting the contributory themes and findings. In Figure 22 , environmental concern is highlighted, followed by a discussion of concern for the environment at the micro, meso, and exo ecological levels.

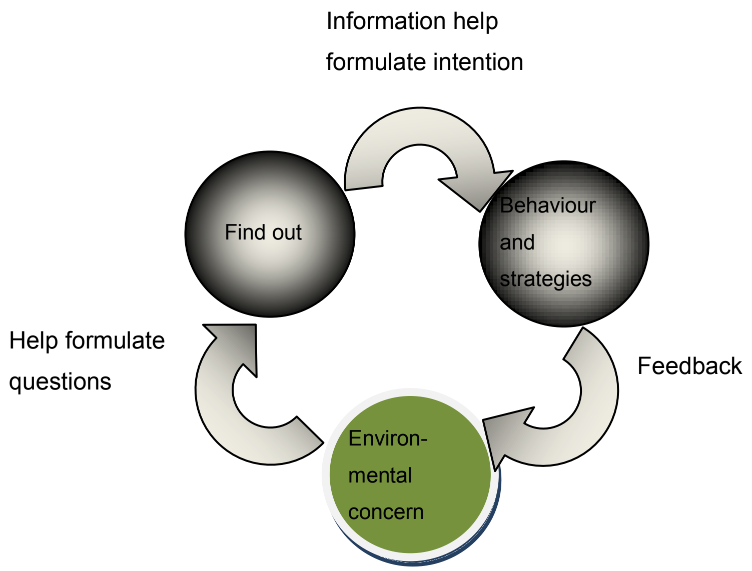

Figure 22 Empowerment cycle's focus on environmental concern

As discussed in Section 2.7.4, environmental concern refers to a feeling of concern or interest in a subject to which importance is attached (Mehlmann et al, 2010). Perkins (2010) defines caring for nature in three dimensions: first, he mentions "feelings of awe, wonder and interest in nature, which are sustained emotions said to evoke feelings of care' (p.456), and then "feelings of love, emotional closeness and interconnectedness with nature, including a spiritual aspect somewhat neglected in the psychology literature" (p. 456); finally, he attributes feelings of responsibility, care and commitment to protect nature to caring for and about the environment.

Over-arching Theme 1 (Environmental concern) refers to concern for the environment, and consists of

- an individual's perception of his or her own concern for the environment/energy efficiency; and
- an individual's perception of others' concern for the environment/energy efficiency.

The first level of concern by the participants in this research was exhibited when they volunteered to participate in the study, possibly due to a pre-existing level of concern for the environment. The themes that emerged from the qualitative analysis of this research and that form part of this over-arching theme are indicated in Table 60.

Table 60

Over-arching Theme 1: Themes and findings on norms and environmental concern

Themes and findings from each phase of analysis presented in Chapter 5			
Phase 2, Part1	Phase 2, Part2	Phase 3	Phase 4
Theme 1: Environmental awareness		Theme 2: Comfort	Salient: personal responsibility
Theme 5: Folk knowledge		Theme 4: Folk knowledge	Salient: Interaction with family and friends

Theme 6: Gender roles		Theme 5: Female as implementer	Differences: Self efficacy
Theme 7: Comfort		Theme 8: From individual to authorities	Differences: values
Theme 9: Role players in energy efficiency			Consumption of folk knowledge
Theme 10: Self and values			

The over-arching theme on the perception of energy efficiency is presented in the ecological framework of norms and environmental concern, in three parts: at a micro level, at which environmental awareness, personal perceptions of norms and self-efficacy are discussed, at a meso level, which refers to societal interaction with family and friends and its implications for energy efficiency, and at an exo level, relating to issues of leadership and a public display of perceived self-efficacy in addressing the issue of energy efficiency in the household.

6.2.1.1 Micro level environmental concern: From awareness to values

In this section, the thoughts and perceptions of the individual participants (the micro level) in response to the third research question are explored in more detail. The third research question asks how people in different areas strategize energy efficiency. Personal motivation for behaviour change toward more energy efficient practices is described and discussed in relation to findings from previously published studies and psychological theory. Personal motivation and concern are explored by means of a description of the research participants' perceived behaviour control and perception of environmental threats, the importance of environmental awareness, and the role of the research participants' environmental values as they see them, focusing on the individual.

Curiosity (the formulation of questions and a desire to find out) (Mehlmann et al., 2010) and an aspiration to save on electricity costs (a gain goal) (Lindenberg & Steg, 2007) were identified by the research participants as their main reasons for participation in this study, as indicated in Section 5.3.2.1. The research participants' motivation for behaviour change (whether it was a motivation that existed at the time of the study or one that changed as a result of the study) is considered in more depth below.

Ajzen's (1991) theory of planned behaviour postulates that attitudes, subjective norms and perceived behavioural control predict behaviour, as discussed in Section 2.6.1. In this study, the perception was clearly expressed that there is no real, immediate and nearby (local) threat to the environment (Phase 2, Part2, Theme 1, Sub-theme 1.1). Loewenstein et al. (2001) argue that global climate change is often discounted because of a human tendency to relate risk to an emotion or feeling, such as fear, anxiety or dread, and a tendency not to react to an "unknown" fear such as global climate change. This is in line with other researchers such as Gattig and Hendrickx (2007), who found that environmental problems go undetected on a personal and immediate level, resulting in a moderate, even lukewarm, approach to "going green", and Uzzell (2004), who reported that perceptions of the threat of global climate change progress in line with physical area levels (in other words, people think that they and their town do not experience environmental problems, but their country and continent do). It was therefore not expected that participants in this study would perceive great climate change risks at an individual level (as identified in Phase 2, Part 1 and Phase 3).

Participants did, however, strongly emphasise the need for awareness of environmental issues (Phase 2, Part 1, Theme 1, Sub-theme 1.2) and education (Phase 2, Part 1, Theme 1, Sub-theme 1.3). They reported that, for them, awareness-making and education presents the solution to the perceived non-existent problem of climate change. In the LSM 6 to 9 Group, authoritative instruction was highlighted as one of the most important strategies in changing the behaviour of members of the household (Phase 4). In this regard, De Young (1996, 2000) found in the American context, and Du Preez (2005) reported in the South African context, that it is a common misperception that awareness will eliminate the problem of ignorance, and that by means of education, awareness is created and the problem of a lack of behaviour change can be addressed. Awareness only forms a small part of the attitude that leads to behavioural intention (Ajzen, 1991). Although information dissemination in the form of lectures (Gifford, 1997), workshops (Geller, 1981), pamphlets (Bell et al., 2004), and mass media campaigns (Staats et al., 1996) may lead to an increase in knowledge, such an increase is not necessarily translated into behaviour change (Abrahamse et al., 2005).

Another aspect that participants commented on was the environmental values that they hold.
Milfont, Duckitt, and Wagner (2010) found that environmental attitudes are predicted across cultures not only by a perception of threat but also by the values held by individuals. Participants in this study did not report perceptions of imminent threats to the environment, and rather emphasised environmental awareness, but they did mention personal values (Phase 2, Part 1, Theme 10 and Phase 3, Theme 8) as motivation for acting in a pro-environmental manner. Comments made by participants on their values and how they see themselves with regard to environmental behaviour included several different aspects, as pointed out in Section 5.3.3.10:

- a sense that the earth is valuable;
- each person can make a difference;
- one has to listen to one's conscience;
- acting environmentally responsibly is a spiritual thing;
- it is their personal responsibility; and
- expressing the need to display consistent pro-environmental behaviour.

Participants in both LSM groups stressed the importance of personal responsibility in environmental behaviour. This was especially emphasised by participants from the LSM 10 Group, who mentioned frugality, personal responsibility, but also comfort. Emanating from the discussions during the in-depth interviews and in the subsequent focus group sessions, their intentions seem to be pro-environmentally inclined, due to internalised values and beliefs, rather than as a result of perceived exo level norms.

For some of the participants, these values and beliefs are grounded in religious world views, as they sometimes mentioned moral reasons for behaviour as motivating their desire for energy efficiency (Phase 2, Part 1, Theme 3). Some participants mentioned their moral responsibility to act in an environmentally friendly manner, but the role of morals in the interaction between intention and behaviour is largely ignored by Ajzen's (1991) theory of planned behaviour. This omission has been criticised by Manstead (2000), but Kaiser and Scheuthle (2003) and Kaiser et al. (2005) have argued that moral norms are already well presented within the attitude dimension of the individual and do not in themselves contribute significantly to increasing the interchange between attitudes and behaviour. Encouraging the development of values, instead of simply providing information or laying down moral norms seems to be more effective in changing behavioural intentions into actual behaviour change, and in this study was also found to be a more important driver than perceived risks.

In this study, it seems that the overriding predictor of environmental attitudes is not primarily driven by a perceived threat to the environment, as such a threat in South Africa was discussed infrequently and without much concern. Participants in this study emphasised personal values and responsibilities more, and the aid of spouses, other household members, family and friends, in both LSM groups, indicating that interaction with others about energy efficiency was important. At a meso level, the actions of and perceived support from family members, neighbours, friends and colleagues encouraged and enforced individuals' perceptions of caring about energy efficiency and asking questions about the environment. This finding is in line with Ajzen's (1991) theory that not only do perceived behaviour control and threat perception play a role in a decision to act in a specific manner, but so does the perception of the subjective norm.

In the next section, the meso level environmental concern about energy efficiency is discussed.

6.2.1.2 Meso level environmental concern: Gender roles

Meso level concern for the environment, and for energy efficiency in particular, refers to themes identified during the analysis of the in-depth interview and the focus groups relating to participants' perceptions of other people regarding energy efficiency, specifically their family members, neighbours and colleagues. Surprisingly, one of the most important interactions mentioned by the research participants was the interaction between responsible role players in the home and the interaction between men and women in the household (Phase 2, Part 1, Theme 6 and Phase 3, Theme 4). Regardless of whether the participants had children or not, interaction regarding the consumption of electricity and ways in which to save electricity was a very important issue in households. The various roles men and women played in households were not initially part of this study and were not thought to contribute significantly to the success of an intervention, but was found to be relevant. In the literature, seeing significant others care about the environment has been highlighted as an important contributing factor to the success of an intervention programme (Staats et al., 2004).

Electricity was regarded as part of the “hardware” of the house and as an issue of home maintenance, but the same attitude did not apply to energy efficiency, which was perceived as an aspect of household routine, rather than as hardware in the home. Hence, energy efficiency was thought to be the responsibility of the person who normally determines and manages the household routine. In this regard, it is relevant to note Carlsson-Kanyama and Lindén’s (2007) comment that

> …depending on how household chores are divided between the sexes, and upon how other tasks necessary for household provision are carried out…the extra workload induced by energy savings may at times be significant and fall upon women in a disproportional way. (p. 2170)

In this study, the responsibility for managing household routine in a more energy-efficient way fell, for the most part, to the women in the households. Women explained that they are the ones who determine and deal with the household routine on a regular basis and therefore they elected to manage the household routine in terms of energy efficiency.

Carlsson-Kanyama and Lindén (2007) note that “traditional surveys where one household member answers about the overall household behaviour cannot capture the intricate pattern of how household chores are divided between men, women and children” (p. 2171). This was also the case in this research. However, the qualitative data gathered in this research, even when it was from only one responsible person in the household, provided some insight into the interactions between various family members at an interpersonal level regarding energy efficiency, especially the interactions between men and women (Carlsson-Kanyama, 2010).

Delener (1994) indicates that role performance, family power and family conflict all play a role in the way in which decisions are made within the home, especially in more traditional households. In contrast to studies focusing on religion, the feminist literature tends to advocate an equal distribution of responsibilities in the home, and the importance of not supporting the notion of value ascribed to a woman only as a result of the number of children she has (APA, 2010). Undoubtedly, these issues are important, but in this study, the roles played by husbands and wives during their interaction focused on another dimension of interaction.

Even though gender differences in managing energy efficiency were not central to this research, the study was able to show that in households where men supported environmental change (or made guiding and household decisions about energy efficiency), women were enabled and supported to make more significant changes to the household routines and reportedly maintained them for longer periods. The APA (2010) notes that psychologists' knowledge about beliefs "and how they influence individual and policy decisions, and decision-making in interpersonal relationships…could all provide useful information for discussions that involve individual and societal decisions" (p. 33). The effect of fundamental beliefs around interpersonal relationships in the household may thus have an effect on the way in which decisions are made in the household. A detailed exploration of these decision-making processes between different members of the household falls beyond the scope of the current study, so it is recommended that decision-making processes at an interpersonal relationship level, particularly about energy efficiency and the socio-economic effect thereof of women in particular, be explored further in future studies.

From this study, it became apparent that electricity consumption is not well defined in households. In many instances, men are expected to manage the "hardware", such as repairing and altering electrical configurations in the home (changing globes or plugs), but in this study women indicated that they were better equipped to make decisions about aspects that influence the household's routine. The interactions between men and women as role players in the home therefore play a supporting role in a household's energy efficiency, which reinforces the importance of the subjective norm.

In the next section, the exo level of energy efficiency, namely leadership and infrastructure, is discussed in more detail.

6.2.1.3 Exo level environmental concern: a perceived lack of leadership in energy efficiency

According to Lang and Hallman (2005), discussions about climate change generally elicit distrust of the government, corporations, the regulatory authorities and even science itself. This was also evident in this study (Phase 2, Part 1, Theme 9 and Phase 3, Theme 8.2). Lang and Hallman point out that "trust is important for the perception of many types of risk" (p. 1241). They postulate that "the public" often classify large organizations into three categories: the evaluators (such as universities and scientists), the watchdogs (such as consumer advocacy and environmental organizations), and the merchants (such as grocery stores, industry and farmers). Of these, evaluators are most trusted, watchdogs are somewhat trusted and merchants are least trusted. In the current study, distrust in government and Eskom was expressed by many of the participants (Phase 2, Part 1, Theme 9) and even collectively expressed in some of the focus group discussions (Phase 3, Theme 8). Mistrust in municipalities was extremely high amongst the participants in this study. According to the Institute for Security studies (ISS), this attitude is also present in the larger population, as is evident from the numerous service delivery protests in South Africa in the recent past (ISS, 2009).

The identified perceptions of mistrust in leadership structures, and the lack of normative goals in the South African energy environment, in some instances increase the lack of perceived behavioural control at an individual level (the micro level). In the following comment from one of the in-depth interviews, the interaction between the micro level commitment and the exo level display of behaviour (by the leadership or a large institution) is clear:

> *You know what can make one really negative is when your streetlights outside are on and you phone and you tell them and you phone a week later and you tell them and it keeps on burning day and night you know …and then you realize you know what, the people feel that they try, but the bigger institutions ha-ha feel nothing...yes your effort means nothing.*
>
> (P7:23T3:26-29)

In the absence of trust in authorities (and a statement and display of a normative goal), participants seemed to substantiate pro-environmental arguments by focusing on their perceptions of people in their society (Phase 2, Part 1, Themes 5 and 9, and Phase 3, Theme 8.2), their household (Phase 2, Part 1, Theme 6 and Phase 3, Theme 5) and themselves (Phase 2, Part 1, Theme 10 and Phase 3, Theme 8.1). This is indicative of a perceived lack of normative environmental goal frames (Lindenberg & Steg, 2007) in South African society, causing individuals to withdraw to their meso or micro system, and to focus on hedonic or gain goal frames instead. Lindenberg and Steg (2007) claim that a normative goal frame is “probably the most important for pro-environmental behaviour in the population at large” (p. 128).

The identification of normative goals in this study was difficult and was often frustrated by participants’ pointing to the unsatisfactory behaviour of the local leadership structures. Lindenberg and Steg (2007) suggest two ways to establish the prominence of normative goal frames. These are, firstly, to establish and strengthen abstract smart norms, linked to lower level smart norms that would result in actual behaviour, and, secondly, to link existing hedonic and gain goals to normative goals where they are compatible. Establishing smart norms and normative goals frames should be supported by policy, as is discussed as one of the policy implications of this study in Section 6.7.

6.2.2 Summary and conceptual placement of micro, meso and exo level environmental concern

Participants in this study were assumed to have pre-existing pro-environmental attitudes which were demonstrated by their volunteering to participate in this research. Curiosity (a desire to find out) or a need to save money (a gain goal frame) motivated participation for most participants. Gender roles were found to be very important, so further investigation into the family decision-making process and the impact of energy issues on women, particularly in South Africa, is recommended. Distrust in the government and Eskom was a prominent theme, indicating that there is a lack of exo level display of normative goals frames; as a result, participants elect to focus on individual (micro level) and social group (meso level) values and responsibilities. The ecological levels of environmental concern in energy efficiency in this study are summarised in Figure 23, below.

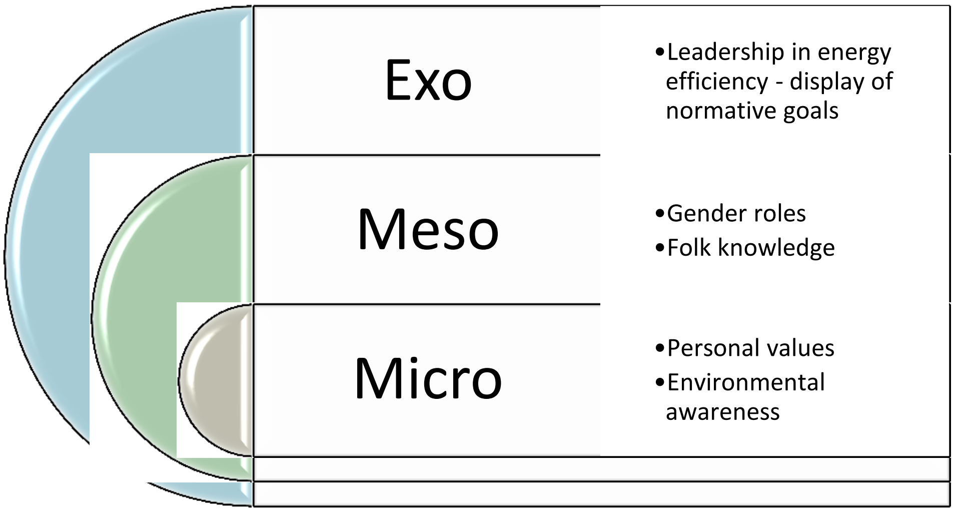

Figure 23 Aspects of ecological levels of environmental concern and energy efficiency identified by participants

A policy implication for the development of normative goals and therefore perceived social norms is the need to establish, exhibit and strengthen normative goal frames at the exo level, as discussed in more detail in Section 6.7. Lindenberg and Steg (2007) suggest addressing such a need by increasing knowledge of environmental problems (awareness creation), providing feedback based on specific behavioural actions (as was supplied in this study), and getting commitment at a local level to indicate a normative (whole social circle) commitment to a specific change.

In both LSM groups, the importance of values, the inter-personal decision-making process between spouses and the need to interact with other household members, family and friends were identified as central themes. This highlights the similarities between these groups in respect of their caring about the environment and their perceptions of social norms. The actual changes made in households in terms of communication and behaviour strategies that were employed are discussed in detail in Over-arching Theme 3 (see Section 6.2.5).

As mentioned earlier, curiosity (the need to find out) was one of the most important motivations for the research participants to take part in this study. This highlights the participants' need for information, feedback and guidance about energy efficient behaviour. Mehlmann et al. (2010) identify the next steps in the empowerment spiral as an opportunity to formulate intention by means of information and creating opportunities for feedback. These steps are discussed in more detail for each of the ecological levels in the next section.

6.2.3 Over-arching Theme 2: Essential input (Find out)

Over-arching Theme 2 focuses on the formulation of intention by means of "finding out" and influencing individuals' level of concern by providing feedback. The human need for information is highlighted by Kaplan (1995) (as discussed in Section 2.7.4). The findings of this study show that information and guidance needs were clearly expressed. The empowerment spiral highlights this issue and stipulates that asking questions plays a very important role in formulating intention and increasing environmental concern, including care about a specific direction of behaviour. This over-arching theme refers to the way in which finding out and feedback work together to increase concern and ultimately change behaviour. The issues “find out”, “help formulate intention” and “feedback” are highlighted in green in Figure 24.

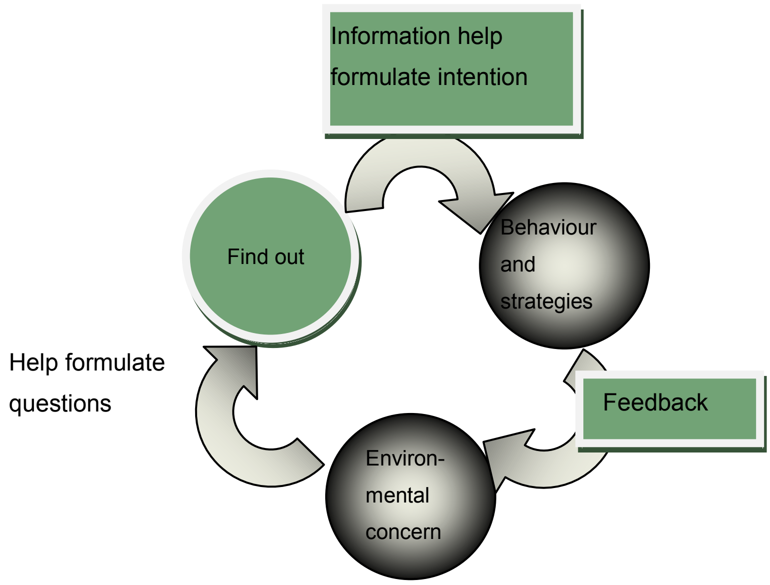

Figure 24 Empowerment cycle's focus on finding out and searching for information

The following themes (see Table 61) are part of over-arching Theme 2, which focus on the expressed need for information, and also for guidance and feedback.

Table 61

Over-arching Theme 2: Themes and findings on the need for feedback and guidance

Themes and findings from each phase of the analysis presented in Chapter 5			
Phase 2, Part 1	Phase 2, Part2	Phase 3	Phase 4
Theme 4: Financial motivation and incentives	Experimental group comparison	Theme 3: Family response	Salient issues
Theme 6: Gender roles’ interaction		Theme 6: Need for guidance	The effect of the intervention
Theme 8: Need: information-based feedback and support		Theme 7: Need for information	

This over-arching theme deals explicitly with the concepts of feedback on electricity consumption and the expressed need for guidance. Feedback is distinguished from guidance: feedback refers to the provision of information (based on the electricity consumption of the household or in the form of general guidelines for energy efficiency); the need for guidance was expressed as participants' comments indicating that information on electricity consumption alone is not enough. Guidance is indicative of the need expressed by research participants for knowledgeable interpretation and suggestions on how to use the information-based feedback, as well as the modelling of the desired behaviour. Feedback plays an informational role, whereas guidance is indicative of a commitment, an understanding of the household situation and a knowledgeable opinion on the information received. The need for feedback and guidance, and the ecological levels thereof, is discussed next.

6.2.3.1 Micro level finding out: personal information, guidance and feedback

The individual's need for guidance and information about energy efficiency was identified as an important theme in Section 5.3.3 (Phase 2, Part 1, Theme 8 and Phase 3, Themes 6 and 7). At the start of the research project, the general need for information was clearly expressed by participants, and curiosity was an important motivator for participation in this study. In the focus group sessions (at the end of the research project), the need for both information and guidance crystallised more strongly than expected (Phase 3, Themes 6 and 7). In this section, the effect of the intervention at a micro level is discussed in answer to the first research question, which relates to the effect of the intervention with an individual on household electricity consumption.

In this study, all the participants (from both experimental groups) received timeous and accurate feedback on their electricity consumption after completion of the baseline recording of one week until the end of the recording period. This brought about some change in the electricity use in every participating household. The differences in use in Experimental Groups 1 and 2 show the effectiveness of the intervention, highlighting the need for information (which was provided to both experimental groups) and for guidance on the interpretation of the feedback and an appropriate response from the research participants.

As in a study by Brandon and Lewis (1999), participants in this study expressed a need for guidance and personalized feedback (Part 2, Theme 8) that would enable them to make the right changes in their households to address their environmental concern. The benefits of this type of guidance (as provided to Experimental Group 1, but not to Experimental Group 2) are evident (see Phase 4, discussed in Section 5.4.6). Guidance, in addition to the real-time feedback, resulted in a higher savings in Experimental Group 1, avoiding the sharp increases in electricity use during winter recorded in Experimental Group 2, as is clear from Table 62 (and as reported in Chapter 5). It is repeated here for clarity.

Table 62
Seasonal and LSM group savings

Pre-existing characteristic (Living standard)	Investigation period	Average saving	Season	Saving
LSM 6-9 (n=13)	LSM 6-9 Exp 1 (n=9)	9%	Winter (n=7)	5%
			Summer (n=2)	13%
	LSM 6-9 Exp 2 (n=4)	-7.5%	Winter (n=1)	-28%
			Summer (n=3)	13%
LSM10 (n=23)	LSM 10 Exp 1 (n=10)	6%	Winter(n=6)	3%
			Summer (n=4)	9%
	LSM 10 Exp 2 (n=13)	-8.5%	Winter(n=7)	-18%
			Summer (n=6)	2%

Abrahamse et al. (2005) note a consistent range of electricity savings reported in the energy efficiency and behaviour change literature, of between 0% and 15%. The same is true in this study, with highest savings being 13% for LSM 6-9 households in Experimental Groups 1 and 2 during summer.

While feedback alone resulted in some savings during summer (2% and 9% for Experimental Group 2), it failed to assist these research participants to save electricity during the winter measurement period (-28% and -18% for Experimental Group 2). It is accepted that in the winter months it is more difficult to save electricity because of the cold and an increased need for warmth comfort (Littleford et al., 2012) (see Phase 2, Part 1, Theme 7 and Phase 4, Theme 2). The savings achieved during winter in Experimental Group 1 (5% in LSM 6-9 and 3% in LSM 10) are indicative of the benefit of individually tailored information (as was provided to Experimental Group 1), which led to a saving in electricity, in spite of the colder weather.

The conclusions that can be drawn from these findings are the following:

- the intervention in Experimental Group 1 (consisting of feedback, personalised suggestions for change, commitment and a goal-setting exercise) was more effective than the intervention in Experimental Group 2 (provision of feedback only); thus
- the feedback received by both groups provided effective support for guidance and personally tailored information, but was not effective on its own (Experimental Group 2); and
- the implementation of the intervention during winter was more successful than the implementation during summer, assisting in largely avoiding the normal increase during winter.

From the findings presented in Section 5.6 on Phase 4, it is clear that participants have different informational requirements. De Young (1993, 1996) advises tailoring communication according to the manner in which people already talk in order to communicate the message more effectively. A slightly different communication approach for people from different LSM groups may be appropriate, since monetary savings on electricity consumption was not mentioned at all by the LSM 10 households, but was very important to households in LSM 6-9.

The benefits of providing guidance and discussion platforms in combination with real-time feedback on energy consumption are indicated in this section, but feedback at an individual level about electricity consumption in the household is not the only feedback loop relevant to taking energy efficiency measures in a household. It is not only a research participant, but also his or her interaction in the family, that brought about change in the electricity consumption of the household. Some participants expressed a need to engage with people outside their own household, at the community level, at work or in their existing social network. In the next section, the meso-level interaction on electricity conservation in the households is brought into focus.

6.2.3.2 Meso level finding out: Response from family and neighbours

Although metering might be helpful in providing people with an incentive to conserve, by showing the benefits of a particular intervention, Van Vugt and Samuelson (1999) indicate that communication accompanying meters should accentuate "both the benefits for the people personally (i.e. lower bills) and those for society as a whole (i.e. resource preservation)" (p. 748). Therefore the gain goal frame should be emphasised on each of the ecological levels – personal, and household/school and society as a whole. In the micro level discussion on feedback and guidance above, the personal level benefits were discussed; this section focuses on the system of interaction in the household.

The behaviour and discussions in the living environment of a given participant undeniably also play a role in individual reactions to feedback and guidance. According to the APA (2010), much of the reaction to the threat of climate change is mediated by people's values and beliefs, what they perceive as threatening and what they view others to perceive as threatening. Similarly in Section 2.6, the pronounced impact of normative perceptions is indicated in predicting behaviour (Asch, 1951, 1956; McKenzie-Mohr & Smith, 1999; Nolan et al., 2008; Reno et al., 1993). These studies show that it is increasingly clear that people might be more likely to conform to modelled behaviour than to do "their own thing" or even "the right thing". This section deals with the perceived social norms in energy efficiency, focusing on the perceptions of the research participants of household members and interactions with neighbours and colleagues, as well as shared beliefs or folk knowledge.

Several perceived social norms were expressed by the research participants in this study and described by the researcher as folk knowledge (Phase 2, Part 1, Theme 5; Phase 3, Theme 4). Folk knowledge prescribes the behaviour and operating procedures used for equipment in homes based on hearsay, and without scientific verification of whether these really affect energy efficiency.

Folk knowledge about energy efficiency should not be underestimated, because DiClemente (1993) has shown that information communicated by a person considered a peer is perceived to be more credible that coming from a third party source. Similarly, Buller, Young, Fisher, and Maloy (2007) have found that people are more attentive to information communicated by someone known to the person receiving the message. Folk knowledge in this study represents erroneous beliefs about energy efficient behaviour, based on discussions with peers about energy efficiency.

One of the key contributions of this study is the identification of the energy savings potential that could be achieved by dispelling such folk knowledge, eradicating erroneous beliefs about energy efficient behaviour, as discussed in Section 5.3.3.5. Folk knowledge is used to guide energy efficient behaviour in the households. Several myths about the optimal control of household appliances including fridges, freezers, computers, electric water heaters and heaters exist in the participating households. In many cases, procedural information about the use of these appliances could be presented in a variety of user-friendly ways, including suitable reading material and direct human contact and demonstration of the principles (Staats, Lockhorst, Hajema, & Van Itersen, 2012). However, information strategies alone are never effective and should be regarded only as a supportive measure, rather than as the main intervention. In this study, dispelling folk knowledge offered a large electricity saving potential at the household level (in the case of one household in the study as much as 22% saving per day).

Staats et al. (2012) point out the importance of explaining even very simple operational procedures for appliances in everyday use (for example, whether shutting the computer down if one leaves the office for more than three hours is desirable/undesirable), in order to create certainty and procedural norms in the desired behaviour in an office. This was clearly also the case for participating households where many misunderstandings about the efficient function of appliances were identified. Staats et al. caution that in a residential area, the onus falls largely on the owner to educate him- or herself about the functioning of household appliances, and fellow home-owners could be a wonderful asset in this regard. In attempts to dispel folk knowledge, the inclusion of a heterogeneous group of people, such as the eco-teams studied by Nye and Hargreaves (2010), in a particular community may be very effective. Carlsson-Kanyama and Lindén (2007) note that “a substantial part of the learning process in how to handle the equipment was through informal contacts between neighbours” (p. 2168), highlighting the importance of structuring an intervention within a supportive community, and the need for such communities in South Africa.

It would seem that a supportive community is particularly important in lower income groups. In this study, the need for guidance (rather than feedback on use) was specifically expressed by participants from the LSM 6-9 households where higher levels of illiteracy were found, as was also the case in a study of Barnes (2010). In this regard, Staats et al. (2012) warn that feedback by means of electronic and technologically advanced methods should be used with caution, and ample training and technical support should be provided, especially in less literate target groups.

In LSM 10, the expressed need was for feedback in terms of electricity consumption. The participants were more accustomed to technology and even liked the "gadgets" installed in the households to provide real-time feedback. However, almost all the participants (from both LSM groups) expressed a desire to understand electricity better and for the researcher to give personal attention to each household. The ASSAf (2011) notes that "[o]ne of the biggest challenges to stimulating low carbon behaviour is…recipients not being able to understand the information provided. Information needs to be relevant to the citizen's life worlds and at a level and language that is understood" (p. 158).

6.2.3.3 Exo level finding out: Normative feedback

Lang and Hallman (2005) highlight that discussions with individuals on climate change generally elicit expressions of distrust in most exo level entities, such as municipalities and governments. During the discussions with participants in this study, it seems that individuals turned from expressing distrust in authorities to examining their own values in-depth (Phase 2, Part 1, Theme 10); in some extreme instances even taking personal responsibility for several municipal services. Normative feedback (which fell beyond the scope of the study) seems to play an important role in supporting individual behaviour change. Two aspects are briefly discussed in this section: the need for normative feedback, and the form in which normative feedback is communicated.

In this study, a need for information in the form of feedback was expressed several times by research participants. Specifically, participants expressed a need to receive feedback on responsible behaviour (feedback as a reward) and a need for consistent billing. This concern was raised in the light of problems experienced by the City of Tshwane municipality with billing consistently, and often estimating electricity consumption. Commitment to providing both of these kinds of feedback at a municipal level would serve as a meta-message on the normative goal – this is strongly related to the way in which normative goals are communicated.

Normative goals should not only be communicated, but also need to be put into practice by larger institutions to show consistent application of clear norms, and display commitment to those norms. This can be achieved by means of policy development in favour of energy efficiency (political will) and financial commitment (national budget allocations to energy efficiency plans), but also by means of mass communication projects that support development and the achievement of the desired normative goals.

6.2.4 Summary and conceptual placement of micro, meso and exo level discussions on finding information

Feedback seems to provide simultaneously a reward and an incentive. Accurate and real-time feedback allowed the research participants in this study to continuously work toward and try to achieve electricity savings during the two weeks following the baseline measurement. In addition, real-time feedback also eliminates a need for external incentives and rewards for becoming more energy efficient. In addition, such feedback enables problems to be detected early. Moreover, personal guidance on the use of the electricity monitors (or any other real-time feedback monitoring device) was highly valued by the participants in this study, and would need to be built into any future programmes, as is evident in Figure 25.

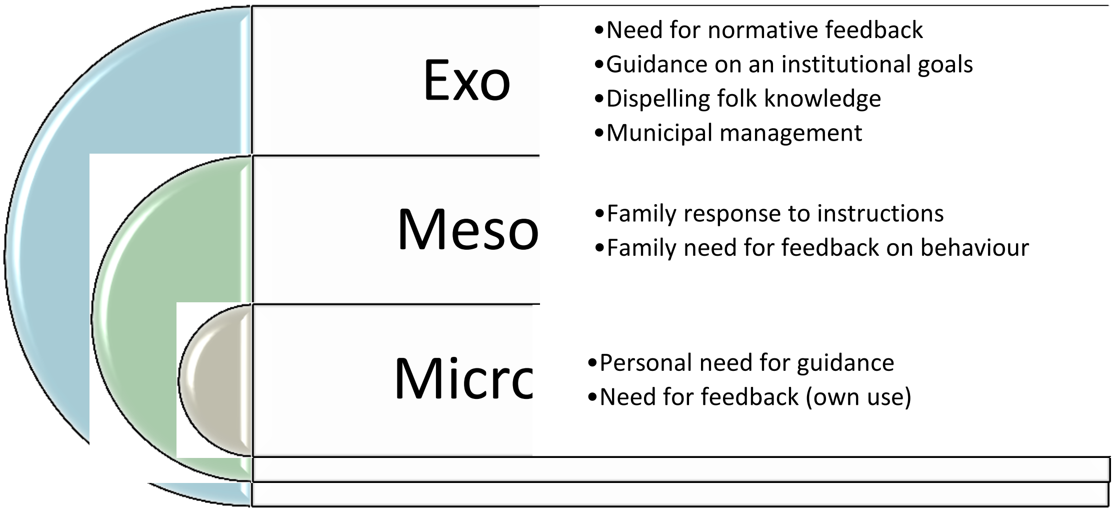

Figure 25 Important aspects in the ecological levels of finding out more about energy efficiency

This leads to the recommendation that in all areas, but especially where literacy levels are lower, the interaction between the research team and the community should be stronger, and more focused on empowerment, using a person from the same community. The need for guidance and information should not be underestimated, regardless of the LSM group of the participant. The use of technological solutions to provide feedback should be accompanied by very clear instructions for use and should ideally also be communicated in person on more than one occasion.
The next over-arching theme focuses on the behaviour employed by the research participants to achieve conserve energy in their homes.

6.2.5 Over-arching Theme 3: Talking and doing (Behaviour and strategies)

Over-arching Theme 3 focuses on the reported changes in behaviour and communication strategies in order to effect energy efficiency in the participating households. This section also answers the second research question (Which energy conservation strategies are employed?) and to some extent also the third research question (How do people from different socio-economic backgrounds attempt to save energy?)

In Over-arching Theme 3, the focus shifts from environmental concern (OAT1) and finding out (OAT2), to behaviour. This includes the formulation of intention (micro level) and the actual behaviour of the respondents in this study (meso and exo level), as is indicated in Figure 26. In this section, behaviour and strategies are discussed both in terms of the type of communication between members of the household and the research participants and others (such as neighbours, family and colleagues) and actual behaviour.

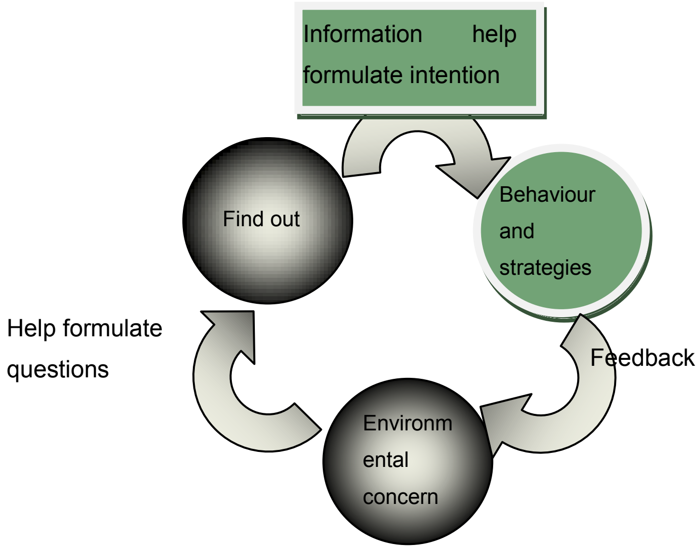

Figure 26 Empowerment spiral focus on behaviour

From the findings shown in Section 5.3 and 5.5, various themes contribute to OAT3: these are presented in Table 63, focusing on the ways in which people plan energy efficiency, talk about energy efficiency and ultimately act in energy-efficient ways.

Table 63

Over-arching Theme 3: Behaviour and strategies

Over-arching Theme 3: Planning, talking and doing			
Part 2 themes:	Part 3:	Part 4 themes:	Part 5:
Theme 2: Behaviour changes	LSM comparison Winter and summer	Theme 1: Behaviour changes and planning	Comfort as warmth
Theme 3: Planning for efficiency		Theme 3: Family response	Quantitizing folk knowledge
Theme 11: Strategies before the intervention		Theme 9: Strategies	

It was assumed that some planning for energy efficiency, communication about energy efficiency and even some energy efficiency strategies were already in place before the commencement of this research project. In this section, the changes in communication, planning and implementation strategies are explored in more detail.

Lutzenhiser (2000) argues that the “machine-centred view” (p. 8.208) that sees consumption as something relating to machines at the end of the consumption chain and not to humans themselves lacks any social and psychological framework, but is likely to continue to determine the kinds of solution sought by governments and consumers alike. In many respects, the findings of this study reflect this machine-centred view, as participants reported buying (or wanting to buy) more energy-efficient products, which they thought to be one answer to conservation and energy efficiency; a view specifically expressed by the more affluent participants in this study. This argument was also reported by Gatersleben et al. (2010a), whose respondents planned to buy products for their households in order to effect energy efficiency rather than to consume less electricity through behaviour change alone.

From the discussions with the participants, it was evident that planning energy efficiency measures does not necessarily lead to action. For example, participants indicated that installing solar water heaters was something they planned for the future, but the return on investment was an issue commonly raised in respect of installing solar water heaters, and none of the participants had a solar water heater installed, not even in the LSM 10 Group.

In the next section, the micro level of intention and behaviour is explored and discussed.

6.2.5.1 Micro level behaviour: Changes of intention and action based on feedback

As was clear from the discussion in Sections 5.3 and 5.5 and the micro level discussion of environmental awareness in Section 6.2.1.1, behavioural intention was slight. Where strong behavioural intention was expressed, it tended to coincide with existing pro-environmental behaviour beyond the scope of this study. This might be indicative of a spillover effect (Thøgerson & Ölander, 2003; Whitmarsh & O’Neill, 2010). Spillover, according to Thøgerson and Ölander (2003), occurs when “environmental-friendly behaviours spread to more and more areas of the consumption pattern in a virtuous circle” (p. 225). In some instances, participants in this research indicated that they were enthusiastic to participate in this research because they have already started acting in a pro-environmental manner (recycling or water harvesting) and perceive themselves as pro-environmental individuals.

The ways in which the self is construed and values are expressed also played a significant role in the way in which the participants in this study acted. Thøgerson (2004) argues that people tend to act according to their own thoughts about themselves, in order to avoid cognitive dissonance, and in some households in this study this seemed to hold true. However, it has repeatedly been shown that attitudes and values do not always translate into actual behaviour, which is influenced by the individual’s or family’s household routines, schedules and comfort requirements (Weihl & Gladhart, 1990). In this study, some participants in Experimental Group 2 raised several arguments against energy efficiency in favour of comfort. This was in line with their behaviour at the time (thus limiting cognitive dissonance by stating attitudes that coincide with behaviour). By contrast, participants from Experimental Group 1 indicated that they thought of themselves as "green" (Phase 4, see Section 6.3) which was in line with their behaviour at the time. Therefore arguments consistent with their behaviour were posed by participants in both groups (as was also evident in the focus group discussions).

Not only did energy efficient behaviour in a household influence the way in which the research participant perceived him or herself, but it also had an impact on the household as a whole. Therefore individual behaviour cannot be discussed in isolation, and the behaviour changes and communication strategies employed by the research participants in relation to other household members and members of their social networks are discussed as part of the meso level interaction in the next section.

6.2.5.2 Meso level behaviour: Changes in household and beyond

Behaviour changes reported by the research participants in this study are put under the spotlight in this section. Two specific appliances (geysers and refrigerators) are discussed separately due to their large impact on electricity consumption and the ability to conserve electricity by regulating their use better. This is followed by a description of the general household strategies used and a summary of these strategies according to LSM group.

- *Geyser use*

Schuitema and Steg (2005) found that people "underestimate the energy use involved in heating water, which suggests that people are not well aware of the fact that energy sources are needed to do this" (p. 4450). Similarly, in this study, participants did not deem scheduling geyser use necessary or thought it would be very difficult to achieve results. Scheduling any type of appliance in a household has the potential to save large amounts of electricity, but few people have the knowledge to install a timer switch and understand the way in which it should be programmed (www.eskomdsm.co.za), or remember to do it manually. This study showed that scheduling geyser use was regarded as more complicated than dealing with other appliances and that many misunderstandings exist around its management. Timing a geyser requires an understanding of the geyser's abilities, a thorough assessment of the household's routine and needs, and the dispelling of folk knowledge or myths around geyser functionality.

Participants agreed that geyser timers may be desirable, but they mentioned various barriers to installation. These barriers typically include the confusing array of timers on the market (varying in price from R 200 to R 1500) and having to contract an electrician to install the timer. The automated timing needs to coincide with the routine and the needs of the household, because, if the timing is not done correctly, the timer will be overridden by the consumer. This argument is also in line with the APA's (2010) warning that if technical solutions "are to approach their technical potential, they need to be designed so that occupants will not counteract the engineering, as many households now do with programmable thermostats" (p. 77), in this instance, programmable timers for geysers. The automation of geysers therefore presents several barriers to electricity consumers, but once these are overcome it could be a comfortable and sustainable solution to managing geyser use. Automation therefore cements the behaviour change and eases the burden on future intention, encapsulating the intention at a time when it is clear and the means are available, eliminating the need for routine pro-environmental behaviour in the management of geysers.

Notwithstanding, Littleford et al. (2012) caution that automation has the potential to erode the perceived responsibility of home owners in managing their electricity use, and ultimately to lead to a rebound effect. This effect may need to be studied further, looking specifically at the South African context where geysers are the main method of heating water, and the daily interaction needed if a geyser is to be managed manually.

- *Fridges and freezers*

Although regular maintenance and defrosting can lower electricity consumption by fridges and freezers, the greatest saving potential in South Africa lies not necessarily in these practices, but in rethinking the need to keep on fridges and freezers other than the main household fridge/freezer. The contribution of fridges/freezers to the electricity consumption load in South Africa is probably underestimated.

This study only identified the possible savings potential of rethinking the need for additional fridges/freezers and did not attempt to quantify the load of one appliance in particular, therefore further research is advised. However, in this study several households reported having more than two fridges and/or freezers. It is speculated that the use and ownership of so many fridges/freezers result from cultural practices. These may include the need to store large quantities of meat at one time after buying in bulk (for example, buying a Karoo lamb when driving through the Karoo) or after a hunting expedition, entertaining outdoors (using additional outdoor fridges) and caravanning or camping (owning additional caravan/camping fridges). Bolstered by the identified belief (folk knowledge, Phase 2, Part 1, Theme 5, and Phase 3, Theme 4) that fridge/freezers tend to break when left unused, these additional fridges/freezers are never switched off, even though they are nearly empty for most of the year. Rethinking the use of additional fridges/freezers is therefore not a trivial matter, and implies a change in lifestyle, even cultural changes.

This study focused on household strategies and the management of all appliances and therefore cannot provide a detailed analysis of the impact of fridges/freezers on the electricity load, but it has highlighted the existence of these erroneous beliefs and the potential savings benefit. The household strategies used to manage other appliances in order to attain energy efficiency are discussed in the next section.

- *Classification of household strategies*

The three main strategies that were employed by the participants to consume less energy were changing the intensity of use, using alternative technology or equipment, and managing appliances differently. The strategies employed in the participating households identified in Section 5.3.3.11 are classified according to these three categories and are presented in Table 64.

Table 64
Classification of strategies

Appliance	Measures	Classification of measures
Heaters	No use of heater	Change intensity – limit reasonable use
	Heat only one room	Change intensity – limit excessive use
	Use alternatives (gas)	Invest in different technology
Kettles	Boil more water at a time and keep warm	Change intensity – increase functionality
	Only boil what you use	Change intensity – increase functionality
	Use immediately after boil	Change intensity – increase functionality
	Everybody drinks tea together	Change intensity – increase functionality
TVs	Switch off when sleeping	Change intensity – limit excessive use
	Switch off standby	Change intensity – limit reasonable use
	Use smaller TV	Change intensity – increase reasonable use
Fridges	Switch additional fridges/freezers off	Change intensity – limit excessive use
	Defrost more regularly	Management of appliances – regular maintenance
	Rethink need for additional fridge/freezers	*Disinvest*
	Sell unnecessary fridges/freezers	Disinvest
Washing machine	Wash a full load	Change intensity – increase functionality
	Wash at a lower temperature	Change intensity – lower expected standard of service
Ovens, stoves and microwaves	Limited oven use	Change intensity – limit excessive use
	Increased microwave use	Change intensity – increase functionality
	Increase use of hotplate	Change intensity – increase excessive use
	Cook for two days	Change intensity – increase functionality
	Don’t cook for lunch	Change intensity – limit reasonable use

Appliance	Measures	Classification of measures
	Cook everything in the oven or everything on the stove	Change intensity – increase functionality, further apart
	Use alternatives (wood/gas)	Investment in technologies
	Buy cooked food	Use alternatives
Air-conditioning	Limit use to really hot days	Change intensity – limit reasonable use
Using alternative energy sources	Gas heaters	Use alternatives
	Gas cooking	Use alternatives
	Buying cooked food	Use alternatives
Underfloor heating	Limit use	Change intensity – limit reasonable use
Wall sockets	Switch standby appliances off at the wall socket	Change intensity – limit reasonable use
Lights	Switch off when not in use	Change intensity – limit reasonable use
	Use energy efficient bulbs	Invest in equipment (CFL globes)
Iron	Iron all in one go, instead of every day	Change intensity – increase functionality
Geyser	Using less hot water	Change intensity – limit reasonable use
	Switch off geysers (timers/manually)	Change intensity – schedule time of use *Invest in equipment (timers)*

The strategies in Table 64 are further classified in Table 65 using the classification system developed by Kempton et al. (1992), combining the various strategies into procurement, management and intensity of use aspects.

Table 65

Strategies in terms of procurement, management and intensity of use

	Procurement of equipment and technology	Management of equipment and technology	Intensity of equipment and technology use
Methods	Buy timers and energy-efficient equipment Sell or recycle obsolete technology and equipment Use alternatives	Maintenance Rethink expected standard of service Use alternatives	Limit use (reasonable use/excessive use) Increase functionality (full loads, cook everything in the oven or everything on the stove and/or further apart)

Schedule time of use

In most cases, the LSM 10 participants in this study limit excessive use of electricity, while the lower income households limit normal use of appliances. No investments were made by the lower income households, who sometimes rely on a simple heuristic to determine the energy intensity of an appliance. This is in line with observations by Schuitema and Steg (2005) that participants in some of their studies “think that energy use is related to the size of appliances” (p. 4450); the larger the appliance, the more energy it is believed to use. In many LSM 6-9 households, smaller appliances instead of larger ones are used in order to save electricity (watching the old small tube TV instead of a big flat screen TV (both available in the house), and lower standards of performance from an appliance are sometimes accepted (using a lower temperature in the washing machine results in clothes that are “not so clean”, for instance) in order to limit its electricity use. The LSM 10 participants chose alternatives (buying cooked food, installing gas stoves) and scheduling use (using geyser timers and motion sensor lights). Maintenance (maintaining optimal functioning of appliances) was not identified by any of the research participants as a meaningful way in which to save electricity. Larger investments such as installing solar water heaters and more expensive technologies had very low uptake, even in the higher LSM group in this study.

In cases where energy efficiency behaviour is shown it can be categorised as investment (buying equipment that would aid in consuming less energy), disinvestment (ceasing to use something because of it high energy consumption levels), or the use of alternatives (using LP gas stove and heaters). In most other cases, however, the actions aimed at energy conservation resorts under curtailment behaviour and practices. Gardner and Stern (2002) pointed out that curtailment behaviour is typically less effective in reducing energy consumption than energy efficiency behaviour as described above.

From the discussions with the focus group participants, several conclusions can be drawn. LSM 10 participants prefer investing in energy efficiency by procuring equipment and harnessing technology (CFL globes or using gas stoves), although they do so to a limited extent (there is low uptake on solar water heaters), attempting to limit excessive use, and scheduling use either manually or by installing timers (for geysers, underfloor heating and lights). Both LSM groups attempt to limit use – LSM 10 households seem focus on limiting excessive use, while LSM 6-9 households even limit reasonable use (for example, not using heaters even if it is really cold). The LSM 6-9 households also noted attempts to diversify sources of energy (using gas heaters, or gas or wood stoves), increasing functionality and intensity (more people working at the same light, or always drinking tea together). The volume of strategies mentioned by the research participants during the focus group sessions increased after the intervention (compared to those mentioned in the in-depth interviews before the intervention). This is an indication that more energy efficiency options were considered, and became more accessible to the participants, after participating in this study.

In the next section, the communication strategies used by the research participants to motivate energy efficiency in the home and beyond are explored in more detail.

- *Measuring the success of energy efficiency projects*

Assessment of the success of an energy efficiency programme should not be limited to measuring a decrease (or increase) in electricity consumption, especially in low income households. Achieving energy efficiency in the household may allow the household additional (much needed) capacity for electricity consumption previously not available to the household. Instead of only measuring electricity consumption (or reduction in use), additional indicators of success in energy efficiency may be necessary. Such indicators include quality of life indicators, and measuring the amount of things that get done with the same amount of electricity, thereby improving impoverished lives. This concept is discussed further as a policy implication in Section 6.7.2.

- *Communication strategies*

There is a lack of prior research on the process of communication in the household driving specific goals such as energy efficiency. In this section, therefore, these communication strategies are explored and conceptualized. The strategies employed by the research participants in order to change the behaviour of family members and others in the participants' larger social network ranged from informal discussions to formal written guidelines. These were illustrated by means of several comments in Phase 2, Part1, Theme 11, and Phase 3, Theme 9. In Table 66 these are summarized (direct quotations are omitted) and they are then discussed:

Table 66

Communication strategies

Strategy	Examples of communication strategies
Authoritative instruction	Written rules Spoken instructions
Communication	Reminders Family discussions Shared responsibilities Request understanding/pity Spread the word
Physical changes	Reminders Lead by example Plan/schedule use

	Pre-paid meters Provide meter-readings
Interactive changes	Open forums Translate recycling information

The effectiveness of each of these communication strategies cannot be commented on, since this was not the focus of the research and too many variables came into the assessment period to be able to pinpoint the effectiveness of a specific communication strategy. However, the communication strategy and the level of application thereof by the participants themselves, are depicted in Figure 27. The figure places the communication strategies employed in the households on two intersecting continuums, that range from very formal to very informal communication types, and the number of people the communication reaches. It therefore classifies whether the communication strategy employed by a research participant has a limited or broad application. This level of application is based on the participants' own assessment of the level of application, and was not independently assessed by the researcher. It was, however, not expected that any of the participants in this study would participate in forms of communication beyond informal chats with neighbours; however, specific formal communication strategies were used by some research participants to communicate energy efficiency and recycling strategies applicable to their workplaces. The plotting of the communication type and level of application makes a unique contribution to the literature, and offers a way to develop a better understanding of the specific communication strategies employed by participants with the directed aim of changing the pro-environmental behaviour of those around them.

In a very limited application of communication strategies, authoritative instructions were given by participants to their household members about the use of electricity. These included written rules posted on a wall in the house, or very specific spoken instructions with the aim of reducing energy consumption. Both these methods have a very specific target audience (only household members) and implementation tended to be restricted to those in the household, whereas other strategies were not only implemented in the household itself, but extended to the workplace (only for some of the participants).

Similarly, requests to consume less electricity out of pity for or empathy with the account holder because of the amount of money he or she had to pay for electricity also had a very limited application. Other communication strategies included the use of written or spoken reminders, formal family discussions on the topic of energy efficiency, and informal discussions with family members, friends, neighbours and colleagues. Broader application seems to be indicative of more personal commitment from the research participant and therefore also better implementation in his or her own household.

Strategies such as physical reminders (set up by participants for themselves to switch off geysers for instance), communicating and monitoring electricity consumption (monitoring usage and regularly reporting on it) and requesting pre-paid electricity meters to be installed also has a medium range of application and is more formalised in terms of communication. Some participants who discussed the study with friends and colleagues started to become more involved in energy efficiency measures at their places of work. This led to a very broad application, and the use of more formalised communication strategies, by creating open forum discussions at work, and translating recycling information into various official South African languages with the aim of increasing uptake and understanding of energy efficiency and recycling practices in the work place.

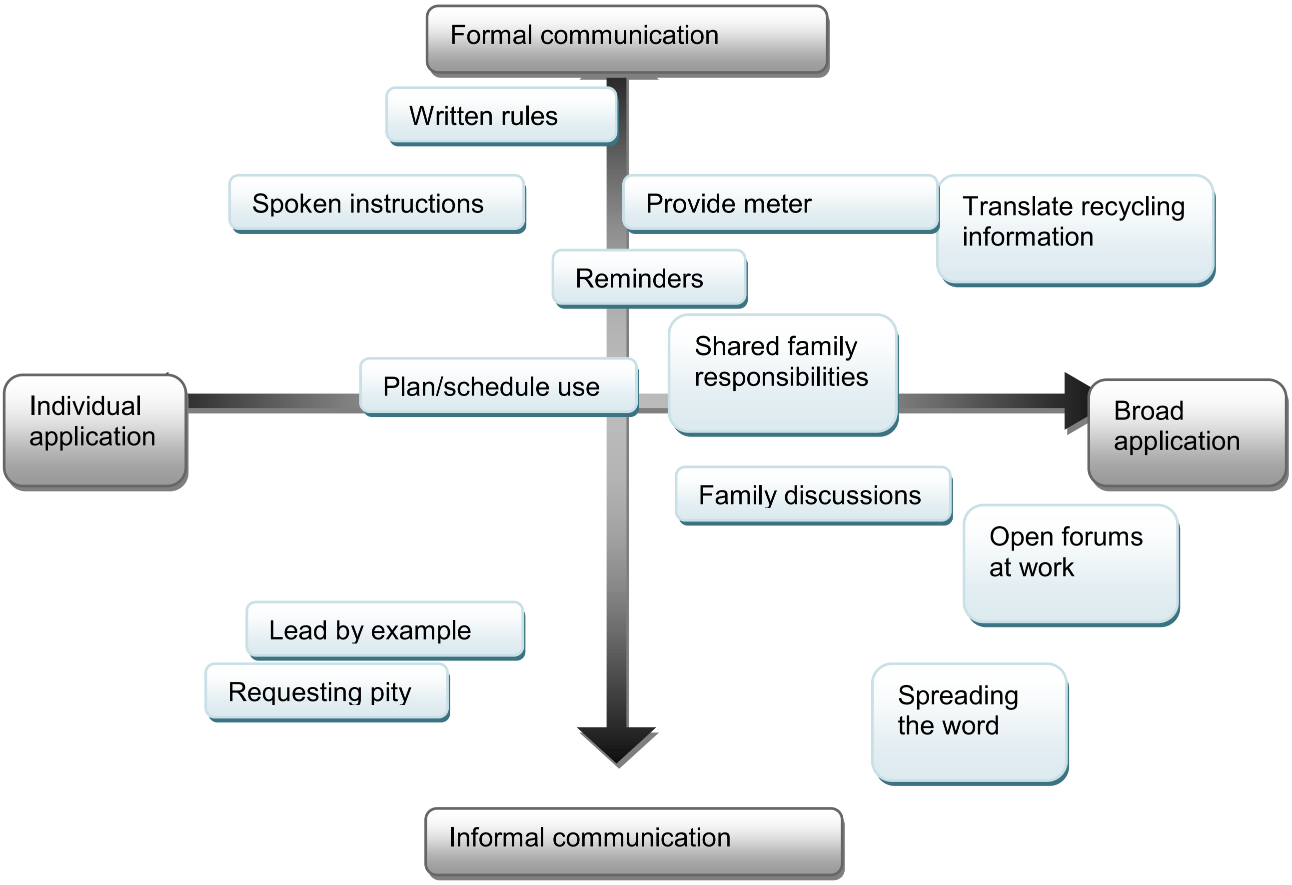

Figure 27 Communication strategies and level of application

These strategies provide some insight into the interpersonal relations inside the home and allowed the researcher an opportunity to understand better how people relate in the home with regard to the collective reaching of a goal. These discussions promote the uptake of energy efficiency practices in the home. Steg (2008) argues that "[e]nergy policies are more acceptable when individuals value the environment, are aware of the problems resulting from energy use and feel responsible for it, and when they feel morally obliged to do their bit to help reduce these problems" (p. 4450). Such values, norms and general awareness are often established in the home through communication strategies.

In the next section the micro and meso level strategies are summarized and put into context. Although the exo level communication strategies (such as advertising campaigns for energy efficiency, government-implemented demand-side management projects and Eskom-initiated projects) have an impact on residential energy efficiency, they did not form part of this study.

6.2.6 Summary and conceptual discussion of micro and meso level strategies

Actual behaviour and communication strategies at a micro, meso and exo level have been discussed, highlighting the ways in which people choose to engage in energy efficiency behaviour. Re-thinking the use of fridges and freezers has been identified as an important aspect of energy efficiency in the South African context. Strategies employed to save electricity have also been identified and discussed, highlighting the main methods of implementing changes in appliance use with energy efficiency as the goal: these include maintenance (not often used in South Africa), procurement (the preferred method among higher LSM groups) and change in intensity of use (used in both LSM groups in this study). Figure 28 summarises the ecological levels of energy efficient behaviour and the communication strategies employed in households.

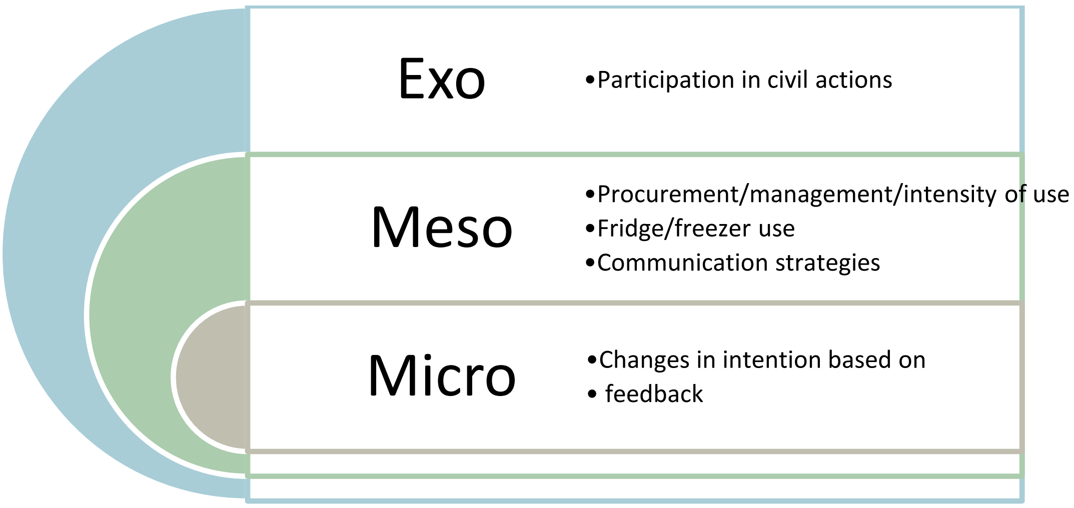

Figure 28 Important aspects in the ecological levels of behaviour and communication strategies.

Communication strategies employed in households range between very structured and very unstructured strategies, and the effectiveness also ranges in their application. The development of communication strategies can be seen as anecdotal evidence of a commitment toward energy efficiency. Encouraging more structured and goal-directed communication at a micro, meso and exo level might result in more formal types of communication between people and therefore also broader application of strategies.

6.3 A conceptual model of residential energy efficiency in South Africa

In this section, the interactive nature of the identified ecological levels of the energy efficiency system is described in the form of a conceptual model, followed by a contextualization of this study into the macro ecological level in South Africa.

6.3.1 Interactive parts of the system

In this conceptual model, Bronfenbrenner's (1977) ecological system was used to distinguish between various interacting parts of the system in which energy efficiency is affected in the residential sphere. In this study, individual participants' perceptions of their own thoughts and behaviour, as well as their perceptions about the meso and exo levels have been explored. The described levels, however, do not operate in isolation from the ecological system of energy efficiency in South Africa as a whole and it should be kept in mind that they do not represent the energy efficiency system as a whole. Capra (1997) points out that "[a]ll members of an ecological community are interconnected in a vast and intricate network of relationships, the web of life" (p. 290). A distinction between the various ecological levels is therefore somewhat artificial. Keeney (1983) also aptly notes that all systems are intertwined to such an extent that it is impossible to separate one from the others. Therefore, a study of individuals in a household can never present the full picture of the thoughts and ideals of energy efficiency in the household, and is even less able to represent the energy efficiency goals and ideals of South Africans.

Thus the interaction between the various parts of the individual system presented in Table 67 is fluid and interconnected, each influencing the others in numerous (as yet unresearched) ways. Nevertheless, Table 67 summarises each of the levels depicted in Figure 29 and represents a coherent summary of the system of energy efficiency from an individual energy user's perspective.

Table 67

Coherent summary of over-arching themes

	OAT1 – Environmental concern	OAT2 – Feedback and information	OAT3 – Behaviour and strategies
Micro	Values Awareness Responsibility Comfort Efficacy	Personal information Pinpointing indicators of success Feedback and guidance on desired behaviour in personal circumstance, informing questions	Cognitive dissonance Spillover in motivation
Meso	Gender roles, family support, influence of religion	Normative feedback on gender roles and acceptable energy efficiency behaviour (folk knowledge), discussion of results with friends and family	Behaviour strategies Communication strategies
Exo	Distrust in government, municipalities and Eskom	Billing system and normative feedback	Campaign focus
Macro	Socio-economic impact, conspicuous consumption	Establishment of normative goals	Normative goals Low carbon citizenry Energy efficiency impact on quality of life

. The logical progression and cyclical nature of this model linking the themes and behaviour identified in this study into the macro context of energy consumption in South Africa, highlight the dimensionality of energy efficiency. A unique contribution of this model is the ability to understand the macro level impacting on behaviour on the exo, meso and even micro-level of the individual consumer. These levels are discussed in detail in this chapter and are depicted in a summative form in *Figure 29*

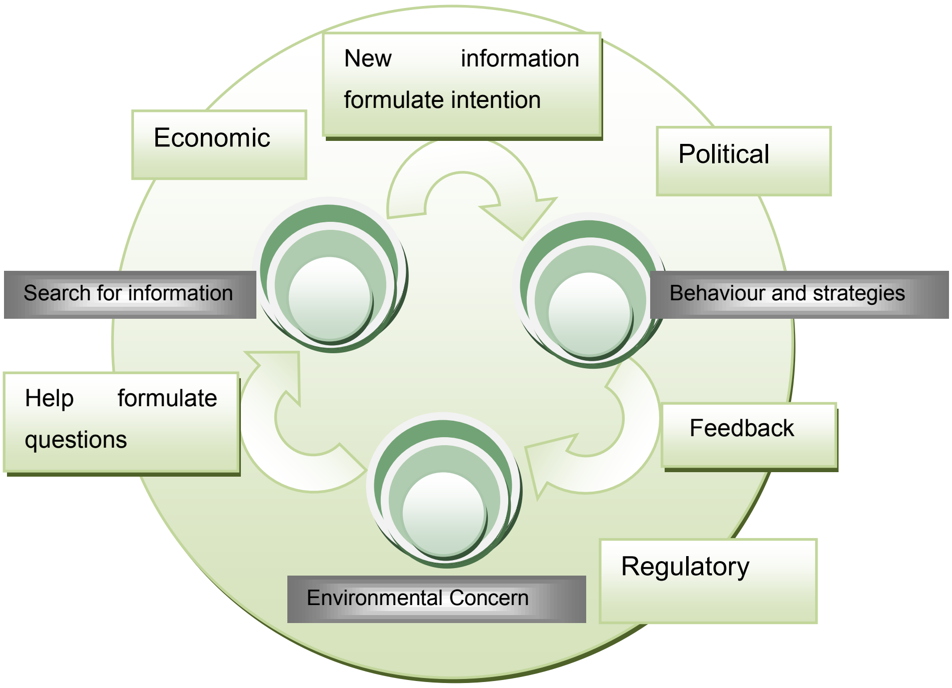

Figure 29 Overview of interconnected levels of behaviour

Although they are not the focus of this research, the regulatory, economic and political macro environment undoubtedly have an impact on the exo, meso and micro levels of interaction between people and their environment pertaining to energy efficiency. Each of these levels has been separately discussed as an over-arching theme in this chapter, but here the interaction between these systems is emphasised.

The interaction between the micro, meso and exo levels of energy efficiency is therefore linked and a concerted effort was made to describe the cyclical and mutually influential nature of energy efficiency of these levels. When a system or ecological level is viewed in isolation, it may seem stable, but when it is considered as part of the whole system, “it is apparent that the system is held within certain limits by way of homeostasis” (Du Preez, 2005, p. 141). Capra (1997) comments on the feedback and interaction within systems when he states that “networks of communications may establish feedback loops” (p. 82) and may develop the ability to self-regulate and self-organize. These are the central concepts of a systems view of life (Capra, 1997).

6.3.2 The macro system

Bronfenbrenner’s (1977) ecological approach defines ideological and institutional patterns of a culture as the macro level. The economic, regulatory and political environments, both historically and currently, undoubtedly contribute to specific culturally framed patterns in South Africa and the lifestyles of individuals. The macro ecological level was not the focus of this study, but it serves as a backdrop for individuals’ lifestyle and behaviour. Lifestyle is defined by Lutzenhiser (2000) as “distinctive modes of existence that are accomplished by persons and groups through social sanctioned and culturally intelligible patterns of action” (p. 8.215).

In South Africa, different lifestyles have different consumer requirements and environmental impacts, and are therefore important. Gatersleben et al. (2010b) have demonstrated that many people hold both materialistic and environmental values simultaneously, and that "different values and concerns are related to consumer attitudes and behavioural intention in different ways" (p. 48). Therefore, it is necessary to promote both environmental awareness and to address material concerns "which requires looking at the larger value context in which actions are situated" (Gatersleben et al., p. 48).

In South Africa, most people grew up in poverty, and the majority are still considered very poor, with 53% surviving on less than R 577 per person per month in 2009, and a Gini coefficient of 0.64 (Stats SA, 2012). Vandenbergh and Steinemann (2007) point out that conspicuous consumption is one way in which consumption patterns have changed significantly in South Africa in recent years, especially for some of those previously less privileged. The aspirations of the poor can act as a barrier to any form of efficiency. Having grown up poor, a person often wants to show that he or she has made it in society by engaging in conspicuous consumption. Since 1994, many have come to expect improved living conditions resulting in increased levels of consumption (ASSAf, 2011).

On the other hand, affluent and educated households, while being strong supporters of "green practices", are also the highest consumers of products that produce high carbon emissions. The number of appliances in the household and the size of the household contribute most toward the amount of electricity used in a household (Abrahamse et al., 2005; Lutzenhiser & Gossard, 2000). It may be argued that "low carbon citizenship" has been adopted as a mantra by the upper and middle-classes, which in South Africa still implies a racial dimension (ASSAf, 2011, p. 158).

Thus, even though the macro level of the ecological system of energy efficiency was not part of this study, it created a backdrop against which concern for the environment, curiosity and any behaviour relating to energy efficiency on all other levels (micro, meso and exo) are enacted. The implications for policy based on the conclusions of this study are discussed in the next section.

6.4 Outcomes and application of these findings

In this section, outcomes are discussed and recommendations are made for similar projects that will aim to reduce household electricity use in the future. The section also indicates how energy efficiency intervention programmes in South Africa could be enhanced.

6.4.1 Micro level intervention

At a micro level, a focus on individual values is recommended, since in this study, distrust in the government and authoritative institutions in South Africa is very high. This lack of trust in authorities' ability, willingness and commitment to promote energy efficiency effectively results in feelings of helplessness. Some participants emphasised taking personal responsibility for saving electricity, citing personal values (frugality), religious reasons (seeing themselves as custodians of the environment) and gain goals (such as saving money) as relevant to changing their behaviour.

Energy audits are a good way to focus on the individual, providing tailored advice and specific feedback. At a micro level, based on the results of this study, energy audits should

- identify the goals of the audit participant (what does he or she want to achieve and why);
- help formulate questions that would encourage care for the environment;
- aid in providing information to answer participants' questions (information could include discussions on operating procedures for household appliances, scheduling of geyser use in line with the family and comfort requirements, an emphasis on re-thinking the need for appliances (additional fridges and freezers in particular) and identifying and clearing up misunderstandings on appliance use and functions);
- identify intention and indicators for feedback; and
- provide feedback on actions.

Ways in which individuals attempt to conserve electricity involve an intention to change their behaviour and consequently interact with other members of the household in order to effect such change. Interaction with an individual in the household should also be linked to the meso level interaction with family members in the home, family outside the home and possibly even colleagues.

6.4.2 Meso level investigation

It is recommended that the context of individuals where behaviour changes are envisaged (meso level interactions) be considered an integral part of the individual him- or herself. A person's context has an impact on the person's attitude, perceived behavioural control and subjective norms and as a result will have an impact on the person's intention to change his or her behaviour. In this study, research participants emphasised the interaction between various family members and their perceived roles in the management of electricity.

At a meso level, based on the findings of this research, energy audits should:

- distinguish between the management of energy efficiency by means of hardware (such as the automation of appliances) and the management of household routine for energy efficiency (for example, when hot water must be available);
- dispel folk knowledge and erroneous understanding of the functioning of appliances;
- use technological interventions with care and adequate guidance;
- aim to understand the gender differences and the impact of the roles on establishing energy efficiency in the home;

- define goals and indicators for feedback within the household, community and civic organization levels; and
- provide and explain feedback in terms of previously identified indicators.

Provision of communication support and feedback on a suburb or at a community level could be beneficial to support and maintain behaviour changes. There are, moreover, several suggestions for future research that focus on the meso level interaction in a household/community/suburb in Section 6.6.2.

6.4.3 Exo level programme design and development

High levels of distrust in the authorities and a lack of strong normative goal frames were both reported in this study. As a result, research and programmes focusing on changing normative values at an exo level in South Africa would be important. In Europe, the Save Energy User Behaviour Transformation Process was published in February 2012 (De Oliviéra & Nina, 2012) and in California in the USA, the Californian Measurement Advisory Council (CALMAC) report was published early in 2013 (Ignelzi et al., 2013). Both highlight important behaviour change strategies. This study, although much smaller than the Save Energy (2012) project and those covered in the CALMAC report, emphasises many of the same approaches to exo level energy efficiency. The Save Energy (2012) process is well documented and includes a holistic and integrated approach to transforming user behaviour in buildings, and residential settings. Future local research on an exo level should include the assessment and experimental establishment of normative goals and goal frames in South African society.

Therefore, a comprehensive intervention plan is necessary: mass media campaigns that highlight the importance of energy efficiency should be supported by a variety of enabling measures to establish energy efficiency, in households, civic organizations and government itself. This would link awareness to actual behaviour change in a more concrete manner. Increasing convenience in terms of energy, water and waste efficiency would increase uptake, especially if it is combined with reliable and regular feedback on the impact of the changes.

6.5 Limitations of this study

Limitations specific to this research relate mainly to the unit of research and the research sample, the design of the intervention, and the research design. These are discussed below. It is believed that this study is methodologically sound, but, in line with the original exploratory objectives of this study, findings cannot be generalized to the South African population as a whole. Furthermore, the quantitative findings are underpowered and conclusions based on the quantitative findings alone, should be avoided. These and other limitations to the study are discussed in more detail in the following sections.

6.5.1 The unit of research and research sample

Research concerning household electricity using an individual intervention can pose a problem. Gatersleben et al. (2002) caution that "[i]t is difficult to determine which behavioural changes result in which savings and which specific individual within a household is responsible for these savings" (p. 339).

In this study, an individual viewpoint was sought about household behaviour. In this regard, Staats et al. (2004) state that "[m]any household behaviours occur frequently and in the stable context of the home" (p. 347), thus household behaviour can be reported by an individual, since accepted household practices are overt and can be identified by an individual in that household. In a study similar to the current study, but on a larger scale, Brandon and Lewis (1999) requested participation from around 1 000 residents in a particular area in the UK, 120 of which volunteered, and subsequently "a representative from each selected household was interviewed" (p. 80). In the current study, the researcher followed suit by asking for a volunteer in each household, rather than predetermining who in a household should take part, or attempting to involve all family members in the research. This method of addressing one person in the household regarding household behaviour seemed to be effective, although gender influences were not initially considered. It was concluded that future research could study the different viewpoints of family members in order to ascertain the extent to which these contribute to the aims of the intervention.

From the literature initially reviewed, it seemed that gender diversity in the participant spread would not significantly affect on the data collected. Several studies (all done in first-world countries) noted that it did not matter who in a household participated in their research, for instance, Gatersleben et al. (2002) pointed out that in their study "[o]nly 37% of the respondents were women. However, because the questionnaire mainly addressed household behavior, this should not be too much of a problem" (p. 342). In another example, Schultz et al. (1995) comment on recycling behaviour, saying that "[b]ecause recycling is often a household behavior, the person doing the recycling on a given occasion may be replaced by a person of the opposite gender on other occasions" (p. 108). By analogy then, the task of managing energy efficiency in the home was also expected to be household behaviour, rather than being driven by an individual, therefore justifying the discussion/interview with only one person in the household. However, the findings suggest that in this South African setting there are distinct differences between decision-makers in the household and their impact on household behaviour. The absence an initial recognition of this interpersonal decision-making process and its impact on household energy efficiency behaviour leads to the recommendation that the impact of this interaction should be studied in more detail in future studies, as discussed in Section 6.6.

It should be noted that participants in this study were invited to participate through churches and civic organizations in the geographical areas targeted by the researcher, possibly contributing to a sample consisting of a larger component of traditional Christians than is the norm in South Africa. According to Pepper et al. (2010), religion has recently been construed as “one type of social network with the potential to shift consumer behaviours in more sustainable directions that respect ecological limits, promote social justice, foster well-being” (p. 2). They found that “Christianity has a positive, though weak influence on sustainable consumer behaviours” (p. 12). Therefore, even if Christianity was not a variable considered in this research, if it did have any effect on behaviour, it is likely to be rather weak.

Participants who indicated their willingness to participate in effect volunteered their participation. In general, using a volunteer sample poses a threat to the validity and generalizability of the research findings and potentially also the outcomes of a study. Welman, Kruger, and Mitchell (2009) note that this could be the case where “volunteers [may] differ from the remainder of the relevant population in respect of variables related to the dependent variable, and biased results may be obtained” (p. 126). In this study, the volunteer sample was used mainly to ensure a pre-existing willingness to participate. This decision is in line with Brandon and Lewis’s (1999) suggestion of using volunteers who already hold a positive attitude toward the environment in order to maximise the benefits that can be derived from an intervention to increase energy efficiency in a home. All the participants volunteered to participate, but consequent random allocation to experimental groups was aimed at establishing similar groups before proceeding with the intervention.

It is believed that the findings of this study present a view of the perceptions of individuals from various economic backgrounds, describing not only the challenges faced by the less affluent but also those faced by people who are very affluent. Nonetheless, due to the qualitative emphasis of this study, the volunteer-based sampling method, and the resulting small sample size, it is important to note that results cannot be generalised to the South African population as a whole.

In the next section, limitations in respect of the intervention used in this research are discussed.

6.5.2 Intervention design

Due to financial and time constraints, the intervention in this study was limited to exploring and measuring energy efficiency behaviour in households over a limited period. Ideally, a longer measurement period, spread across at least a year, would enable better comparison within the household, and consequently a better understanding of the long-term effects of the intervention on the changes in energy efficient behaviour. The intervention design should be adjusted to include participatory consultation with the research participants from the start of, and for the duration of the study, providing them with an opportunity to identify their own needs, formulate their own questions and thus ensure an empowering and more sustainable change in behaviour. Additional methods that could be used include participatory consultation and appointing locally based “energy champions” (GAP, 2012; Staats et al., 2004) to increase the effectiveness of the intervention and create the necessary platform for group commitments, as suggested by Lewin (1951).

These aspects could be supported by the provision of normative feedback, communication and a display of normative goal frames (Lindenberg & Steg, 2007), the establishment of a community consultation platform and peer guidance (Staats et al., 2004), individual assessment (energy audits), sensitivity toward decision-making processes in the households and a focus on willing participants (Brandon & Lewis, 1999).

In the next section some limiting aspects of the research design are discussed.

6.5.3 Research design

Limitations of the research design relate to the experimental section of this study. The experimental section of this study could have benefitted from several different approaches. These include using a pre- and post-test assessment of environmental concern in each group; using qualitative diaries (which would require participants to keep memos about energy efficiency behaviour) in Experimental Group 2; and using a control group (where no interaction with the participants would occur at all). These options are discussed below.

Pre- and post-tests assessing environmentally responsible behaviour and attitudes toward the environment, such as the New Ecological Paradigm used by Dunlap et al. (2000) could have validated the qualitative findings in this research further. Historical research on electricity consumption in each household could also have added additional insight into usage patterns.

The quantitative section of this study is underpowered. A larger sample size would have increased the certainty with which quantitative conclusions could be drawn and their ability to be generalised. The intense level of interaction between the researcher and each participating household during the data collection phase, however, prohibited a sample group much larger than the one attained in this study. Each household in Experimantal Group 1 was visited on three different occasions (installation, intervention and removal) at a time convenient to the home owner. This resulted in 123 separate visits to households of the research participants. Logistically and financially the current sample size was at the maximum that could be managed by the researcher in her personal capacity. Ideally, however, there should be at least 25 participants in each sub-group (Leedy & Ormond, 2013). This would result in at least 100 participants (25 LSM 10, Experimental Group 1; 25 LSM 10, Experimental Group 2; 25 LSM 6-9 Experimental Group 1 and 25 LSM 6-9 Experimental Group 2). This would result in better quantitative results, but will require an exceptionally large financial, logistical and human resources commitment.

The lack of the inclusion of a control group makes it difficult to ascertain the precise impact of the intervention. A control group, where no interaction with the research participants occurs (Leedy & Ormrod, 2013), could have assisted in crystallising the effect of the intervention even more strongly. This is recommended for future research. In this study, however, it was important for the researcher to provide both groups with the same information, in line with Salkind's (2012) suggestions on sharing benefits during the research process. This was done due to the potential benefits of saving them money and making a real difference in their lives, but more specifically because the households with low socio-economic backgrounds could potentially benefit the most. This may have decreased the perceptible effect of the intervention in Experimental Group 1 since each household in either group had access to real-time feedback.

In some cases, significant changes took place in Experimental Group 2 (for example, in the case of 21K1 and 3K2), but the reasons for these changes were not captured, since these participants had limited contact with the researcher. This could be addressed by means of the inclusion of diaries in Experimental Group 2. Reid et al. (2009) suggest the use of full scale diary studies that could play a very beneficial role in developing an even better understanding of electricity consumption in households, without regular personal interaction with the researcher. It may however, not work well when targeting people with low literacy levels.

Although all and any of these measures described above could have improved the description of the differences between the two experimental groups and the effect of the intervention in each, the researcher believes that the research design used was able to answer the research questions sufficiently. The researcher indicated the ways in which people from various socio-economic backgrounds strategized energy efficiency, highlighted the strategies they employ and identified folk knowledge, in-household inter-relationships, as well as a need for personal and normative feedback as important issues.

In the next section, suggestions for future research are discussed.

6.6 Recommendations for future research

In this section, areas for future research are pinpointed, looking at the micro and mesolevels, culminating in methodological recommendations for future research.

6.6.1 Micro level suggestions for future research

Aspects at the individual (micro) level of energy efficiency that could be considered in future research include the effects of technical automation of the desired behaviour; individual perceptions of normative goal frames; and the effect of a participatory approach on an individual's attitude toward the environment. These suggestions are summarised in Table 68.

Table 68

Micro level suggestions for future research

	Future research
Environmental concern	• Identification of goal frames for individuals • Identify perceptions or normative goals on energy efficiency in the South African society • Explore spill-over in motivation for attempting pro-environmental behaviour • Study individual perceptions of meso level interventions
Find out	Quantify the existence and proliferation of erroneous beliefs of functioning of appliances
Behaviour and strategies	Further explore the impact of intervention implementation in low income households, taking specific cognizance of the impact of the researcher and considering participatory approaches or action research

Individuals do not usually attempt energy efficiency in isolation and the individual's experience of participation in a meso level interaction should also be explored. Meso level outcomes from this study are presented in the next section.

6.6.2 Meso level suggestions for future research

The impact of interpersonal relationships in the household with specific reference to energy efficiency was highlighted as an important contributing factor to the success of energy efficiency programmes at a residential level. Although the presence of such interactions was identified in this study, these interpersonal interactions were not the focus of the study and could only be highlighted as important. It is therefore strongly recommended that the impact on energy efficiency of the decision-making process in interpersonal relationships in households be investigated in future research. This would enhance understanding of the potential for energy efficiency in the home and the impact on the workload of some household members. Meso level recommendations for future research are presented in Table 69.

Table 69

Meso level recommendations for future research

	Future research
Environmental concern	• Study inter-personal decision-making processes that affect the uptake of residential pro-environmental behaviour • Quantify the existence of and level of commitment to normative goals in South Africa • Identify normative goals that counter pro-environmental behaviour in South

	Africa
Find out	• Tailor information dissemination techniques for low-income and illiterate research participants • Explore participatory research as a means to disseminate information and change behaviour, specifically in low-income households
Behaviour and strategies	• Ascertain the impact of behaviour automation by means of timers and quantify the savings potential • Quantify savings potential of folk knowledge in terms of fridges and freezers

This study focused on one individual in each household, and conclusions indicate that a participatory approach in the design of the study and consequent implementation on a meso level could be beneficial. This could possibly allow for more buy-in from participants, collaboration toward mutual goals and support for more normative goals. These issues need to be researched further.

6.6.3 Methodological recommendations for future research

Researching energy efficient behaviour presents some unique challenges to researchers due to the extent of differences among participant demographics, their household occupants, their routines and schedules, and their electricity consuming appliances. They do not only differ in terms of age, family size and socio-economic standing (which are all known to influence electricity consumption), but they also differ materially (the house and its content). Recommendations emanating from this study are mentioned here and focus primarily on isolating and controlling for variables. Methodologically, the study could be improved when the researcher:

- Select building stock that are exactly the same or largely similar
- Assess pre-existing attitudes toward the environment in the form of a pre-test
- Include a control group
- Assess one ‘type’ of user, for instance, pensioners or families with your children
- Limit the number of subgroups from the population
- Assess post-intervention attitudes in the form of a post-test

Although applying these recommendations in future research would yield more reliable results, the validity of the findings become constraint and would not necessarily be applicable in real-life situations. In the next section, some policy implications identified in this research is highlighted.

6.7 Policy implications

Policy implications emanating from this study focus on the provision of real-time feedback to every electricity-consuming home in South Africa and commenting on a yardstick for determining the success of an energy efficiency programme. These issues are discussed below.

6.7.1 Provision of real-time feedback

The benefits of real-time feedback have been discussed throughout this thesis. Therefore the provision of access to better personal electricity management systems per consumer is strongly encouraged. Policy in this regard should be structured in such a way as to encourage, enable and enforce the provision of real-time feedback to direct consumers of electricity (and other resources such as water). In addition, normative feedback could be made available to electricity consumers sporadically. All such feedback on energy efficiency needs to be user-friendly, supported by information campaigns that both advocate specific behaviours, and linking hedonic and gain goal frames to smart norms and normative goal frames. These goal frames should be developed in a transparent manner and should be communicated clearly, and should be seen to be implemented by the leadership and authorities themselves.

6.7.2 Measuring success in energy efficiency programmes

The yardstick for success in energy efficiency projects should not focus solely on a reduction of electricity consumption in an isolated system (such as the household). Rather, it should assess the impact of the project on the overall quality of life for each individual, each household and the community. Participatory consultation and engagement approaches ensure buy-in, encourage participation and would also assist in the identification of suitable people from the targeted residential area who could play a role in the day-to-day activities from within the targeted area. This would also in effect provide a model of the desired social norms within the targeted residential area (Asch, 1951, 1956; McKenzie-Mohr & Smith, 1999; Nolan et al., 2008), possibly leading to an alteration of values, rather than a superficial display of the desired behaviour. A focused monolithic measure for success could cause a lot of damage, and the possible rebound effect should be studied further, especially in low-income households where quality of life can potentially be greatly influenced by energy efficiency projects.

Rebound is defined as the way in which the achieved energy savings are “taken back” by various behavioural responses in reaction to the savings (Druckman, Chitnes, Sorrell, & Jackson, 2011). In the context of energy efficiency, rebound is highly undesirable and poses very specific problems for measuring actual energy savings, since behaviour changes as a result of the savings may possibly result in an increased use of energy elsewhere. In some instances, the increased use may even exceed the initial savings.

From a socio-economic viewpoint, rebound, especially in the lower income groups is not necessarily detrimental. Energy savings, and consequently also monetary savings, can be applied to address another need that exists in the household, for which previously there were no resources available. These needs may in fact take the form of electricity use. Practically, changing to energy efficiency light bulbs, and using a geyser instead of a stove to heat water may save energy; this saving could be employed to cook hot food more often, or could give increased access to entertainment (TV, internet or music); therefore it may not necessarily bring about a reduction in energy use, but rather an increase in the quality of life of the people in the household where savings are attained. The implication of the rebound effect in the South African low-income environment should therefore take quality of life into consideration, and not simply focus on electricity savings. Future research to understand the effect of an energy efficiency programme on the quality of life of low-income households is recommended.

6.8 Conclusion

In this chapter, three over-arching themes were discussed, alongside the theoretical discussions from Chapters 2 and 3. These themes focused on the micro, meso and exo levels of the empowerment spiral elements, namely concern for the environment, the desire for information, and behaviour and strategies. The discussion identified key conclusions and implications throughout that were conceptually placed into the systems theoretical point of view in Section 6.3. Prior to this study, the savings potential of dispelling folk knowledge were largely unknown. Erroneous beliefs about the functioning of appliances were identified, and interaction between the micro, meso and exo levels of energy efficiency in the residential sector was explored in more detail. The limitations of this study were discussed in Section 6.4, focusing on the unit of research, sampling and generalisation; the intervention design and research design.

Despite the limitations of this study, this study has successfully identified micro, meso and exo level implications of energy efficiency in terms of the empowerment spiral, highlighting the cyclical interaction between environmental concern, finding out and finally acting and strategizing in a pro-environmental way. In Section 6.5, recommendations were made for future research, focusing on each of the ecological levels to structure these recommendations. The need for personal feedback at an individual level, but also the importance of linking hedonic and gain goals to more universal smart norms in the form of normative goal frames was highlighted. Policy developers were cautioned to take cognisance of the impact of energy efficiency measures, especially on women in lower socio-economic groups who may bear the brunt of the increased task of managing energy efficiency, thus emphasizing the need not to use reductions in electricity consumption as the only indicator of the success or failure of an energy efficiency project.

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Appendix A: Invitation for Participation

INVITATION TO THE PEOPLE'S POWER PROJECT

Please volunteer, so that we can do an energy audit at your house, for free!

What is an energy audit?

We check how electricity is used in the home, and make recommendations that may help you save money through saving electricity.

How will we do this?

An energy auditor will come to your house to install a little monitor recording your electricity usage. We will then give you some advice on how to save money and electricity.

All information will be kept confidential.

What participation is required?

If you live in a built house, with electricity, and for longer than three months, then we need 3 hours of your time, one hour a week, over three weeks. Appointments will be made to suit your needs.

Please contact Wilhelmina if you are interested, she will send your names through to Mathilda du Preez, the project leader; or

1) SMS "energy audit" to 083 657 7007 (normal SMS rates) OR
2) send an e-mail to mathildadupreez@gmail.com

What will happen after I register?

We will put your name on a list. You will be assigned to a research group. We will phone you to make an appointment and to install the monitor in your house. You will be contacted to arrange the installation. Participation is confidential.

Contact information:

Mathilda du Preez

Cellphone: 083 657 7007

NOVA office: 012 809 9771

*E-mail:*mathildaupreez@gmail.com

Appendix B: Consent Forms

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Lead researcher: Mathilda du Preez

Contact number: 083 657 7007

Participant information sheet

You are invited to participate in research with the title: Household energy use: intervention, exploration and comparison in three South African communities.[1]

I am a doctoral student at the University of Pretoria, and in collaboration with the NOVA Institute, will be conducting energy audits and discussions about energy efficiency in the communities of Garsfontein, Mamelodi and Woodhill/Menlopark. The process to be followed is explained below:

1) Monitoring electricity use in your home for the period of three weeks – the energy audit

Time required: Two 1-hour slots (for the installation and the removal of monitoring equipment)

Duration of monitoring: 3 weeks

Risks or benefits: No risks are envisaged. The benefits include personalised feedback information about your household's energy use.

Schedule of participation: Appointments will be made with you at a time that suits you.

Purpose of the monitoring: The installation of the monitoring equipment will be done by a trained energy advisor, who will come into your house and in collaboration with you, install an energy monitoring device. This device will measure the amount of electricity used in your household. It is installed at the distribution box in your home, but does not require cutting of any wires. Usage data is sent via a sender and collected by a receiver. This information can then be downloaded on a computer when the advisor or the researcher comes to remove the system.

The device should not be a hindrance to you or anybody else in your household. You will be requested to keep the monitoring equipment safe and avoid changing anything in the set-up for the duration of the three weeks. You will also be requested to provide the researcher with a recent copy of your electricity bill to compare your historical electricity usage to your current electricity use by means of municipal data. This, however, is not compulsory.

[11] This was the original title of the thesis.

Confidentiality and access to gathered data: To ensure that only the NOVA Institute and the researcher have access to your personal information, you will be allocated an audit number. This will be used as your identifier throughout, and no personal information will accompany usage data. Only the researcher and the NOVA Institute will have access to data connecting the audit number to your personal details. The NOVA Institute, the lead researcher and assistant researchers as well as the University's academic staff will have access to the usage data (not personal information, just the audit number). In line with the University of Pretoria's data storage policy, all data will be stored for 15 years from the completion of this project (until 2026) at the University of Pretoria's Department of Psychology.

2) To assess the impact of a behaviour change discussion that will be held with members of the household - the intervention

Time required: 1 hour (for a discussion about energy use and feedback on the usage data)

Schedule of participation: Appointments will be made with you at a time that suits you.

Selection of participants: This intervention will only be held with half of the households in the monitored area in order to allow the researcher to compare participating households with each other.

The intervention consists of an interview, information on how to use an up-to-the minute feedback monitor, a goal-setting exercise and a signed personal commitment. This up-to-the-minute feedback will be provided to the households in the experimental group after the first week. For the control group, feedback will be given after the three-week measuring period. All participants will receive a booklet about their personal electricity use data approximately three weeks after the measurement has been concluded.

Purpose of the discussion: The discussion will only apply to households in the experimental group. At the end of the first week or the beginning of the second week of monitoring, the lead researcher will come to the monitored house to have a discussion about the household energy use and to make some recommendations. Together with the researcher, you will be aided in setting an energy-saving goal, and will be requested to sign a personal commitment (optional) to that end. A short discussion with only one member of your household (older than the age of 18) about your energy use will ensue. This discussion will be recorded for research purposes. The researcher will use these discussions to understand how people strategize about electricity usage and to develop a focus group discussion guide.

Confidentiality and access to gathered data: These discussions will be kept confidential. The discussion will be digitally recorded and transcribed. Again the audit number will be used as identifier, and only the NOVA Institute, the lead researcher, assistant researchers and University of Pretoria's academic staff involved in the project will have access to these transcriptions. Transcriptions of your discussion with the researcher can be made available to you on request. In line with the University of Pretoria's data storage policy, all data will be stored for 15 years from the completion of this project (until 2026) at the University of Pretoria's Department of Psychology.

3) To facilitate a group discussion examining the groups' perceptions about energy efficiency and use – the focus group

Time required: 2 hours (for a group discussion about energy use)

Selection of participants: General members of the public will not be invited to the focus group meetings. Only participants in the project will be invited to the focus groups meetings. It would be advisable that one member from a household represent that household at the focus group meeting.

Schedule of participation*:* Two time slots will be advertised for each community, one for test households who were in the control group and one for those in the experimental group. You will be invited to attend these discussions.

Venue: The focus group would be held in a public venue in the community (such as a church hall, or a club meeting room).

Purpose of the discussion: You will be invited to a group discussion about the energy audit and the behaviour changes and savings that took place during the three week audit. Members in your community that have also been audited will join in the discussion.

Access to gathered data: As with the individual discussions, the discussions will be transcribed and analysed as part of my research. Again only the NOVA Institute, the lead researcher, assistant researchers and University of Pretoria's academic staff will have access to these transcriptions. Your groups' discussions could be made available to you on request. In line with the University of Pretoria's data storage policy, all data will be stored for 15 years from the completion of this project (until 2026) at the University of Pretoria's Department of Psychology.

Confidentiality: As a whole group of people who might know each other from their communities will be gathered at this discussion, it is not possible for the researcher to ensure confidentiality. The researcher undertakes, however, to use the same audit number as before as an identifier in transcriptions and during analysis of the data.

4) **Feedback**

Each household will receive written feedback about their household energy use within three weeks of the electricity monitor being removed from their homes. More general feedback about the findings of the study as a whole will be published in the form of an article in the local newspaper, and may only be available after the completion of my doctoral studies, i.e. at the end of 2011.

5) Use and storage of gathered data

Data will be used by the lead researcher, the NOVA Institute, assistant researchers and academic staff of the University of Pretoria for the purposes of this project and may be used by other academic researchers in the future for the purposes of research and/or training. No personal information will accompany the usage data. In line with the University of Pretoria's data storage policy, all data will be stored for 15 years from the completion of this project (until 2026) at the University of Pretoria's Department of Psychology.

Thank you for volunteering to participate!

Please note:
The University of Pretoria will not be held liable for any damages or injuries incurred during participation in this project.

Your rights: There are no risks involved in this study. Please take note that you are under no obligation to continue your involvement in the project. Should you wish to withdraw, it will be without negative consequences and all gathered information will be destroyed.

You are also welcome to request your interview transcription and that of the focus group in which you participated from the lead researcher. The lead researcher can be contacted at the following number:

Mathilda du Preez
Cell phone: 083 657 7007
E-mail: mathildadupreez@gmail.com

If you have any questions, suggestions or requests, please contact me.

__________________________	__________________________
Mathilda du Preez	Prof. Claire Wagner
Lead Researcher	Promoter

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Lead researcher: Mathilda du Preez

Contact number: 083 657 7007, e-mail: mathildadupeez@gmail.com

Consent form – Energy audit

Please note: The University of Pretoria will not be held liable for any damages or injuries incurred during participation in this project.

Please read the participant information sheet carefully before committing to participate in this study.

I understand that there are no risks involved in this study and that I am free to withdraw from this study at any stage of the research.

By signing this form I acknowledge and agree to the following:

- I agree to participate in a three-week home energy audit and all that it entails;
- I agree to provide the researcher with a recent copy of my electricity bill;
- I agree to ensure that the equipment remains in my house for the duration of the monitoring period;
- I agree to avoid changing the equipment set-up as installed by the advisor for the duration of the three weeks;
- I acknowledge that data will be used by the lead researcher, the NOVA Institute, assistant researchers and academic staff of the University of Pretoria for the purposes of this project and may be used by other academic researchers in the future for the purposes of research and/or training. No personal information will accompany the usage data. Data will be stored for 15 years at the Department of Psychology, i.e. until 2026.

Please sign the consent form below.

I, ____, have read and understood the purposes of this study.

Participant

Signed:______________________________ Date:_________________________

Name in print:_____________________________________

Researcher

I have explained the study to the participant, and provided him or her with a copy of the participant information sheet.

Signed:______________________________ Date:_________________________

Name in print:_______________________________

Lead researcher: Mathilda du Preez Contact number: 083 657 7007

Consent form – Interview and Intervention

Please note: The University of Pretoria will not be held liable for any damages or injuries incurred during participation in this project.

Please read the participant information sheet carefully before committing to participate in this study.

I understand that there are no risks involved in this study and that I am free to withdraw from this study at any stage of the research.

By signing this form I acknowledge and agree to the following:

- I agree to participate in the interview as part of this research;
- I agree to participate in the intervention as part of this research;
- I understand that I will form part of the experimental group;
- I understand that the intervention includes up-to-the-minute feedback on usage, a goal-setting exercise and a written commitment to save electricity (voluntary);
- I agree that the interview may be recorded;
- I understand that the recording will be transcribed and analysed;
- I understand that the information will be used for research and educational purposes;
- I acknowledge that no personal information will accompany the transcriptions of the interview;
- I understand that an audit number will be used to identify me during transcription, analysis and for publication purposes; and
- I acknowledge that data will be used by the lead researcher, the NOVA Institute, assistant researchers and academic staff of the University of Pretoria for the purposes of this project and may be used by other academic researchers in the future for the purposes of research and/or training. No personal information will accompany the usage data. Data will be stored for 15 years at the Department of Psychology, i.e. until 2026.

Please sign the consent form below.

I, ____, have read and understood the purposes of this study.

Participant

Signed:_____________________________________ Date:______________________________

Name in print:____

Researcher

I have explained the study to the participant, and provided him or her with a copy of the participant information sheet.

Signed:_____________________________________ Date:______________________________

Name in print:____

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Lead researcher: Mathilda du Preez   Contact number: 083 657 7007

Consent form – Focus Group

Please note: The University of Pretoria will not be held liable for any damages or injuries incurred during participation in this project.

Please read the participant information sheet carefully before committing to participate in this focus group.

I understand that there are no risks involved in this study and that I am free to withdraw from this study at any stage of the research.

PLEASE TAKE NOTE: Due to the nature of a focus group, the researcher cannot ensure confidentiality as group members may discuss the issues amongst each other, or non-participating community members, after completion of the discussion. Participants will be requested not to divulge sensitive information. Confidentiality on the side of the researcher is, however, assured.

By signing this form I acknowledge and agree to the following:

- I hereby agree to participate in the focus group as part of this research;
- I agree that the focus group may be recorded;
- I understand that the recording will be transcribed and analysed;
- I understand that no personal information will accompany the transcriptions of the focus group, only an allocated audit number;
- I understand that confidentiality cannot be assured as I will be part of a group discussion;
- I acknowledge that data will be used by the lead researcher, the NOVA Institute, assistant researchers and academic staff of the University of Pretoria for the purposes of this project and may be used by other academic researchers in the future for the purposes of research and/or training. No personal information will accompany the usage data. Data will be stored for 15 years at the Department of Psychology, i.e. until 2026.

Please sign the consent form below.

I, ___________________________________, have read and understood the purposes of this study.

Participant

Signed:_______________________________________ Date:________________________________

Name in print:____

Researcher

I have explained the study to the participant, and provided him or her with a copy of the participant information sheet.

Signed:_______________________________________ Date:________________________________

Name in print:____

Appendix C: Interview and Focus Group Discussion Guides

Interview	
INTERVIEWER DETAILS	**RESPONDENT DETAILS**
Name:	Name:
Surname:	Surname:
	Audit number
	RECORD INTERVIEW TIMES BELOW
Next appointment date:	Date:
	Start time:
	End time:
	Total recording time: H minutes

INTERVIEWER INSTRUCTIONS

PLEASE GO THROUGH THE CONSENT FORM WITH THE RESPONDENT IN DETAIL. BOTH THE INTERVIEWER AND INTERVIEWEE TO SIGN AND DATE THE CONSENT FORM.

PLEASE NOTE THAT THIS IS A DISCUSSION GUIDE AND AS SUCH IT SHOULD GUIDE YOU THROUGH THE DISCUSSION. IF ADDITIONAL INFORMATION COMES UP THAT IS NOT MENTIONED IN THIS GUIDE, USE YOUR JUDGEMENT TO GAUGE ITS USEFULNESS AND PROBE FURTHER APPROPRIATELY.

Introduction

Hi/Good afternoon, my name is___________________. Thank you once again for agreeing to meet with me/us. In order to listen carefully to what you will be saying without having to write detailed notes during our conversation, I would be grateful if you could allow me/us to record the discussion. I can then listen to the recording and transcribe it for analysis later. Is that OK with you?

No one else except my fellow researchers, staff at the NOVA Institute and UP will have access to the audio files. Also, nowhere in the reports will you be mentioned by name. If you agree with this would you please sign the consent form indicating your willingness to participate? Thank you very much.

Draft Interview guide

I would firstly like to ask a few questions about your reason for volunteering for this study.

Section 1

1. What motivated you to volunteer for this project?
   Listen and ask for more info, or repeat key words…
2. Why does this motivate you?
   Prompt: Values, or guilt or financial reward or peer/social pressure
3. What sense do you make from the whole global warming issue?
   Prompt: the so-called green-movement?,
   the increased emphasis on human impact on the environment
   If the participant isn't clear on what you are asking, say: Why do you think there is more emphasis these days on 'saving the environment'? and then: What do you think about this recent emphasis?
4. Where do you fit into this issue?
   Prompt: What are your responsibilities, What are the roles you assume as a result?

Impact on household

5. How has your view (what you just described) influenced your household?
   Prompt: physical changes in the household, in the routine?
6. Do people in your household share your view?
   Prompt: most or all? agree fully or only a little?
7. Are you particularly motivated to change anything in your household?
   Prompt: Do you think, in particular, about how to get the people using your electricity to change the way they think?
8. Have you ever suggested any changes to be made in your household?
   Prompt: Details about the change/ Why not?
9. Is there anybody in your household specifically motivated to bring about change in the use of electricity?
10. How do you/this person impact on the motivation of others in the household?
11. Who is the least motivated?
12. How do this person's actions impact others in the household?
13. Do these people's actions impact broader than the household? How?
14. **ASK ONLY IF YES AT 12** - If you were to make some changes in your household, what would you do/change?
15. Do you have any other plans in mind for the near future?
16. What do you hope to achieve with these planned changes?
    Prompt: What is the goal of the changes you will make?
    Further prompt: Rand value, reducing footprint, Self- worth
17. What prevents you from making these changes you just mentioned?
    Prompt: specific people – their habits etc.

Section 2

18. Are there aspects, other than people, that may prohibit change in your household? Please describe them.

    Prompt: infrastructure, recycling services, knowledge?

19. If you think about what is made possible by the public structures, for instance, the council or possibly a community programme, how enabled are you to make the changes you would like to make?
    Prompt: is it easy, are there programs running, have enough info, know what needs to be done

20. What changes are necessary to facilitate these actions you would like to take?
    Prompt: Need for leadership? Information?

21. Who should instigate change in the household?
    Prompt: Should change come from within? Or motivated from through regulations or incentives?

22. What should be the main method of motivating change?
    Prompts: incentives, change driven by council, change driven by law, change driven by self-motivation

23. Do you employ any secondary means of conserving electricity, for instance in the form of water conservation, waste recycling, and using alternative modes of transport? (lift clubs etc.?)

INTERVENTION (if applicable)

Based on the personalized information just provided by ………………………..(name of energy auditor). How much energy do you think you are able to save during the next week or two of measurement compared to the first?

Would you be willing to sign a commitment to decrease your household energy use by 10% in the next two weeks?

If yes - Complete the commitment sheet.

Do you have any questions?

Could we make an appointment for ……..?

Thank you very much for your time. We will be in contact again soon.

Focus Group guide	
MODERATOR DETAILS:	**PARTICIPANT DETAILS**
Name:	1
Tel no:	2
	3
OBSERVERS:	4
Name:	5
Name:	6
Name:	7
	8
FOCUS GROUP RECORDING	
Date	
Time start	
Time end	
Total recording time	
Venue	

Draft focus group discussion guide

Thank you for attending this focus group session. All of you who are here today have undergone a home energy audit and have received some feedback. You are also all from the same geographical area. Today I would like us to discuss how your household dealt with the energy audit.

Let us start by going around introducing ourselves, you could use only your name, and quickly explain why you are here this evening (other than practical reasons).

1. Experiences self

1.1 Could you share some of your experiences during the energy audit with the group?

Prompt: motivation for attending and volunteering

Prompt: learning

Prompt: Information sharing

Prompt: commitment statement

Prompt: conservation strategies

1.2 Why did you choose to participate?

Prompt: ecologically conscious

Prompt: socially conscious

Prompt: frugally conscious

1.3 How do you view nature?

Prompt: Nature is sacred because it was created by God "sanctification of nature"

Prompt: Nature should be protected because it was created by God "stewardship"

Prompt: Nature is an exploitable resource that exists for the use of humankind "dominion"

2. Experiences within household

2.1 How did the members of your household affect your ability to do something about energy use?

Prompt: Positive effects

Prompt: Negative effects

2.2 Elaborate on your ability reach a goal in energy use, when it has to be communicated to other family members.

2.3 Who in the family has been most supportive of this?

2.4 Who hasn't been at all?

3. Strategies employed by the household, from the individual's point of view

3.1 How did other household members react toward the electricity monitor?

Prompt: interested

Prompt: not interested

Prompt: played with the monitor

Prompt: ignored the readings

Prompt: struggle to understand, struggle to explain

3.2 Did you involve them in the decision – or the commitment – to change?

3.2.1 How?

3.3 What was their reaction toward your commitment?

4. Change

4.1 Was there any change in your routine?

4.2 Was there any change in the routine of other members of the household?

4.3 Did you bring about any physical changes in the home, such as CFLs or solar water heaters?

4.4 Did any other member of your household bring about physical changes in the home?

4.5 Have there been open discussions about the use of electricity in the home?

Additional questions may come in as a result of the personal interviews…

Is there anybody who would like to make some concluding remarks?
If everybody is satisfied, I would like to thank you all for attending and providing some insight into this issue.

Please remember to take an information leaflet and feel free to contact me if you have any further queries.

Appendix D: Intervention Pack

Interview and Intervention		
Date of interaction:		
Audit number:		
Participant name:		
Telephone number:		
Address:		
Advisor name:		
1	Intervention consent form	Yes or No
2	Interview	
3	Instructions	Yes or No
4	Advice	Leave with participant
5	Guidance on goal-setting	
6	Commitment	Leave with participant
Signature and name		

1. Complete the consent form.
2. Complete the interview.
3. Follow instructions.

What is a Kilowatt?

On your appliances you will see the number of WATTS that the appliance uses. This number is usually stamped underneath or at the back of your appliance.

An example:

An iron uses 1500 watts.

This is 1.5 kilowatts or 1.5 kW.

(To change watts to kilowatt, move the comma three spaces to the left, i.e. 1500 w= 1.5 kW). Electricity is charged per kWh, and costs R0.99 after increases in July 2010.

You then multiply the number of kilowatts by the price of one unit of electricity (1.5 * 0.99 = R 1.49). It will thus cost you R1.49 to use the iron for one hour.

For three hours: 1.5*0.99*3= R 4.45.

Another example:

Your geyser will use about 3000 watts or 3 kW.

It is on for 10 hours a day.

3kW * 10 * 0.99 = R 29.70 per day

R 29.70 * 30 days = R 891 per month (just for your geyser)

The spreadsheet below should be helpful in determining how your appliances make up your total electricity use.

Note the difference between kW and kWh.

kW is the power currently being used (at this moment in time)

kWh is the amount of power used in an hour. You are billed R 0.99 per kWh.

The E2 monitor and how it works

Functions

Instant

Displays the instant power (kW), could also display the $KgCO_2$ per hour and the estimated electricity cost (in Rand) per hour.

Average

This will show the daily, weekly and monthly averages of kWh, kg, CO_2 and cost (in Rand) consumption

History

This will display the consumption of the last 7 days, the last 7 weeks and last 24 months in kWh, cost (in Rand) and $kg.CO_2$

Mode button

Power = kW

This will show the power used at any particular moment in the house.

Note: at average and history, the display shows energy consumption in kWh.

Cost per hour

Estimated cost in Rand (although no Rand symbol is available on the display unit, only after downloaded).

Carbon emissions

This is an estimate of your carbon footprint.

Date button

Choose from daily, weekly or monthly information.

Arrows

Select specific days, weeks, months.

Advice

If you are not using it, switch it off.

Geyser

Install a timer and try to condense use of hot water to one time slot. Heat the water for that time slot only.

Lighting

Replace all incandescent lamps with CFLs. Payback time is only two months, so it is really worth the investment.

Standby electricity

Don't leave appliances on standby. Appliances can still use up to 50% of their power when they are in standby mode.

Refrigeration

Make sure that your fridge and seals are in good working order. Don't leave the door open for long periods of time.

Room temperature

Keep room temperature between 18 and 22 degrees Celsius and use blankets in winter or natural ventilation in summer.

Showerheads

Water-saving shower heads should be used, as they not only save water, but also electricity, as they use less hot water that requires energy to be heated.

Walk-through

The purpose of the walk through is to aid you in looking at your home with 'energy-eyes'. Walk through your house. Look at what makes use of electricity to operate. Look for appliances that are always on (geysers, freezers and fridges), on standby (DVD players, bedside clocks) and equipment that uses a lot of watts instead of a few (some light fittings).

Take the monitor in your hands and walk through the house. Put off everything that is normally off when you are in bed or not at home and take a look at the monitor. This amount will be an indication of your baseline costs, usually including the geyser, the fridge, the freezer and some standby use. Then try switching everything off at the wall sockets and try to get the monitor to show 0. Next start by switching the essentials back on, leave off the appliances that are usually on unnecessarily.

You might find that the set of down lights in your kitchen uses far more electricity than you realized. Consider also how long your appliances are left on for.

The key about energy saving is that IT ALL ADDS UP. Leaving a big light on at night might only make a R30 difference per month, but look at the example below…

	5 down lights = 5x50watt = 250watt per hour	**1 CFL lamp = 11 watt**
4 hours in the evening	=250watt * 4 = 1kW	= 11watt * 4 = 44watt
Every evening in one month	1kW x 30 = 30kW	44 x 30 = 1.32kW
Cost per month	30kW x R0.99 = R 29.70	1.32kW x R0.99 = R 1.31
Over one year	= R 356.4	= R 15.68
WHY WOULD YOU CHOOSE TO PAY R350 PER YEAR FOR A LIGHT AT NIGHT INSTEAD OF R15.50?		

Remember, a simple change in the way you do things could make a very big difference in the amount of electricity you will use.

Goal-setting

How do you set a goal that is reachable?

You have already taken the first steps in becoming more energy efficient! Knowing what and how you pay for electricity is a very big step in understanding how to conserve electricity.

Look at your findings from the walk-through.

Decide which changes need to be made:

- You might want to replace your incandescent lamps with CFLs.
- You might want to install a timer for your geyser.
- You might want to install motion sensors for the outside lights.
- You could choose more efficient lights to leave on during the night.
- You could use natural ventilation instead of the air conditioner in summer.
- You could insulate your ceiling and geyser.
- Try to put everything off when you are done using it.

Discuss this with others in your house, as this is a collective effort.

Commit to 10% saving.

Energy audit daily usage log

Energy audit average daily usage					
Household Audit Number					
E2 kit number					
Date	**Day count**	**Day description**	**Day Average (kWh)**	**Savings Achieved**	**% saving**
		Monday, Tuesday, Wednesday etc.	(read from history on monitor)	Compared to similar day, a week before, e.g. 1st Monday= 15kWh, 2nd Monday is 11kWh. Savings = 15-11=**4kWh**	**=4/15*100 =26%**
Start:	Day 1				
	Day 2				
	Day 3				
	Day 4				
	Day 5				
	Day 6				
	Day 7				
Intervention:	Day 8				
	Day 9				
	Day 10				
	Day 11				
	Day 12				
	Day 13				
	Day 14				
	Day 15				
	Day 16				
	Day 17				
	Day 18				
	Day 19				
	Day 20				
	Day 21				
	Day 22				
	Day 23				
	Day 24				
	Day 25				
	Day 26				
	Day 27				
	Day 28				
	Day 29				
Removal:	Day 30				

Commitment

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I hereby elect to attempt conserving at least 10% on my electricity consumption during the next two weeks.

I agree that my saving, in comparison with other households in the measured area, may be published in the local newspaper.

Please note that no personal information would accompany such information in any publication and that you will be informed about your saving in the final report on your household.

Signed:____

Date:__________________________

Audit number: ________________________

Appendix E: Quantitative Data Collection Instruments

	HOUSEHOLD DETAILS						
	Audit number						
	Gender						
	Age						
	Highest education						
	Number of adults in household						
	Number of children in household						
	Number of people at home during the day						
	Are you the home owner or renting						
	INVENTORY						
1	**House or flat**						
1.1	When it is a house, it is freestanding	yes	no				
1.2	How many living rooms are aviable						
1.3	How many square meter do the house/flat have						
1.4	How many floors do the house/flat have	1	2	3			
1.5	Is the ceiling insulated	yes	no				
1.6	Do you have shutters	yes	no				
1.7	Do you have curtains that you use to control temperature in the house	yes	no				
2	**Outside**						
2.1	Do you have a **pool**	yes	no	if no - skip to question 2.2			
2.1.1	Do you use a timer for the pool pump (settings)						
2.1.2	Do you use a electric heater for the pool	yes	no				
2.1.3	Do you have lights for the pool	yes	no				
2.1.4	Energy saving lamps for pool lighting	yes	no				
2.2	Do you have a **garden**	yes	no	if no - skip to question 2.3			
2.2.1	Do you have lights for the garden	yes	no				
2.2.2	Energy saving lamps	yes	no				
2.2.3	Do you use a timer for the outside lamps (settings)	yes	no				
2.3	Do you have an electric fence	yes	no				
2.4	Do you have an electric gate	yes	no				
3	**Inside**						
3.1	**Living rooms (TV, dining, sitting, entertaining)**	Define room		Define room		Define room	
		room 1		**room 2**		**room 3**	
3.1.1	Lights with energy saving lamps	yes	no	yes	no	yes	no
3.1.2	TV	yes	no	yes	no	yes	no
3.1.2.1	television tube or flat screen	tube	flat	tube	flat	tube	flat
3.1.2.2	on stand by all day	yes	no	yes	no	yes	no
3.1.2.3	size bigger than 60cm/32 inch	yes	no	yes	no	yes	no
3.1.3	computer / Laptop	yes	no	yes	no	yes	no
3.1.4	any heater plate or radiator	yes	no	yes	no	yes	no
3.1.5	air con with timer or thermostat (normal setting 26 degr)		degr		degr		degr
3.1.6	hifi system / DVD etc...	yes	no	yes	no	yes	no
3.1.6.1	stand by on all day	yes	no	yes	no	yes	no

3.2	**Bedrooms**	Define room		Define room		Define room	
		room 1		**room 2**		**room 3**	
3.2.1	Lights with **energy saving lamps**	yes	no	yes	no	yes	no
3.2.2	**TV**	yes	no	yes	no	yes	no
3.2.2.1	television tube or flat screen	tube	flat	tube	flat	tube	flat
3.2.2.2	stand by on all day	yes	no	yes	no	yes	no
3.2.2.3	size bigger than 60 cm	yes	no	yes	no	yes	no
3.2.3	any **heater plate or radiator**	yes	no	yes	no	yes	no
3.2.4	**air con** with timer or thermostat (normal setting 26 degr)		degr		degr		degr
3.2.5	**hifi system / DVD etc...**	yes	no	yes	no	yes	no
3.2.5.1	stand by on all day	yes	no	yes	no	yes	no
		Define room		Define room		Define room	
3.3	**nursery /guest / children / working**	**room 1**		**room 2**		**room 3**	
3.3.1	Lights with **energy saving lamps**	yes	no	yes	no	yes	no
3.3.2	**TV**	yes	no	yes	no	yes	no
3.3.2.1	television tube or flat screen	tube	flat	tube	flat	tube	flat
3.3.2.2	stand by on all day	yes	no	yes	no	yes	no
3.3.2.3	size bigger than 60 cm	yes	no	yes	no	yes	no
3.3.3	**computer / Laptop**	yes	no	yes	no	yes	no
3.3.4	**any heater plate or radiator**	yes	no	yes	no	yes	no
3.3.5	**air con** with timer or thermostat (normal setting 26 degr)		degr		degr		degr
3.3.6	**hifi system / DVD etc...**	yes	no	yes	no	yes	no
3.3.6.1	stand by on all day	yes	no	yes	no	yes	no
4	**Kitchen**						
4.1	Lights with **energy saving lamps**	yes	no				
4.2	**TV**	yes	no				
4.2.1	television tube or flat screen	tube	flat				
4.2.2	stand by on all day	yes	no				
4.2.3	size bigger than 60 cm	yes	no				
4.3	**fridge freezer combined unit**						
4.3.1	older than six years	yes	no				
4.3.2	regular defrosted	yes	no				
4.3.3	seal in proper function	yes	no				
4.3.4	stand alone or integrated	std alon	integr				
4.3.5	volume		litre				
4.3.6	setting (normal 7-8°C)		degr				
4.3.7	setting (normal -18°C)		degr				
4.4	**fridge**						
4.4.1	older than six years	yes	no				
4.4.2	regular defrosted	yes	no				
4.4.3	seal in proper function	yes	no				
4.4.4	stand alone or integrated	std alon	integr				
4.4.5	volume		litre				
4.4.6	setting (normal 7-8°C)		degr				
4.5	**freezer**						
4.5.1	older than six years	yes	no				
4.5.2	regular defrosted	yes	no				
4.5.3	seal in proper function	yes	no				
4.5.4	stand alone or integrated	std alon	integr				
4.5.5	volume		litre				
4.5.6	setting (normal -18°C)		degr				

4.6	**stove**						
4.6.1	ceramic/steel/spiral stove top						
4.6.2	clean and level hob	yes	no				
4.6.3	electric	yes	no				
4.7	**microwave oven in use**	yes	no				
4.8	**electric kettle in use**	yes	no				
4.9	**dishwasher**	yes	no				
4.9.1	older than six years	yes	no				
4.10	**washing machine**	yes	no				
4.10.1	older than six years	yes	no				
4.11	**dryer**	yes	no				
4.11.1	with extract air or condensation or heat pump	yes	no				
5	**Bathroom**	Define room		Define room			
5.1	Lights with energy **saving lamps**	**room 1**		**room 2**			
5.2	**geyser**	yes	no	yes	no		
5.2.1	electric	yes	no	yes	no		
5.2.2	with thermostat setting max 60 degr	yes	no	yes	no		
5.2.3	is the geyser insulated with geyser blanket		degr		degr		
5.3	Water saving showerhead	yes	no	yes	no		
remarks							

South African
Advertising Research Foundation

LSM questionnaire

Thank you for agreeing to complete the LSM questionnaire. This is a measurement instrument developed by the South African Advertising Research Foundation (2010). This will aid the researcher in understanding how electricity is used in your home and to understand the specific challenges you are faced with in your home.

Simply answer true/false by marking the applicable option.

e.g. I have a TV in my home, then mark Question 1

TV set

~~True~~	False

Question	Answer	
I have the following in my household:		
TV set	True	False
VCR	True	False
DVD player	True	False
M-Net/DSTv subscription	True	False
Hi-fi/music centre	True	False
Computer /Laptop	True	False
Vacuum cleaner/floor polisher	True	False
Dishwashing machine	True	False
Washing machine	True	False
Tumble dryer	True	False
Home telephone (excluding a cell)	True	False
Deep freezer	True	False
Fridge/freezer (combination)	True	False
Electric stove	True	False
Microwave oven	True	False
Built-in kitchen sink	True	False
Home security service	True	False
3 or more cell phones in household	True	False
2 cell phones in household	True	False

Audit number:_______________

Home theatre system	True	False
I have the following amenities in my home or on the plot:		
Tap water in house/on plot	True	False
Hot running water from a geyser	True	False
Flush toilet in/outside house	True	False
There is a motor vehicle in our household	True	False
I am a metropolitan dweller	True	False
I live in a house, cluster or town house	True	False
ALL TRUE Total		
I live in a rural area outside Gauteng and the Western Cape	True	False
There are no radios, or only one radio (excluding car radios) in my household	True	False
There are no domestic workers or household helpers in household (both live-in & part time)	True	False

Appendix F: Data Storage Form

FACULTY OF HUMANITIES

RESEARCH PROPOSAL AND ETHICS COMMITTEE

Declaration for the storage of research data and/or documents

I / We, the principal researcher(s): Mathilda du Preez

and supervisor(s): Prof. Claire Wagner

of the following study, titled: Household energy use in South Africa: a systemic study of an individual intervention will be storing all the research data and/or documents referring to the above-mentioned study in the following department: Department of Psychology

We understand that the storage of the mentioned data and/or documents must be maintained for a minimum of 15 years from the commencement of this study.

Start date of study: January 2011

Anticipated end date of study: December 2013

Year until which data will be stored: 2026

Name of Principal Researcher(s)	Signature	Date
Mathilda du Preez		
Name of Supervisor(s)	**Signature**	**Date**
Professor Claire Wagner		
Name of Head of Department	**Signature**	**Date**

Appendix G: Interview Themes, Codes and Quotation Count

Interview themes and codes lists

HU: Interview themes
File: [C:\Users\Mathilda\Dropbox\PhD\Analysis\Atlas.ti training course\Interview themes.hpr7]
Edited by: Super
Date/Time: 2013-10-24 12:12:03

Code Family: Awareness
Created: 2012-05-23 12:01:51 (Super)
Comment:
References to the importance of awareness of global climate change and possible behaviour options
Codes (37): [Actions have no impact] [Adult children] [At home vs at work] [Awareness increase is important] [Country-wide problem] [Educate children] [Educate others] [Education – teenagers] [Eff – no options available] [Eff – not a priority] [Eff – a serious issue] [Family views not shared] [GCC – blown out of proportion] [GCC – cost of going green] [GCC – natural occurrences] [GCC – no knowledge] [GCC – not worried] [GCC – reality] [GCC – scary] [GCC – unsure about own impact] [GCC help – awareness] [GCC help – going green] [GCC help – responsible living] [Hold others responsible for their own behaviour] [Individual efforts vs authorities' efforts] [Interaction with neighbours/friends/family] [Limited ability as an individual] [Motivation for participation – efficiency] [Motivation for participation – not enthusiastic] [Perception – most people are ignorant] [Perception of GW scary] [Rationalization – no recycling behaviour] [Recycling – not important] [Recycling – driven by schools and churches] [Shared family responsibility] [Shared family views] [Small children – understanding]
Quotation(s): 138

Code Family: Behaviour changes
Created: 2012-05-24 10:53:24 (Super)
Comment:
References to changes in behaviour, routine behaviour, automated behaviour and energy efficiency practices
Codes (17): [At work during day] [Behaviour change – visitors] [Eff – no equipment changes] [Eff – appliance use] [Eff – Financially driven] [Eff – geyser use] [Eff – lights: CFL use] [Eff – lights: down lighters] [Eff – lights: motion sensors] [Eff – lights: switch off] [Eff – no options available] [Eff – other strategies] [Excessive use] [non-compliant behaviour] [Non-eff behaviour] [Routine env behaviour] [Strategy – minimize impact of actions]
Quotation(s): 97

Code Family: Comfort
Created: 2012-05-24 10:57:16 (Super)
Comment:
Comfort and lifestyle choices: including the importance of comfort and the need for convenience
Codes (12): [CFL – light quality issues] [Comfort – convenience] [Comfort – important] [Comfort – outside lighting] [Lifestyle decision] [Pre-paid meters: effort] [Recycling – more effort] [Recycling – paper] [Routine env behaviour] [Solar – maintenance] [Solar – ROI] [Solar is a luxury]
Quotation(s): 61

Code Family: Efficiency planning
Created: 2012-05-24 11:19:04 (Super)
Comment:
Planning in terms of energy efficiency, also a possible indicator of the unreachable, since it has not been implemented already.
Codes (8): [Eff planning – appliance use] [Eff planning – consideration no action] [Eff planning – distant future] [Eff planning – doubtful] [Eff planning – geyser timer] [Eff planning – newer technology (cfl, tv and fridges)] [Eff planning – recycling] [Eff planning – solar]
Quotation(s): 26

Code Family: Financial motivation and incentives
Created: 2012-05-23 12:16:03 (Super)
Comment:
Mentions of the financial drivers and incentives for energy efficiency
Codes (15): [Eff – Financially driven] [Emotion – favours cost over carbon] [Emotional reaction to cost] [Husband – financially motivated] [Husband – pays bills] [importance of energy efficiency] [Incentive – is a motivation] [Incentive – motives in doubt] [Incentives – no green agenda] [Incentives as primary driver] [Increased costs] [Motivation for participation – account holder] [Motivation for participation – costs savings] [Negative motivation/incentives] [Solar – ROI]
Quotation(s): 57

Code Family: Folk knowledge
Created: 2012-05-24 11:33:50 (Super)
Comment:
Folk Knowledge generally accepted amongst the interviewees, but scientifically disproven
Codes (6): [Myth – don't switch freezers off] [Myth – down lighters] [Myth – geyser is too old to put off] [Myth – heater use] [Myth – Pre-paid meters use a lot of electricity] [Myth – smaller appliances]
Quotation(s): 6

Code Family: Gender roles interaction
Created: 2012-05-23 11:36:18 (Super)
Comment:
Identification and definition of roles within a household, mainly defined by the interviewees in terms of gender roles.
Codes (8): [Conflict – electricity behaviour] [Driver of action] [Female: responsible for action] [Female: responsible for bills] [Husband – financially motivated] [Husband – monitor use] [Husband – pays bills] [Husband wife interaction]
Quotation(s): 52

Code Family: Need: information based feedback and support
Created: 2012-05-24 10:42:31 (Super)
Comment:
Expressed need for information, based on facts and providing a basis for action, including guidance from authorities, municipal staff and sales people
Codes (16): [Desire for personal training] [Desire to understand] [Distrust – product quality] [Distrust in sales people] [Expressed need – consistent billing] [Expressed need – feedback] [Expressed need – feedback on responsible use] [Motivation for participation – curiosity] [Motivation for participation – electricity wasted] [Motivation for participation – problems with municipality] [Municipal administration problems] [Municipality – unfriendly staff] [Municipality should provide pre-paid meters] [Professional services in renewables] [Recycling – more effort] [Recycling – need to be more structured]
Quotation(s): 61

Code Family: Role player identification
Created: 2012-05-24 11:24:15 (Super)
Comment:
The identification of the roles that should be played by different role players including the government, municipalities, Eskom, civil society and individuals
Codes (18): [Designated responsibility] [Distrust – product quality] [Distrust authorities] [Diverted responsibility] [External forces – combined effort] [External forces – community drives] [Incentive – motives in doubt] [Increased costs flag problems] [Individual efforts vs authorities' efforts] [Multiple users] [Municipal administration problems] [Municipality – unfriendly staff] [Municipality should provide pre-paid meters] [Recession – decreased demand] [Recycling – driven by schools and churches] [Recycling – Personal responsibility] [Supply and demand impact] [Trust in government and municipalities]
Quotation(s): 80

Code Family: Self and values
Created: 2012-05-23 12:15:38 (Super)
Comment:
Aspects that the person him-/herself worked through, ideas that still challenge the concept of self in energy efficiency and self-reported values
Codes (19): [Defensive – half truth] [Each person can make a difference] [Earth is valuable] [Emotion – consistent behaviour] [Emotion – favours cost over carbon] [Emotional reaction to cost] [Listen to conscience] [Personal responsibility] [Recycling – Personal responsibility] [Resource eff – electricity] [Resource eff – water] [Self – environmentally conscious] [Self – forget about geyser] [Self – uninformed about electricity] [Self education] [socio-economic issues] [Spiritual responsibility] [Value – is irritating to others] [Value – use resources sparingly]
Quotation(s): 102

Code Family: Strategy
Created: 2012–05–24 11:45:00 (Super)
Comment:
Specific strategies employed by the participants in this research to coerce family members to participate in energy efficiency behaviour in the household.
Codes (16): [Motivation for participation – recommended by trusted party] [Strategy – authoritive instruction] [Strategy – communication] [Strategy – lead by example] [Strategy – minimize impact of actions] [Strategy – no communication] [Strategy – not confrontational, but serious] [Strategy – not well formulated] [Strategy – open forums at work] [Strategy – plan/schedule use] [Strategy – pre-paid meter installed] [Strategy – provide meter readings] [Strategy – red card green card] [Strategy – reminders] [Strategy – request understanding/pity] [Strategy – translate recycling information]
Quotation(s): 47

Interview codes and primary documents table																			
Code-Filter: All [155]					PD-Filter: All [18]								Quotation-Filter: All [614]						
	P 1: 21T4	P 2: 21T5	P 3: 22T1	P 4: 22T3	P 5: 22T4	P 6: 23T2	P 7: 23T3	P 8: 3T1	P 9: 3T12	P10: 3T14	P11: 3T16	P12: 3T17	P13: 3T19	P14: 3T20	P15: 3T3	P16: 3T4	P17: 3T6	P18: 3T9	TOT
Awareness	7	13	7	8	8	10	18	5	3	5	9	1	1	2	19	8	8	6	138
Behaviour changes	12	12	2	4	0	2	4	2	6	3	12	5	2	3	12	3	4	9	97
Comfort	3	3	1	11	12	8	2	0	1	1	5	1	0	0	8	1	4	0	61
Efficiency planning	1	1	1	1	3	1	0	2	3	5	6	0	0	0	0	0	0	2	26
Financial motivation and incentives	8	2	0	6	5	17	1	1	2	2	3	3	1	4	0	0	1	1	57
Folk knowledge	1	1	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	6
Gender roles interaction	0	2	0	9	6	8	3	0	0	8	10	1	0	3	0	1	0	1	52
Need: information-based feedback and support	5	3	4	3	7	8	1	3	0	2	2	1	3	1	9	1	1	7	61
Role player identification	8	10	2	1	3	18	5	0	3	0	0	0	3	0	10	7	2	8	80
Self and values	4	6	14	10	10	4	9	1	0	4	5	0	0	0	25	5	3	2	102
Strategy	4	4	0	1	0	3	3	2	2	3	1	2	3	2	4	7	2	4	47
TOTALS:	53	57	31	54	54	79	47	16	21	33	53	14	13	16	87	34	25	40	727

Appendix H: Focus Group Themes, Codes and Quotation Count

Focus group themes and code list

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HU: backup of Focus group themes1
File: [C:\Users\Mathilda\Dropbox\PhD\Analysis\...\backup of Focus group themes1.hpr7]
Edited by: Super
Date/Time: 2013-10-24 12:14:51

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Code Family: Behaviour changes and planning
Created: 2012-05-24 10:53:24 (Super)
Comment:
References to changes in behaviour, routine behaviour, automated behaviour and energy efficiency practices and planned changes
Codes (21): [After feedback - behaviour change in place] [Alternative energy sources] [Behaviour change - visitors] [Eff- appliances are broken] [Eff- no equipment changes] [Eff - appliance use] [Eff - geyser use] [Eff - lights: CFL use] [Eff - lights: day night switches] [Eff - lights: switch off] [Eff - other strategies] [Eff is a temporary measure] [Eff planning - consideration no action] [Eff planning - cover swimming pool] [Eff planning - distant future] [Eff planning - geyser timer] [Eff planning - solar] [Feedback - behaviour change] [non-compliant behaviour] [Non-eff behaviour] [Routine env behaviour]
Quotation(s): 97

____

Code Family: Comfort
Created: 2012-05-24 10:57:16 (Super)
Comment:
Lifestyle choices and the need for comfort including consumption patterns and recycling behaviour
Codes (9): [CFL - expensive] [CFL - light quality issues] [Comfort - convenience] [Comfort - important] [Comfort - outside lighting] [Lifestyle decision] [Routine env behaviour] [Solar -ROI] [Solar is a luxury]
Quotation(s): 50

____

Code Family: Family response
Created: 2012-05-23 12:01:51 (Super)
Comment:
References to the responses of the family (and broader) as perceived by the research participant
Codes (31): [Actions have no impact] [Adult children] [Already aware] [Awareness increase is important] [Doubtful impact] [Educate children] [Educate others] [Education] [Education - teenagers] [Eff is a temporary measure] [Emotion: load shedding and community drives are an irritation] [Family - uninterested] [Family response - insane] [Family use of electricity] [Feedback - exciting gadget] [Feedback - fill information gap] [Feedback - highly visible] [Feedback - interesting] [Feedback - miss when it is gone] [GCC - scary] [Individual efforts vs authorities' efforts]

[Interaction with neighbours/friends/family] [Limited ability as an individual] [Motivation for participation - efficiency] [Motivation for participation - understand impact on environment] [No expectation of others to change] [Perception - most people are ignorant] [Shared family responsibility] [Shared family views] [Small children - understanding] [social obligation]
Quotation(s): 139

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Code Family: Female as implementer
Created: 2012-05-23 11:36:18 (Super)
Comment:
Identification and definition of roles within a household, as defined by the interviewees in terms of gender roles.
Codes (7): [Conflict - electricity behaviour] [Driver of action] [Female: responsible for action] [Husband - financially motivated] [Husband - pays bills] [Husband wife interaction] [Wife: not responsible for electricity behaviour]
Quotation(s): 37

____

Code Family: Folk knowledge
Created: 2012-05-24 11:33:50 (Super)
Comment:
Folk Knowledge generally accepted amongst the interviewees, but scientifically disproven
Codes (3): [Myth - geyser is too old to put off] [Myth - geyser timer is ineffective] [Myth - heat pump]
Quotation(s): 7

____

Code Family: Need for guidance
Created: 2012-05-24 10:42:47 (Super)
Comment:
Expressed need for guidance and a sense of leadership, not necessarily information focussed
Codes (14): [Desire for personalized energy advice] [Desire to understand] [disappointed by lack of interest] [Distrust - product quality] [Distrust in sales people] [Feedback - monitor complicated] [Hawthorne effect] [Illiterate] [impact of the researcher] [Ineffective research communication] [No time to participate] [No understanding of the research process] [No value in interaction] [Recycling - need to be more structured]
Quotation(s): 37

____

Code Family: Need for information
Created: 2012-05-24 10:42:31 (Super)
Comment:
Expressed need for information, based on facts and providing a basis for action, including monetary information, price based information, and recognition for electricity savings achieved.
Codes (12): [Expressed need - consistent billing] [Expressed need - feedback on responsible use] [Feedback - saw the difference] [High cost of electricity] [Husband - financially motivated] [Husband - pays bills] [importance of energy efficiency] [Incentives as primary driver] [Motivation for participation - costs savings] [Motivation for participation - curiosity] [Motivation for participation - efficiency] [Solar -ROI]
Quotation(s): 38

Code Family: Perceived responsibility: from individual to authorities
Created: 2012-05-23 12:15:38 (Super)
Comment:
Participants' perceptions around responsibility ranging from the individual and the household to societal structures and governmental structures.
Codes (19): [Distrust – product quality] [Distrust authorities] [Each person can make a difference] [Earth is valuable] [Emotion: load shedding and community drives are an irritation] [External forces – community drives] [Individual efforts vs authorities' efforts] [Passionate about change] [Personal responsibility] [Resource eff – water] [Self – discipline] [Self – environmentally conscious] [Self – uninformed about electricity] [Self education] [socio-economic issues] [Spiritual responsibility] [Strategy – Mutual dependence] [Trust in government and municipalities] [Value – use resources sparingly]
Quotation(s): 76

____

Code Family: Strategy
Created: 2012-05-24 11:45:00 (Super)
Comment:
Specific strategies employed by the participants in this research to coerce family members to participate in energy efficiency behaviour in the household.
Codes (9): [Motivation for participation – recommended by trusted party] [Strategy – authoritative instruction] [Strategy – communication] [Strategy – no communication] [Strategy – plan/schedule use] [Strategy – reminders] [Strategy – spread the word] [Strategy – written rules] [Strategy –children involved]
Quotation(s): 27

Focus group code count in each theme
Code-Filter: All [117] PD-Filter: All [5] Quotation-Filter: All [451]

	P19: Garsfontein	P20: Garsfontein	P21: Mamelodi	P22: Menlopark	P23: Menlopark	TOTALS
Behaviour changes and planning	15	24	7	16	35	97
Comfort	9	25	0	3	13	50
Family response	24	37	17	25	36	139
Female as implementer	4	6	3	16	8	37
Folk knowledge	0	6	0	0	1	7
Need for guidance	1	5	24	5	2	37
Need for information	4	11	9	3	11	38
Perceived responsibility: from individual to authorities	11	24	10	6	25	76
Strategy	5	9	9	0	4	27
TOTALS:	73	147	79	74	135	508

Appendix I: Summary of Quantitative Data per LSM Group

Summaries by LSM level 6-9

Mathilda du Preez T11079 8 March 2012

LSM 6-9 household energy data including new variables - summary statistics

The MEANS Procedure

Variable	N	Mean	Std Dev	Median	Minimum	Maximum
Age	13	44.61538	10.8208014	47	28	62
Adults	13	3.461539	1.7614097	3	1	7
Children	13	2.076923	2.5645512	2	0	9
Livingrooms	13	1.307692	0.4803845	1	1	2
Bedrooms	13	3.076923	1.255756	3	2	6
Bathrooms	13	1.076923	0.4935481	1	0	2
TVs	13	1.307692	0.6304252	1	1	3
HiFiDVD	13	0.692308	0.4803845	1	0	1
Computers	13	0.230769	0.438529	0	0	1
Heaters	13	0.153846	0.3755338	0	0	1
Geysers	13	0.846154	0.5547002	1	0	2
Week1	13	18.54154	12.7877721	14.4	6.8	51.39
Week2	13	18.04769	15.8936461	13.66	5.94	65.11
Week3	13	18.96769	16.5736886	13.96	5.03	66.6
NWeek1	13	2.361539	1.7475976	2.2	0.36	7.56
NWeek2	13	2.465385	2.6416555	1.9	0.37	10.74
NWeek3	13	2.693846	3.2373177	1.9	0.39	13.06
AppCount	13	8.461539	1.7134461	9	6	11
NewRatio	13	0.355128	0.2642586	0.3333333	0	0.75
HeadCount	13	5.538462	4.0746244	5	1	16
AvgUse	13	18.51897	14.9574707	14.0066667	5.9233333	61.0333333
PerCapitaUse	13	4.682643	3.3021338	3.03	0.7404167	10.1722222
PNightUse1	13	14.29604	7.2012662	13.1322094	2.6200873	26.5588915
PNightUse2	13	14.22876	6.4939914	15.2207002	2.3241206	26.7716535
PNightUse3	13	14.54428	8.0940454	12.9440588	3.4223706	30.9589041

Summaries by LSM level 10						
Mathilda du Preez T11079 8 March 2012						
LSM 10 household energy data including new variables – summary statistics						
The MEANS Procedure						
Variable	**N**	**Mean**	**Std Dev**	**Median**	**Minimum**	**Maximum**
Age	23	50.21739	10.565624	51	27	69
Adults	23	3	1.4142136	3	1	7
Children	23	0.73913	0.9637706	0	0	3
Livingrooms	23	2.217391	0.6712622	2	1	3
Bedrooms	23	3.782609	1.2415724	4	2	6
Bathrooms	23	2.347826	0.7751068	2	1	4
TVs	23	1.652174	0.7751068	2	1	4
HiFiDVD	23	1.826087	1.3366231	1	0	5
Computers	23	1.391304	0.8387832	1	0	4
Heaters	23	0.913044	1.7032868	0	0	6
Geysers	23	1.608696	0.6563764	2	1	3
Week1	23	32.39435	14.2558982	35.36	6.3	52.89
Week2	23	31.74652	14.203695	28.86	7.2	55.38
Week3	23	34.35522	16.1938234	40.17	5.43	59.98
NWeek1	23	5.810435	2.7285452	6.22	0.95	9.9
NWeek2	23	5.481739	2.4646015	5.9	0.85	8.94
NWeek3	23	6.159565	2.9377194	6.34	0.84	11
AppCount	23	15.86957	4.3437975	16	10	27
NewRatio	23	0.448085	0.2322965	0.5	0	1
HeadCount	23	3.73913	1.7113894	4	1	7
AvgUse	23	32.83203	14.539952	38.96	6.31	55.81
PerCapitaUse	23	9.546294	4.0373078	9.9116667	2.3011111	19.48
PNightUse1	23	17.84858	3.7082076	16.657213	12.3465211	26.9614218
PNightUse2	23	17.53674	5.1688711	17.183827	8.8851635	28.9572393
PNightUse3	23	18.18073	4.1759539	17.651349	10.8804745	25.9445844

Appendix J: Historical Weather Data

Comp#	**Station Name**	**Latitude**	**Longitude**	**Altitude**									
30164	PRETORIA - ARCADIA	-25.73857	28.20733	1400									
MAXIMUM TEMPERATURES [°C]													
Year	Jan	Feb	Mar	Apl	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1999	--	--	--	--	--	--	--	--	--	27	28.47	26.75	27.4
2000	25.16	25.59	25.29	22.39	20.07	--	--	--	25.79	26.33	25.11	26.06	24.64
2004	--	--	--	--	--	--	--	--	25.24	27.67	29.76	27.6	27.56
2005	28.07	29.1	26.86	22.85	22.76	21.38	20.93	23.47	28.56	29.28	28	28.07	25.78
2006	26.58	26.44	25.63	--	--	--	--	20.4	25.84	28.84	27.52	29.51	26.35
2007	29.51	30.87	28.95	25.17	22.01	18.62	18.73	21.97	27.51	23.53	26.47	26.15	24.96
2008	25.25	27.95	25.09	23.3	21.29	19.46	18.91	23.05	26	28.34	28.91	28.62	24.68
2009	27.52	26.67	26.11	24.75	20.92	19.22	17.19	21.14	26.17	26.42	25.72	27.57	24.12
2010	26.93	28.14	27.43	22.57	22.14	18.66	18.65	22.37	26.96	28.79	27.31	27.1	24.75
2011	26.22	26.96	27.68	21.87	20.86	18.24	17.67	21.05	26.28	27.03	27.88	26.8	24.05
2012	28.59	29.1	27.27	23.41	--	--	--	--	--	--	--	--	27.09
AVERAGE	27.09	27.87	26.7	23.29	21.44	19.26	18.68	21.92	26.48	27.32	27.51	27.42	~~~

MINIMUM TEMPERATURES [°C]													
Year	Jan	Feb	Mar	Apl	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1999	--	--	--	--	--	--	--	--	--	13.5	16.26	16.54	15.43
2000	15.6	16.87	16.45	12.03	7.96	--	--	--	12.89	14.31	14	16.34	14.05
2004	--	--	--	--	--	--	--	--	12.43	14.79	17.06	16.88	15.29
2005	17.46	17.76	15.5	13.07	10.22	8.19	6.89	11.08	13.92	15.33	15.97	16.23	13.47
2006	17.7	17.62	15.12	--	--	--	--	7.7	11.48	15.78	15.6	17.65	14.83
2007	17.15	17.9	16.61	13.6	8.3	6.48	5.52	8.38	14.5	13.3	15.81	15.81	12.78
2008	16.9	17.06	15.15	11.37	9.91	6.98	6.39	9.77	11.49	15.56	17.42	17.19	12.93
2009	18.07	16.91	15.5	12.72	10	7.74	4.62	8.12	13.15	15.14	14.96	16.22	12.76
2010	17.61	17.34	16.73	14.04	10.25	5.46	7.16	8.3	12.75	15.3	15.84	16.4	13.1
2011	17.16	16.83	16.82	13.36	9.53	5.16	5.14	7.57	12.59	14.28	16.16	17.06	12.64
2012	17.33	18.24	16.2	12.03	--	--	--	--	--	--	--	--	15.95
AVERAGE	17.22	17.39	16.01	12.78	9.45	6.67	5.95	8.7	12.8	14.73	15.91	16.63	~~~