The Influence of Home Energy Management Systems on the Behaviours of Residential Electricity Consumers: An Ontario, Canada Case Study

by

Jeremy Schembri

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis including any required final revisions, as accepted by my examiners.

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Abstract

The current state of Ontario's electricity system and natural environment has prompted the provincial government to call for the province to adopt a 'culture of conservation.' Answering this call will involve the promotion of a variety of solutions. Included in that will be the use of information and communication technology, which encompasses technologies such as home energy management system (HEMS). It is believed that the feedback and home automation features of the HEMS will enable its users to alter their electricity consumption behaviours, via net reductions and/or load shifting. This study has assessed the ability of HEMS to encourage reduction in total and on-peak electricity consumption while in a time-of-use pricing environment. Additional focus was on which consumers had the greatest success using the HEMS to adopt electricity conservation behaviours. Two hundred and sixteen participants of a Milton, Ontario HEMS pilot study were chosen to take part in this case study. These participants were divided into two equal groups: a sample group, those who received a HEMS, and a control group, those who did not receive a HEMS. Participants from both groups were asked to complete two surveys and allow their electricity consumption data to be analyzed. The initial survey was to establish some baseline information about the participants. The second survey was designed to determine if changes had occurred in the household since the initial baseline survey. Through the analysis of the survey and households electricity consumption data, conclusions were drawn on how participants used the HEMS. The study had a 2.9% relative reduction in total electricity consumption and a 13.2% relative reduction in on-peak electricity consumption. However, additional analysis of the results revealed promising findings with regard to the HEMS ability to catalyze conservation and demand management among recent time-of-use pricing adopters.

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Table of Contents

List of Figures

List of Tables

Acronyms

CDM	Conservation and Demand Management
EIA	Energy Information Administration
GDP	Gross Domestic Production
HVAC	Heating, Ventilation, and Air Conditioning Systems
HANS	Home Area Network Systems
HEMS	Home Energy Management Systems
ICT	Information and Communication Technologies
LCD	Local Distribution Company
OPA	Ontario Power Authority
PNNL	Pacific Northwest National Laboratory
RPP	Regulated Pricing Plan
RFP	Request for Proposals
TOU	Time-of-Use

Chapter 1-Introduction

Section 1.1- Electricity Conservation in Ontario

The importance of electricity conservation became abundantly clear to most Ontarians on August 14, 2003, when Ontario and a number of Northeastern States were victims of an international electricity blackout. The blackout left fifty million people without power (Kelly 2006). It cost Canadian businesses 18.9 million work hours, resulting in a 0.7% reduction in August's gross domestic production (GDP), and many workers receiving no compensation for lost wages (Mackie and Campbell 2004). It also required the importation of expensive out of province electricity. These monetary losses helped put the reliability of Ontario's energy system on the political agenda. Concern surrounds on-peak demand periods when the current system does not have the capacity to provide the required electricity, forcing the province to import additional energy (Faruqui et al. 2007). As a result, the Ontario government has called for a 'culture of conservation', with the hope that changes in Ontarians' behaviours and attitudes may reduce on-peak and total electricity consumption.

Rising concern for the environment is another reason for the promotion of a 'culture of conservation'. Air pollution and climate change are on the minds of many Ontarians (Neuman 2007). These concerns are closely linked with the consumption of electricity. By 2004 Canada's electricity generation greenhouse gas emissions had risen by 28.5% from 1990 levels (NRCan 2006). Ontario's electricity generation is the second largest source of sulphur dioxide and the third largest source of nitrogen oxides in the province. Both air pollutants are renowned for the damage they inflict on human's health and on the environment (MOE 2001). These are all problems that can begin to be addressed through reductions in electricity use (Stern 1992).

To address these concerns, the Government of Ontario has placed increased emphasis on electricity conservation strategies. These strategies include the promotion of conservation behaviour, efficiency measures, demand management, fuel switching, and cogeneration. It is argued that these approaches are: 'cost effective ways to meet energy needs, crucial for the future of the environment, will assist with provincial and local prosperity, and will require the participation and leadership of all sectors in society' (CB 2007:6). With these messages in mind, the Ontario government, with the cooperation of the Ontario Power Authority, implemented the following residential conservation programs: Every Kilowatt Counts, Summer Savings, Cool Savings Rebate, the Refrigerator Roundup, and peaksavers (OPA 2008a).

Smart meters are another initiative put in place by the Ontario government to help the province reduce its on-peak electricity demand. This initiative involves having the entire Ontario population wired through smart meters by 2010 (OFGEM 2006). It is believed that the additional information provided through the smart meter will allow consumers to make educated decisions regarding their electricity consumption, with the hope that curtailment and/or load shifting will ensue.

One of the primary focuses of the smart meters initiative is residential electricity consumption. Some critics have argued that the focus should be primarily on the institutional and commercial sector and that the residential sector is not the problem (Stern 2000). However, the residential sector is responsible for 33% of Ontario's total electricity consumption; therefore ignoring its potential for electricity conservation would be ill advised (CB 2008).

It is also important to encourage conservation within the residential sector because of potential beneficial spin offs. If adopted within this sector, conservation can become a norm within society. This could lead to residential consumers demanding conservation within the industrial and commercial sectors. These demands will be made through the purchasing power and democratic clout of residential consumers (Stern 1992). There is also the potential for residential electricity consumers to adopt new consumption behaviours in the home and bring them to work (Katzev and Johnson 1987). This infiltration of electricity conservation is another way conservation can be encouraged in the commercial and industrial sectors via the residential sector.

As concern for the environment rises, domestic electricity consumption will be an area that will be increasingly looked upon to address environmental problems. This is because domestic electricity consumption is an action where the relationship between environmental problems and individual behaviours are identifiable (Poortinga et al. 2004, Brandon and Lewis 1999). However, this relationship requires further research, with specific attention to the underlying determinants of energy use and energy-related behaviours (Abrahamse et al. 2005).

In order to empower residential consumers and give them the means necessary for change they must become better informed about their electricity use. Electricity consumption is invisible to most consumers. There is little knowledge about how their electricity is being consumed or how this consumption affects their lives (Darby 2006). Academics like Fischer (2007), Darby (2006), and Abrahamse et al. (2005) feel that supplying consumers with electricity consumption feedback is one way that this can be addressed. This feedback can be provided in a variety of ways, but one way that is becoming increasingly popular is the use of in-home displays. Advanced in-home displays can provide consumers with real time updates on the amount of electricity a household is consuming, and how that may affect their lives. It is hypothesized that this information could be put to greater use if the in-home display was part of a home energy management system (HEMS). Home energy management systems, also referred to as home area network systems (HANS), are information and communication technologies (ICT) that educate electricity consumers through the provision of their electricity consumption feedback. The system also enables consumers through the system's automated control of the household's thermostat, pool pump, lighting, and select household appliances and electronics. This is done through the system's web portal that can be accessed at home or remotely through most online devices. Wilson and Dowlatabadi (2007) argue that technological advances like these will help address the 'energy efficiency gap' in society. This gap occurs when potential energy savings are not achieved due to society's failure to adopt appropriate technologies. According to Green and Marvin (1994), this gap could be closed if increased attention was given to the potential for ICT to address environmental problems like those surrounding energy issues. Gronli and Livik (2001) call for additional research to be carried out in this research area with increased focus on the potential of the aforementioned technology to catalyze electricity conservation.

Section 1.2- Study Purpose

This study will explore the influence that a HEMS may have on residential electricity consumption behaviour. Focus will be on the effect of feedback information provided through HEMS. Further analysis will be completed to determine if a synergy of the HEMS's feedback and automation features assisted participants in achieving electricity conservation behaviours. The correlation between feedback and action will be reviewed under the lens of a variety of behavioural theories. The objective is to assess the ability of HEMS to promote conservation and demand management. Conclusions reached in this study will be based on an analysis of metered residential electricity consumption and the results of the study's multiple surveys.

Section 1.3- Research Question

To reach the previously mentioned conclusions the following question must be asked: 'Do home energy management systems influence the total and on-peak electricity consumption behaviours of participating households in Milton, Ontario?' This research will assess the ability of technology to empower individuals by providing education about electricity consumption, an interface to view electricity consumption habits, and enhanced control over their use of electricity. This will help determine if the synergy of these interventions can assist in altering household electricity consumption, resulting in reductions in total and/or on-peak electricity use.

Section 1.4- Boundaries of Study

This case study will take place in the town of Milton, Ontario. Milton is 55 kilometers west of Toronto. It is located near the convergence of the 401, 407, and 403 highways. These highways are the arterial routes for Milton's 53,939 residents, a population that has seen a 71.4 % increase in the past five years (Raymaker 2007). Due to this rapid growth, many of the town's homes are found in newly developed subdivisions.

With this population explosion it is important for the town's public officials to be cognizant of reducing the environmental impacts associated with growth. This forward thinking is evident among the executives of Milton Hydro Inc. Milton Hydro Inc. was one of the first local distribution companies (LDCs) in the province to provide its customers with smart metering technology. This allowed their customers to take advantage of the incoming provincial time-of-use (TOU) regulated pricing plan (RPP). They also chose to use HEMS technology, the Direct Energy Smart Home Energy Conservation System, to assist them in performing their ‘peaksavers’ program obligations.

The presence of a TOU RPP, along with a progressive LDC, and a HEMS pilot, were the main criteria when selecting Milton as the case study site. Within this case study the unit of analysis was the household. The primary unit of data acquisition was the household’s energy manager. They were responsible for providing pertinent information via the study’s online surveys.

This study began in August 2007 and ended in January 2008. During this time participant’s electricity consumption behaviours were studied. The study included a control group to isolate internal and external variables that may influence electricity consumption (Miller and Salkind 2002). By controlling for these variables it became increasingly feasible to draw conclusions about the potential for HEMS to alter residential electricity consumption behaviours.

Section 1.5- Target Audience

The potential of a conservation and demand management (CDM) approach created by combining technology with behavioural theories is a concept that would be of interest to a variety of actors. Among these actors are officials from Canada’s federal and provincial governments. Both orders of government are in search of ways to reduce electricity consumption. Therefore, the potential successes of the HEMS could have implications as they go forward creating CDM energy policy. Since the provinces have jurisdiction over energy related issues they will likely have an increased interest in this study’s findings. This study will take place in Ontario, so it is likely that the Ontario government will be among the most interested provinces. Due to their responsibility of overseeing government initiated energy policies and programs, an organization like the Ontario Power Authority (OPA) would also be part of the study’s target audience. Other Ontario LDCs designing future CDM programs will likely take an interest in this study, along with LDCs in the United States that have become increasingly interested in the role HEMS may have in future Smart Grids. Lastly, the study's key stakeholders, Bell Canada Enterprise Inc., Direct Energy Ltd, and Milton Hydro Inc, have a vested interest in this study and its results.

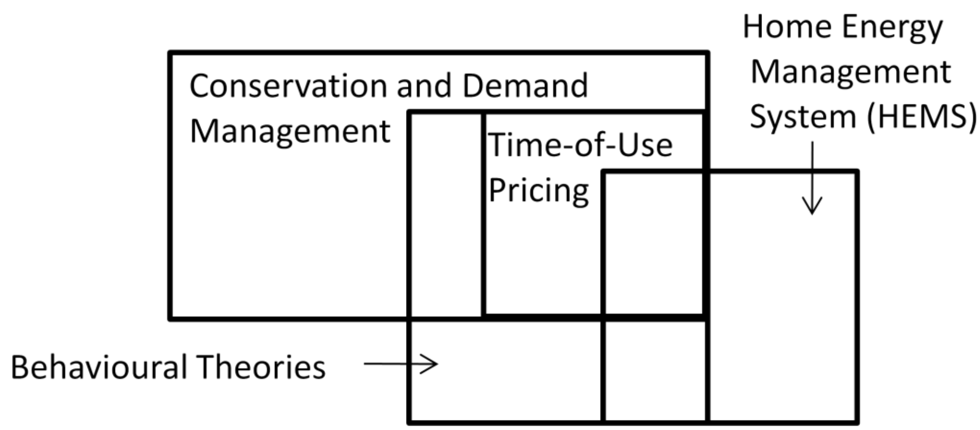
In addition to CDM, academics interested in behavioural change and the potential of behavioural theories such as feedback theory may be interested in the findings of this study.

The remainder of this thesis will consist of a Literature Review, a Methodology, a Results, a Discussion, and a Conclusion chapter. The literature review chapter 2, entitled 'Conservation with HEMS', will provide an overview of relevant concepts and theories that will assist in justifying decisions made in the methodology and discussion chapters, and substantiate conclusions drawn in the final chapter. The methodology chapter 3 will provide details about the approach and processes that were involved in the research design with the hopes of providing added credibility to the study's findings. The results chapter 4 will present the findings of the studies' multiple methods of inquiry. The findings presented in the results chapter 4 will provide the foundation for the analysis that will be completed in the discussion chapter 5. In the final chapter 6, the responses to the study's research question will be presented; in the light of these results, relevant theories will be critiqued and recommendations for future research will be offered. The end goal being the exploration of the many unknowns associated with HEMS and their relationship with behavioural research.

Chapter 2- Conservation with Home Energy Management Systems

The following literature review is intended to enhance the understanding of the concepts and theories that underlie the purpose and objective of this study and are the foundation of the study's hypothesis and conclusions. The following conceptual framework (see Figure 2.1) was created to present the ideas and concepts of this research and guide the development of this chapter.

Figure 2.1- Home Energy Management System Conceptual Framework



As stated in the introduction, the purpose of this study is to determine if HEMS can encourage electricity conservation through reducing and shifting electricity consumption. With conservation and demand management being the foundation of this study this chapter begins with Sections 2.1 and 2.2, the former providing an overview of the history of the Ontario power sector and the latter provides an outlook on the future of Ontario's energy policy. With a key goal of Ontario's current energy policy being a 'culture of conservation', Section 2.3 briefly discusses what would be required to achieve this goal. Recognizing that the achievement of Ontario's conservation initiatives requires changes in Ontarians' behaviours and attitudes, Section 2.4 covers the many variables - contextual, personal, and external - that may influence an individual's electricity consumption behaviour. Having established what variables may influence electricity conservation, Section 2.5 provides additional details about the conservation behaviours popular among residential consumers. With the hypothesis that HEMS can assist consumers with electricity conservation, the next sections discuss the prerequisites and components of HEMS technology, Section 2.6 addresses smart metering technology, Section 2.7 in-home displays, and Section 2.8 has an extensive review of the functions and merits of feedback. Leading into Section 2.9, an overview of the value of HEMS technology and the current path the technology has taken are presented. The chapter's final section, Section 2.10, will highlight areas in the literature where additional research is required and what this study intends to address.

Section 2.1- Why Conservation?

Conservation and demand management (CDM) is a primary component of this study's conceptual framework (see Figure 2.1). Therefore, it is important to understand the role of CDM in Ontario's previous and future energy policies. The promotion of electricity conservation had not been a primary concern in Ontario for the past century, but in the advent of twenty-first century it became apparent that the electricity provision practices that had been promoted in the past were becoming increasingly inappropriate (Duncan 2005). These practices have been described by some as 'hard path' approaches (Lovins 1976). This was a path dependent on fossil fuels and the development of infrastructure on a massive scale (Lovins 1976). In Ontario, it began with a reliance on hydropower and imported coal (Nelles 1974). By the middle of the 20th century hydropower production had grown significantly and coal was being replaced with nuclear energy (Nelles 1974). These energy sources came with high ecological and financial costs. The burning of fossil fuels emits harmful greenhouse gases contributing to global climate change, and toxic particulates causing ground level ozone and the associated negative health effects. Hydro dams require the large scale flooding of areas causing harm to the flooded and surrounding ecological and social environments. Nuclear power generation has high financial costs and uncertainties due to the difficult disposal of its radioactive waste (Hill 2004).

Section 2.2- Direction of Ontario Energy Policy

The Ontario government is now recognizing that the hard path it has taken for many years is leading the province in the wrong direction. As Ontario faces the potential of future electricity crisis, there has been an increased effort to put the province on the ‘right path’, one consisting of the increased use of conservation and renewable energy (Duncan 2005).

Ontario’s electricity generation mix in 2007 was 51% nuclear power, 28% hydro-power, 14% coal power, and 7% from other sources including alternative energy sources (IESO 2008). The Government of Ontario has put forward a plan that they believe will increase the proportion of alternative electricity production to 10% by 2010 (Ministry of Energy 2007a). This required a series of Request for Proposals (RFPs) that led to the development of 12 wind projects, three hydro projects, two landfill gas projects, and one biogas project (Ministry of Energy 2007b). This plan also involves net metering and standard offer contracts. Net metering will allow all Ontarian customers that produce less than 500 KW of electricity through renewable sources to sell their excess electricity back to the grid at a premium rate offered through Ontario’s standard offer contract program (OPA and OEB 2006)

The promotion of renewable electricity is a supply-side solution that has made a lot of technological and social progress over recent years. However, some critics still argue that these solutions are currently limited by their relatively high monetary costs and poor reliability (Adams 2006). Having considered the potential and limitations of renewable electricity it has been hypothesized that by 2020 Ontario could be producing 32000 GWh of energy annually through low-impact renewables. However, it is estimated that this will be 25000 GWh less than what the Ontario population will require (Winfield et al. 2004). It is believed that this is a gap that can be addressed through the promotion of conservation behaviours. Recognizing the potential of electricity conservation, the Ontario government has further diversified its approach to addressing the province’s electricity concerns by increasing its emphasis on CDM. (These approaches will be elaborated further in upcoming sections.) The Ontario government believes that through the promotion of CDM it will be able to reduce the province’s total demand for electricity by 1,350 MW by the end of 2010, and an additional 3,600 MW reduction between 2010 and 2025 (OPA 2006).

Section 2.3- Achieving a 'Culture of Conservation'

To achieve and exceed the Ontario government's conservation targets and adopt a 'culture of conservation', Ontarians must begin to evaluate and change their current consumptive lifestyles. (Lifestyle is defined as the 'product of the fundamental values and norms manifested in [economic, demographic, social] frames' (Nielsen 1993:1136).) Based on the experience of the environmental movement these changes come in waves (Carter 2001). Gladwell (2000) argues that change is the result of an accumulation of events that lead to a tipping point or paradigm shift. Due to their relatively short existence, waves of environmental consciousness should not be mistaken for paradigm shifts. Paradigm shifts are responsible for lasting change evolving into social norms (Kuhn 1996). It has been argued that the promotion of social norms to encourage energy conservation has been underutilized (Griskevicius et al. 2008). The influence of social norms on behaviours has been made evident in a number of behavioural studies ranging from littering and recycling to helping the poor and smoking among youths (Griskevicius et al. 2008, Gladwell 2000, Sunstein 1998). When behaviors are viewed to be the norm, people's attitudes will adjust appropriately (Sunstein 1998). However, the expediency and success that individuals have in adopting these behaviours can be subject to the influences of a variety of variables.

Section 2.4- Determinants of Electricity Conservation Behaviours

Electricity conservation is a goal strived for by Ontario policy makers, generators, distributors, and consumers. Electricity conservation involves the reduction or shift in electricity consumption. To allow for improved conservation it is important to understand the influence that different variables may have on this behaviour. These variables can have an influence of conservation, and more specifically the use of TOU pricing and HEMS, as presented in the study's conceptual framework (see Figure 2.1). There have been a variety of studies completed in this area, yet a consensus on the determinants of electricity use has not been attained.

The determinants of electricity conservation are often categorized according to similarities (NRC 2005). How they are grouped and categorized has been a process that has evolved over the past 30 years. Black et al.'s (1985) Causal Model has been a popular guideline for this process of categorization. In designing the Causal Model Black et al. (1985) created a simple framework for categorizing variables that may influence electricity use. The model divides the variables into two groups, contextual variables and personal variables. Contextual variables include demographic, economic, and structural variables, whereas, personal variables are attitudes, beliefs, and norms. This set the framework for academics in following years to create similar approaches- for example Nielsen (1993), Lutzenhiser (2002), and Gatersblein et al. (2002). The Causal Model's method of categorization will be used for the remainder of this section as a framework to communicate the findings of other electricity conservation studies.

2.4.1- Contextual Variables

As mentioned, the first of the two variable categories in the Causal Model are contextual variables (Black et al. 1985). This category includes all variables found in the social, economic, and physical environments in which electricity consumption occurs (Black et al. 1985).

Contextual variables such as a household's structural items can be viewed as the limiting agent of conservation. If a person has a large house or three fridges it becomes difficult for them to conserve electricity, even with the best of intentions. Generally the findings have been that the larger the home, the greater the electricity consumption (Nielsen 1993, Stern 1992).

Like the size of the home, the home's age is another contextual variable that can influence the household's electricity conservation. For instance Brandon and Lewis (1999) found that older homes are less energy efficient due to poor insulation and design. To offset the inefficiencies that may be associated with older homes, upgrades and renovations are often promoted. The presence of upgrades and renovations are another example of contextual variables that can influence household electricity use. Examples include, but are not limited to, upgrading the home's insulation, and purchasing energy efficient heating, ventilation, and air conditioning systems (HVAC) and appliances. However, it is possible that upgrades like those mentioned can produce outcomes opposite to the intended results due to consumers' misunderstanding and overestimating the potential of upgrades.

Worldwide investments in appliances and electronics are at unprecedented levels (Atanasliu et al. 2007, Roth and McKenny 2007). The electricity consumption of small appliances and electronics within Canadian homes has increased 71% from 1990 levels (NRCan 2006). This can be explained partly by lower prices and increased availability of these units, but may also be the result of a rebound effect (NRCan 2006, Wirl and Orasch 1998). The 'rebound effect' occurs when owners of energy efficient technology over-estimate its conservation value. This leads to increased consumption in other areas, such as purchasing additional appliances and electronics or high consuming appliances like LCDs or plasma TVs (Atanasiu et al. 2007, Roth and McKenny 2007). It can also result in increased use of electricity consuming electronics and appliances. For instance, Canadian's use of electricity for lighting is now 40% higher than 1990's levels (NRCan 2006). These findings demonstrate that along with the type of appliance and electronics, the number of appliances and electronics, and their frequency of use, can influence the household's ability to conserve.

In addition to the number of electronics and appliances in the home, the number of household occupants can also be a contextual determinant of electricity conservation. There are those who argue that as the number of occupants in a household increases so does the home's electricity consumption. This is associated with the increased use of appliances and electronics, size of home, and presence of occupants (Nielsen 1993). Yet, there are those, like Schipper (1997) who argue that electricity consumption decreases with increased occupancy. This reasoning is based on evaluating consumption on a per capita basis. For instance, the primary consuming unit of electricity in the home is the heating (if powered by electricity) and air conditioning systems (Abrahamse et al. 2005). Therefore, if a home has only two occupants it is likely that their electricity consumption per person will be higher than a household with additional occupants. Schipper (1997) also argues that not only does the number of occupants matter, but so does their age, noting that homes with young children on average have improved conservation success when compared to families with older children.

A large amount of research has been done examining the relationship between an individual's age and their likelihood to conserve electricity. Often age has been categorized subjectively, with the 'young' cohort being under 50 years, the 'older' cohort being 50 years and older (Stern 1992). There are many academics who believe younger individuals are most likely to conserve electricity (Uitdenbogerd 2007, Staats et al. 2004, Straughan and Roberts 1999, Dietz et al. 1998). Straughan and Roberts (1999) believe that this is the result of younger generations growing up in a time when the environment was a more salient issue, the exception being those who kept the conservation attitudes and behaviours developed living during the Depression. Uitdenbogerd (2007) attributes an unwillingness to change as to why older individuals do not typically conserve electricity. This unwillingness to change may also explain why those born during the Depression maintain their conservation practices. Schipper (1997) notes that it may not be an unwillingness to change, but rather the lifestyle of an older individual that results in an inability to conserve. Some older individuals may spend extended periods of time at home. Others require certain household temperature settings to maintain their health. However, there remain those who believe that an individual's age and household electricity use have no correlation and that other variables must be considered (Gatersleben et al. 2002).

One of the other variables that Gatersleben et al. (2002) were referring to was total household income. Many researchers have concluded that the greater the income the greater the potential for electricity conservation (NRC 2005, Nielsen 1993). This is largely due to the relatively high level of electricity consumption occurring in the home prior to a particular conservation effort (Abrahamse et al. 2005, Gatersleben et al. 2002). Higher incomes may also lead to the household having expendable income to invest in conservation efforts (Straughan and Roberts 1999, Mackenzie-Mohr 1994). This tends not to be the case for lower income households that often have less income available to invest in electricity conservation and fewer motives to do so, due to the propensity of low income households to rent their homes (Brandon and Lewis 1999, Mackenzie-Mohr 1994). When renting a home the cost of utilities may be included in the rent and the tenant has no opportunity to receive a return on conservation investment when the home is sold.

As with the age of an individual, there is also debate over the relationship between gender and electricity conservation. According to Parker et al. (2005) gender is an irrelevant variable that is of little consequence for electricity conservation. Others have found that females are more likely to conserve when electricity conservation is related to environmental behaviours. According to Dietz et al. (1998) and Straughan and Roberts (1999) the relationship between gender and environmental issues like electricity conservation is ‘far from conclusive’. However, Straughan and Roberts (1999) concede that it is possible that women could have a heightened concern due to socially developed gender roles that result in women being more concerned for the well being of others. Still, there are those who believe that the behvaiours one gender exhibits over the other is irrelevant. They feel that one’s ability to conserve electricity is often limited by their knowledge and understanding of the behaviour.

Knowledge and understanding of electricity consumption and conservation has been argued to be the most influential determinant of electricity conservation. Knowledge of electricity use allows homeowners to conceptualize electricity consumption (Shove 1997). This is important because unlike many other resources electricity is difficult to visualize, making it difficult to conserve. Those with high levels of knowledge are more likely to have high levels of behavioural commitment towards conservation (Heberlein and Warriner 1983). Pre-existing knowledge of conservation also plays an important role in assisting interventions intended to address electricity consumption concerns (Dwyer et al. 1993, Stern 1992). Pharnell and Larsen (2005) claim that one’s knowledge and understanding of electricity conservation can be associated with one’s cognitive capacity. De Young (2000) refers to this as competence; he elaborates on this by saying that “knowing what they should do and why they should do it is not enough, they need to know how” (519). To assess cognitive capacity and competence researchers often make assumptions based on the highest level of education that an individual has attained (Black et al. 1985). The use of this technique can be supported by studies that have shown that there is a correlation between education and one’s willingness to sacrifice (Stern 1992). It has also been shown that those with higher levels of education are more likely to display electricity conservation (Uitdenbogerd 2007) and environmentally conscious behaviours (Faiers et al. 2007). However, Wood and Newborough (2003) believe that the potential of knowledge and understanding can be limited and may require different forms of intervention. The NRC (2005) also believes that the potential of knowledge can be limited depending on how it interacts with an individual's values and beliefs.

2.4.2- Personal Variables

Black et al.'s (1985) Causal Model defines personal variables as the values, norms and attitudes that encompass an individual. In energy research attitude has been referred to as 'those beliefs and values which are held by individual electricity users that influence their energy consumption decisions and behaviors.'(Heberlein and Warriner 1983:109). Attitude is believed to be strongly influenced by an individual's values (Poortinga et al. 2004, Stern 2000), values being the preference that is given to one thing over another (Oreg and Kratz 2006). They are the goals and standards that guide one through life (Poortinga et al. 2004). Helping guide these life goals and standards are social norms (Nielsen 1993). Social norms are 'the rules shared by a group for contextually bounded behaviour: they depend on the situation and the roles of the participants' (Maxwell 1999, 1000). Wilson and Dowlatabadi (2007) believe social norms are readily adopted when they are observable. They argue that this is an unfortunate reality for advocates of electricity conservation that is further complicated by electricity consumption being embedded in norms of comfort, cleanliness, and convenience. Maxwell (1999) argues that it is important not to confuse social norms with attitudes, for attitudes apply to everything, the evaluation of any psychological object (Ajzen and Fishbein 1980), whereas social norms only apply to specific behaviour. However, this should not discount the ability of social norms to influence one's attitude towards a particular behaviour. This is evident in studies that have shown that friends' and family's opinions of household electricity use can be indicative of the participant's attitude toward household electricity conservation (Stern 1992). Values are also distinct from attitudes in that they function as "an organized system and are typically viewed as the determinant of attitude" (Schultz and Zelenzy 1998:255). This line of reasoning is the basis for Stern and Dietz's (1994) value-basis theory.

The value-basis theory argues that one's attitude toward an object can also be indicative of that person's values. If people are aware that their behaviour is negatively affecting something that they value, the person is likely to change their attitude toward that particular action and subsequently change their behaviour (Stern and Dietz's 1994).

Schultz et al. (2005) use the value-basis theory to argue that values and not culture should be considered when trying to determine what influences peoples' attitudes.

The tenets of the value-basis theory have resulted in some academics arguing that the presence of positive environmental attitudes can be indicative of positive electricity conservation attitudes (Dietz et al. 1998, NRC 2005). Others feel that attitudes towards electricity conservation can be the result of potential monetary saving or fear of energy-reliability problems. The latter reasoning does not have any connection to environmental problems, thus, making it ill advised to focus on environmental attitudes when completing research in this area (Stern 1992, Schultz and Zelenzy 1998, Kaiser et. al 1999, cited in Gatersleben et al. 2002).

Along with values, self-perception can also have an influence on a person's attitude towards electricity conservation. It is important to consider the perception that one has of oneself within the energy picture (Brandon and Lewis 1999, Verhallen and van Raaij 1981). One common question to determine this is 'Are you doing all you can to conserve electricity?' (Neuman 2007). However, differing interpretations of this question can make responses misleading. A 'yes' response may indicate that the respondent is taking some actions but lacks the knowledge necessary to recognize that more can be done. The interpretation of a 'no' response can be even more complex. The respondent may be choosing not to take part in electricity conservation for a variety of reasons (the problem is too big for one person to solve, it is not their problem, conservation is not the answer, there is no need to conserve), or it may mean that they are conserving electricity, but are aware that more can be done (Neuman 2007).

2.4.3- External Variables

External variables are often responsible for consumers behaving uncharacteristically. Therefore, it is important to be aware of such variables when evaluating individual's electricity conservation efforts. One of the more popularly reviewed external variables in electricity conservation research is weather. The occurrence of abnormal weather patterns is out of an individual's control and may force them to increase their dependence on heating and air conditioning, thus, making electricity conservation difficult. However, if equipped with the proper tools and knowledge these are the conditions where the most impressive electricity conservation results can be achieved (Katzev and Johnson 1987). The price of electricity is another external variable that is believed to have an influence on electricity consumption. Proponents of rational economics argue that a person's decision to conserve electricity will be influenced by price. They believe that the decision consumers make will be based on what is in their economic self interest (Mckenzie-Mohr 1994). However, this theory is contested by those who feel the role of price is secondary to the comforts associated with individual electricity wants and needs (Nielsen 1993, Black et al. 1985). The media is another external variable that is believed to have an influence on electricity consumption. The manner in which the media chooses to portray electricity conservation can have an influence on societal norms and values, and therefore influence individual behaviours and attitudes (Wilson and Dowlatabadi 2007, Abrahamse et al. 2005). The media's stance is often related to current societal norms and political ideologies of the time. These are also external variables and should be considered when evaluating variables that influence electricity conservation.

Section 2.5- Conservation Behaviours

2.5.1- Curtailment and Efficiency

The act of reducing or shifting electricity consumption is a conservation behaviour change. For many residential consumers this takes the form of curtailment, which involves a decrease in the use of capital equipment (eg. furnace), or the form of efficiency, which involves substituting capital for electricity (eg. insulation to use the furnace less) (Black et al. 1985). Efficiency measures are often one time investments that come at a financial expense, but have the potential of future monetary savings with no direct effect on daily routines and comforts (Black et al. 1985). Curtailment requires participants to be willing to repeat behaviours. This may be dependent on the personal values and norms, and social support of family and friends. In some cases personal health or work schedule may prevent people from performing a particular curtailment activity such as turning down the heat or off the lights. Advocates of efficiency measures point to this as a reason curtailment is an inferior conservation behaviour (Black et al. 1985). They cite studies that have shown improved electricity conservation by insulating the home rather than turning down the thermostat (Gardner and Stern 2002). They believe that efficiency measures are also more likely to be maintained, while the 'fall-off effect' is more prevalent with curtailment because over time people can become disinterested in practicing this behaviour. However, proponents of curtailment note that there are no guarantees with efficiency measures. People with efficient technologies have been known to over-estimate its efficiency and over-consume and experience the previously discussed 'rebound effect' (Abrahamse et al. 2005, Dwyer et al. 1993). Successful electricity conservation is also dependent on one's motive to adopt efficiency practices. Rather than trying to reduce overall electricity consumption, some people look to efficiency to affordably increase capital use. (If a compact fluorescent bulb is twice as efficient as an incandescent bulb then it could become affordable to leave the lights on twice as long.) This problem does not occur with curtailment as it requires a sacrifice of amenities. Black et al. (1985) also note that the monetary costs associated with investing in efficiency limits the population that can afford to adopt such practices. Alternatively, curtailment is free, making it a potential strategy for all segments of society.

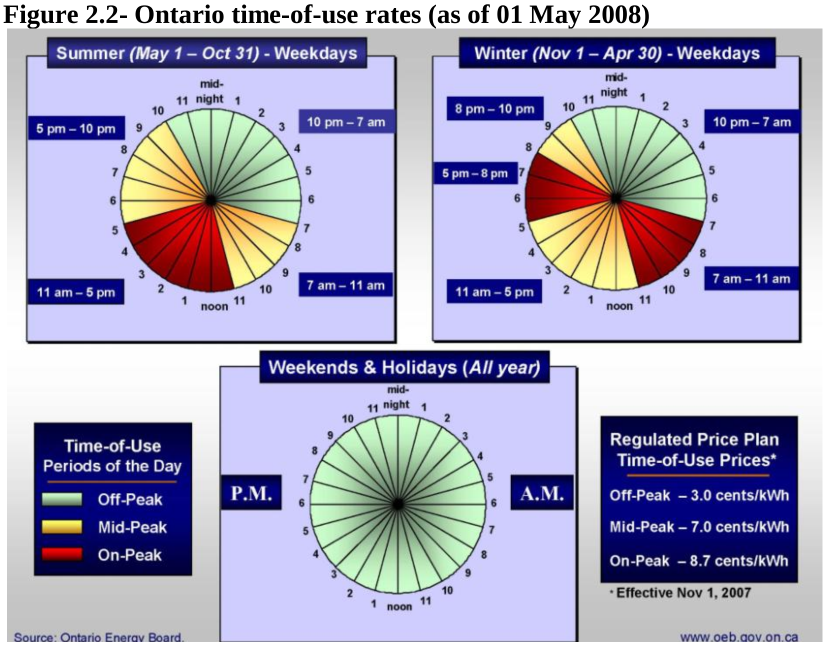
2.5.2- Demand Management

Another conservation approach that has been gaining credence within the area of residential electricity conservation is demand management, more specifically demand response and load management. Owen and Ward (2006) argue that the benefits of these demand management approaches are three-fold. They encourage shifts away from consumption during on-peak periods, thus, reducing the need to upgrade or construct new power generating facilities to meet needs of on-peak periods. In Ontario only 32 hours of consumption is responsible for the top 2000 MW of the province's 27,000 MW peak demand (Faruqui et al. 2007). Reducing electricity during these peak periods could reduce the need for the construction of electricity generators and infrastructure for transmission and distribution that would be needed only during critical peak periods (Faruqui et al. 2007). Secondly, it improves the security of supply, by helping prevent blackouts and reducing dependence on imported energy. Lastly, it helps address concerns over global climate change and air pollution by eliminating the need for additional electricity production, via fossil fuels, during peak demand times and by making use of energy that may go unused during off-peak hours (Violette 2006).

The focus of demand response is to reduce electricity use when prices or production costs are high. The US Department of Energy has defined demand response as, 'changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.' (Faruqui and Sergici 2008). This CDM approach requires utilities to inform the customer that the reliability of the system is a concern and that electricity prices will be high during this period. This is done in hopes that one customer will limit their electricity consumption so that others may be served (Sioshansi and Vojdani 2001). This is exemplified through event based responses, which are often tied to system load or price signals (Violette 2005). This approach will often remunerate the low value added customers (ie. residential) who choose not to consume electricity at on-peak periods so that high value added customers can continue consuming (Sioshansi and Vojdani 2001). In 2006, Toronto Hydro implemented a successful demand response program called 'peaksavers'. The following year the OPA enacted a province wide 'peaksaver' program with the hopes of matching Toronto Hydro's previous success. Through the 'peaksaver' program customers are given financial incentives to participate and in return they allow their LDC to remotely 'cycle down' the home's air conditioning use during critical peak periods. In July 2008, Ontario had two demand response events. It has been estimated that a single event was responsible for saving over 40 megawatts of electricity province wide (OPA 2008b).

The intention of the load management approach is to move electricity use from on-peak periods to off-peak periods (OEB 2002, Sioshansi and Vojdani 2001). With this objective load management tends to be tied closely to dynamic pricing structures. The objective of a dynamic pricing structure is to have electricity rates that reflect the marginal cost of producing electricity. The Government of Ontario has decreed its intent to have all Ontario residential electricity consumers subject to a dynamic pricing system, referred to as time-of-use pricing, by 2010. In this pricing structure consumers will pay premium rates to consume electricity during on-peak periods. Based on the season, winter or summer, consumers will be given different pricing schedules. These schedules are broken into three periods, on-peak, mid-peak and off-peak. Electricity prices will be at their highest during on-peak periods and at their lowest during off-peak periods. (See Figure 2.2 for details of Ontario's time of use pricing structure). The Ontario Energy Board has assigned a price of 8.7 cents/kWh for electricity during on-peak periods. In June 2006 the Ontario Energy Board tested this pricing structure with the *Smart Price Pilot* in Ottawa. They found that participants had a greater ability to shift loads to off peak periods during summer months. Also noted was that in addition to shifts in consumption TOU pricing encouraged reduction in total and on-peak electricity use (IBM 2007). However, some within the study found that their lifestyles prevented them from shifting consumption to off peak periods, while others found that the monetary savings were not worth the effort. Yet, even among the families that were unable to shift consumption to off peak periods no participants felt that they were penalized under a time-of-use pricing system (IBM 2007). BC Hydro completed a similar pilot study involving TOU pricing. Its participants reduced their electricity consumption by 7.6% during winter peak periods. Comparable studies have been carried out within the United States producing similar results (Farqui and George 2005, CNT 2004, Herbelein and Warriner 1983). Time-of-use pricing has been highlighted within this study's conceptual framework (see Figure 2.1) as a concept that could be more effective when synergized with a HEMS, a result that may be explained through the use of the study's behavioural theories.

Figure 2.2- Ontario time-of-use rates (as of 01 May 2008)



Courtesy Ontario Energy Board

Section 2.6- Smart Meters

An important component of future conservation and demand management projects is smart meters and a prerequisite for HEMS is smart meters. This concept would fall within the overlap of CDM and HEMS within the study's conceptual framework. (See figure 2.1.) At its most basic form smart meters provide interval measurements of a building's electricity consumption and communicate this information to the LDC (Owen and Ward 2006). By measuring electricity consumption smart meters allow many of the previously mentioned CDM approaches to be possible. It is for this reason, along with limiting fraud and improving billing accuracy, that provinces and states, in countries such as Canada (Ontario), United States (California), and Australia (Victoria) have initiated the mass implementation of smart metering devices in the residential sector (OFGEM 2006). With the European Union's recent approval of the 'Directive on End-Use Efficiency and Energy Services' it is to be expected that the number of countries installing smart meters en mass should increase significantly (Ferreira et al. 2007). Recent projects in Canada and the United States further support these sentiments.

To date, smart meters have been predominately used to measure electricity consumption (OFGEM 2006). However, there is growing interest in the possibility to meter other resources such as gas and water. One smart metering study in Leicester, England, found that by metering water consumption in schools they were able to reduce water consumption by 60% (Ferreira et al. 2007).

Along with its potential for success, smart meters have obstacles they must overcome to be widely adopted (Owen and Ward 2006). Utilities must be convinced that security and remote metering features of smart meters make them a wise investment (Owen and Ward 2006). Smart meters must also be proven to be a sound investment to advocates of additional electricity generation infrastructure (Owen and Ward 2006). Lastly, Owen and Ward (2006) argue that for smart meters to be successful they must become more user friendly. This may require meters to have additional features such as an in-home display, with a user friendly interface, that can be accessed via other means (internet, mobile phone), a two-way interval meter, and the capability to displaying data in a variety units of measurement (e.g., kWh, $CAD, GHG emissions).

Section 2.7- In-Home Displays

Modern in-home displays are the response to Owen and Ward's (2006) final concern. Like smart meters in-home displays are a prerequisite for effective HEMS units and therefore fall within the HEMS section of the conceptual framework. (See figure 2.1.) In-home displays can provide consumers with real time electricity consumption and cost information, resulting in an increased awareness of an invisible product that is often ignored (Stein 2004). They can come in a variety of forms ranging from an Energy Orb, a glass globe that glows different colours based on the current price of electricity, to the more common display panels that provide real time electricity consumption information to customers through a variety of units of measurement (Darby 2006, Stein 2004). Most in-home display units allow customers to see their historic, current, and projected electricity consumption and expenditure. This allows customers to make what they deem to be appropriate changes in real time, rather than receiving this information with the monthly bill. This range of settings and features makes it possible for in-home displays to become an interactive tool that stimulates the user's curiosity and may lead to experimenting with behaviours to alter consumption patterns (Fischer 2007). However, these same features may be difficult for some to understand leading to ill-informed decisions or unit neglect (Wood and Newborough 2003). Stein (2004) argues that even if the user does understand the information being communicated through the unit's interface there are a variety of other issues and concerns that in-home display producers must address in order to have wide scale adoption and use. To begin, in-home displays must be moved away from the circuit panel, where traditionally many have been located, and into high traffic areas within the home. Therefore, units must be given the capability to communicate with the meter remotely. Ideally, this will be done without requiring a licensed electrician for installation. Customers would also like to access their in-home display information remotely via the internet and/or mobile phone (Owen and Ward 2006). Lastly, interval data on the home's total electrical consumption is not enough; there is growing demand for consumption information regarding individual home electronics and appliances (Wood and Newborough 2003).

Even with these remaining issues, the effectiveness of in-home displays has appeared to improve over the years. In the mid-1980's it was reported that in-home displays could reduce electricity consumption by 4-5% (Hutton et al. 1986), 20 years later reports indicate that displays can achieve 15% reduction in electricity consumption (Wood and Newborough 2003). However, according to studies completed by Mountain (2008) 15% reductions in electricity consumption remain an upper tier result. Mountain (2008) has completed a variety of studies on in-home displays across Canada. Only Newfoundland, with 17% total electricity consumption reductions, is in the range of results reported by Wood and Newborough (2003). Mountain's (2008) Ontario in-home display pilot resulted in 6.5% reductions in electricity, while the British Columbia pilot had a 2.7% reduction. From these studies Mountain (2008) found that homes with air conditioning, electric water heating, and electric heating had the greatest potential to reduce consumption of electricity through the use of in-home displays. The most common behaviour change was the curtailment of lighting. The group least responsive to the in-home displays was senior citizens, which was believed to be due to the technical nature of the unit. Stein (2004) anticipates that the results of studies involving in-home displays can be improved by the implementation of pricing systems like TOU pricing.

Section 2.8- Feedback

The ability of in-home displays to assist in reducing and shifting electricity consumption is the results of its feedback feature. In the current system consumer's knowledge of the cost of electricity consumption can be likened to shopping in a store which has no prices on individual items (Mckenzie-Mohr 1994). These sentiments have been supported by Baird and Brier (1981); they argue that homeowners base the hourly electricity consumption of a product on the product's mass. This may help explain why few people can accurately rank their top three electricity consuming appliances (Mansouri-Azar et al. 1996 cited in Wood & Newborough 2003). This lack of knowledge can make it difficult for consumers to adopt the habits and behaviours that are conducive to electricity conservation. Feedback theorists believe that this can begin to be addressed through the provision of electricity consumption feedback.

Feedback serves two purposes: 'it fills a gap in the knowledge and/or it can be used to motivate behaviour' (Stein 2004). Two popular forms of feedback are direct and indirect. Direct feedback is feedback that is available upon demand. It may come through a variety of media, from self-reading an electricity meter to display monitors and ambient devices (Darby 2006). Indirect feedback is raw data that have been processed by the utility and become part of the billing information (Darby 2006). Direct feedback encourages 'learning by looking or paying', whereas indirect feedback requires 'learning by reflecting or reading' (Darby 2006). It is thought that the immediacy of direct feedback makes it a more effective tool in shifting and/or reducing electricity consumption (Darby 2006). Van Houwelingen and van Raaij (1989) believe that providing feedback in accordance with other policy mechanisms is also important to have feedback work optimally. This is supported by Uitdenbogerd (2007) who argues that feedback will be an ideal intervention to coincide with rising electricity prices and the implementation of smart meters.

The effectiveness of feedback is highly dependent on how successfully it performs its functions. Van Houwelingen and van Raaij (1989) argue that feedback has three main functions: i) a learning function ii) a habit formation function, and iii) an internalization of behaviour function. In the case of electricity consumption feedback, the learning function connects a particular behaviour with the amount of electricity it requires. The habit formation function is the result of the subject putting what they have learnt into practice, resulting in changed behaviour. Finally, the internalization of behaviour function arises from the new habits that have been formed due to changed behaviour that with time will change people's attitudes to coincide with their new behaviours.

The first of van Houlwelingen and van Raaij's (1989) feedback functions is learning. Learning comes as a result of consumers educating themselves through the feedback that they receive. Feedback can teach consumers to conserve by communicating information about how electricity is consumed in the household (Becker 1978). In many homes the electricity bill is the only way consumers can track their electricity use, with little or no indication of how the electricity was consumed (Parker et al. 2006). This makes it difficult to make the appropriate investment, management, and curtailment decisions to correct consumption behaviour (Mckenzie-Mohr 1994). This problem can begin to be addressed through feedback that allows consumers to make informed decisions about electricity consumption and improve their ability to conserve (Wood and Newborough 2003).

When the learning function of feedback has been applied effectively the habit forming function can be adopted. It is hoped that when feedback is received people will become motivated to change their preexisting behaviours and form new habits. There are a variety of ways that feedback can motivate behavioural change. Some approaches include: highlighting one's self-efficacy and cognitive dissonance, and combining it with other interventions involving social comparison, goal setting and antecedent information.

Self-efficacy relates to an individual's belief that their capabilities can have an influence over events in their life (Banduar 1994). When a consumer receives feedback on how their home consumes electricity, they are receiving information about how they can conserve. By providing consumption feedback a consumer's level of self-efficacy increases (Abrahamse et al. 2005). It gives the recipient an increased sense of control over their behaviour. They recognize the perceived possibilities for electricity conservation and thus take action (Abrahamse et al. 2005). This can be further influenced by the manner in which feedback is framed. It has been found that when feedback is provided in a positive manner, one's self-efficacy is higher and conservation efforts have greater success (Geller 2001).

The way feedback is framed can also create a state of cognitive dissonance. Cognitive dissonance is when a person's attitude does not correlate with their behaviour (Kantola et al. 1984). When consumers receive feedback on their electricity consumption that does not correspond with their attitudes and beliefs, a state of cognitive dissonance ensues (Geller 2002). Cognitive dissonance theorists believe that when this occurs individuals will take measures to reduce this dissonant state in an effort to have their behaviours mirror their beliefs (Mckenzie-Mohr 1994, Kantola et al. 1984, Fishbein and Ajzen, 1975). This process will start with small commitments that will then lead to larger commitments (Mckenzie-Mohr 1994).

Behavioural change can also be encouraged through social comparison. This intervention involves providing recipients with comparative feedback. This feedback compares the recipient's consumption with the consumption of others. In doing so, it is believed that a feeling of competition or social pressure may be evoked, resulting in the recipient making additional efforts to change their behaviour (Abrahamse et al. 2005). It is argued that these results can be improved by increasing competition through rewards and prizes. However, several studies have suggested that the effects of awards are short lived (Abrahamse et al. 2005). The success of this approach may also be limited if the consumption results the recipient is being compared to are too low or too high. In the case of the former, the recipient may become apathetic due to the daunting task of bringing their consumption down to perceived acceptable levels. In the latter case, people that have consumed less than the average may begin to consume more to follow perceived norms (Brandon and Lewis 1999). This same problem can arise when feedback is used for goal setting.

Goal setting theorists believe that to achieve optimal results recipients must set a goal to attain (Stein 2004). It is believed that the direct attention given to goal-related tasks energizes an individual's mind, leading to the discovery of knowledge and strategies (McCalley 2006). Feedback is a necessary antecedent intervention that allows individuals to determine what goal should be set and help them determine if the goal is being achieved. Locke et al. (1996) argue that the motivational effect of feedback is the result of goal setting. This motivation is heightened and longer lasting if recipients make written or oral commitments to achieve their goal (Abrahamse et al. 2005, Dwyer et al. 1993). However, as is the case with comparative feedback, goal setting can be counterproductive if an inappropriate goal is set.

Antecedent information can also be influential to the success of a feedback intervention. It can be communicated through a variety of media, from pamphlets and workshops to mass media campaigns (Wood and Newborough 2003). This information may give practical advice, personal information, or inform people about different conservation programs (Staats et al. 2004). It should be presented in a simple, salient, personally relevant and visually appealing manner (Wilson and Dowlatabadi 2007). Equally important is the reputation of the antecedent information provider. The success of antecedent information interventions is dependent on the level of trust people hold in the message provider (Parker et al. 2005, Pharnel and Larsen 2005, Mckenzie-Mohr 1994). When applied correctly antecedent information can raise awareness, substantiate beliefs, and influence behaviour (Lutzenhiser 1993).

There is no universal source of antecedent information that is suited for all audiences. The way it interacts with an individual's values and attitudes, societal norms, and economic resources is indicative of its effects on a particular behaviour (NRC 2005). The cognitive capacity of an individual may also limit antecedent information's effect. If one's cognitive capacity is too low to utilize the provided information then the pursuit of a new behaviour is hindered, even if the individual is aware that it is the right thing to do (Kaplan and Kaplan 1985 cited in De Young 2000). Feedback can assist antecedent information with this problem by providing consumers with consumption information related to particular behaviours, therefore empowering them with the knowledge of how to realize the desired behavioural change. Some argue that a combination of antecedent and feedback information is not enough to provoke action. They believe there remains the need for incentives, often citing recognition and monetary rewards as appropriate means (Brown 2001 cited in NRC 2005). Others feel that behaviour change will not occur unless inappropriate actions are met with penalties or fines (Skinner 1987 cited in Geller 2002). Yet, Herberlein and Warriner (1983) argue that change information (antecedent and feedback) remains the quintessential variables, 'for the effect of knowledge is twice as large as the price ratio, and one's ability has as much influence as the incentive'(125).

Statements like Herberlein and Warriner's have inspired many researchers to study the effect of feedback on behaviour. These studies have been completed in a variety of research areas. In 1989 van Houwelingen and van Raaij completed a study that found frequent feedback on natural gas consumption could reduce natural gas consumption by 12%. Geller et al. (1983) found that feedback encouraged domestic water conservation. Schnelle et al. (1980) completed a study that provided participants with feedback about the amount of litter they were producing. While feedback was provided littering subsided, but it returned to previous levels when feedback was no longer present.

As was the case with the aforementioned studies the effectiveness of electricity consumption feedback is dependent on its frequency, temporality, framing, synergy with other interventions, and its medium. Within each of these conditions experts have rarely reached a consensus on the ideal approach.

The one condition where a consensus is most likely to be met is frequency of feedback. Most academics argue that the effectiveness of feedback improves as the frequency of feedback increases, with the ideal feedback being 'real time' or 'instantaneous' (Darby 2006). This is feedback that provides consumers with immediate updates on their electricity consumption while they consume. Studies in this literature review have found that feedback can encourage reductions in electricity use ranging from 2.1% to 20% depending on the conditions and treatment, but generally the range is 5% to 12% (Darby 2006). It is important to note that ranges exist within feedback studies with similar feedback frequencies. Parker et al. (2006) completed a study where participants received feedback instantaneously, resulting in electricity consumption reductions ranging from 15% to 20%. As previously mentioned, Mountain (2008) completed a similar study, where the participants receiving instantaneous feedback had an average reduction in electricity consumption of 6.5%. Discrepancies also arose with regards to daily feedback. Bittle et al.'s (1979) study found that daily electricity consumption feedback reduced electricity consumption by 4%, whereas Stern (1992) argued that daily feedback will result in reductions ranging from 10% to 15%. The results of monthly feedback studies tend to be consistently lower with studies having electricity consumption reductions below 5% (Robinson 2007, Hayes and Cone 1981). It should be noted that in addition to frequency, many of the behavioural theories discussed in previous sections may also help to explain these inconsistent results.

The duration of a study involving feedback is another condition that may influence study results. Studies have consistently shown that in the short-term feedback will have a positive effect on shifting and/or reducing consumption levels. Unfortunately, 'short-term' is a relative term that can have values ranging from two months to two years. Within these short-term periods the immediacy of optimal results is also debated. Wilhite and Ling (1995) found that feedback success was highest within the first year of their study, while Staats et al. (2004) found that the effectiveness of feedback improved in the second year. Also debated is the lasting effect of feedback interventions. In some cases when the provision of electricity consumption feedback ended, the household's consumption behaviour returned to its baseline levels (Van Buerden 1983 cited in van Houwelingen and van Raaij 1989). Others found that after the removal of the feedback intervention, homes continued to conserve electricity (Dobson and Griffin 1992 cited in Parker et al. 2006, Bittle et al. 1979 cited in Abrahamse et al.

2005, de Young 1993, Dwyer et al. 1993). Darby (2006) explains that the effects of feedback tend to last longer among those who were internally motivated to conserve, rather than being motivated by external incentives.

The framing of feedback is influential in the process of motivating individuals to conserve electricity. Framing feedback pertains to the manner in which the information is presented to the recipient. There are a variety of ways that this has been approached, with varying degrees of success. To begin feedback results can be communicated in a positive or negative manner. With a topic like electricity consumption feedback can be framed to promote certain ideals or beliefs such as environmentalism or load shifting. However, attempts to dictate ideals through feedback have not been successful (Brandon and Lewis 1999, Sexton et al. 1987). Successfully framed approaches are often more liberal, allowing the recipient to make decisions based on their interpretations of the feedback.

Another determinant of the success of a feedback study is the unit of measurement used to communicate the results. In most cases electricity feedback is communicated in energy and/or monetary units. Of the two approaches the merits of monetary feedback appear to cause a higher level of debate. It has been argued that cost based feedback will not result in reduction in electricity consumption across all samples. This alludes to the notion that cost based information may be more effective for particular demographics within a population (i.e. low income) (Hutton et al. 1986). Others studies have found that cost based feedback consistently resulted in reductions in electricity consumption (Farhar and Fitzpatrick 1989 cited in Brandon and Lewis 1999). In cases where dynamic pricing systems like TOU pricing were present, cost based feedback led to substantial shifts in electricity consumption from on-peak to off-peak periods (Darby 2006, Sexton et al. 1987, Heberlein and Warriner 1983). In these cases shifts in electricity consumption were larger than reductions. As previously discussed, recipients of feedback in kilowatt hours tend to not have problems conceptualizing their electricity consumption.

In an effort to improve reductions in electricity consumption, researchers have attempted to synergize education with feedback, with varying degrees of success. Fischer (2007) argues that for feedback to be effective it is imperative that the recipients receive some form of education on how to interpret the feedback and how to address any concerns that may arise. These sentiments are supported by a number of studies that found providing antecedent information and tips along with feedback improve the recipient's ability to conserve electricity (Abrahamse et al. 2005, Staats et al. 2004, Kantola et al. 1984, Gaskell et al. 1982 cited in Darby 2006).

Lastly, as it is often argued in communication sciences and learning theory, the medium and mode in which information is presented is crucial in its adoption (Roberts and Baker 2003). Robinson (2007) tested the effectiveness of receiving feedback in hardcopy versus softcopy and found the softcopy, email, to be more effective. Like Robinson (2007), other studies have recognized the importance of providing feedback digitally. Whether it is through an interactive website or an in-home display, these studies found that digital feedback can lead to electricity consumption savings ranging from 5% to 13% (Mountain 2008, Darby 2006, Dobson and Griffin cited in Wood and Newborough 2003, McCelland and Cook cited in Geller 2002, Brandon and Lewis 1999).

Section 2.9- Managing a Home Energy Management System

The final section of the conceptual framework (see Figure 2.1) that has yet to be discussed is the home energy management system. As mentioned earlier the HEMS is an innovative piece of ICT that has the empowering capabilities of modern home automation technology and the feedback capabilities of an advanced smart metering device, such as an in-home display. It is argued by Grønli and Livik (2001) that this form of ICT, coinciding with electricity tariffs like TOU pricing, will allow for a virtuous cycle of electricity conservation. This is due to consumers' receipt of information about their electricity consumption through the HEMS's feedback function and capability to program automated responses to changing electricity prices. Through their pilot study they have hypothesized that this combination of technology and dynamic pricing can result in 13% to 25% reduction in electricity use during peak demand periods (Grønli and Livik 2001).

As previously mentioned a primary feature of HEMS is its feedback and home automation features. It is understood that the feedback feature of the HEMS is primarily used for resource conservation (Wood and Newborough 2003). However, the motives for the use of home automation technology or ‘smart home’ technology are not as broadly agreed upon. Surveyed North American and European consumers indicated that conservation, convenience, and security were the primary reasons why people adopt home automation technology (Green and Marvin 1994). This raises the possibility of people purchasing a HEMS for convenience and security, then unintentionally adopting conservation habits and attitudes due to the unit’s provision of electricity consumption feedback.

Home energy management systems also provide conservation, convenience, and security to LDCs. If residents properly use the HEMS, providers will be able to conserve energy during on-peak hours, limiting the need to acquire additional electricity through additional infrastructure (OFGEM 2006, Grønli and Livik 2001). Convenience will be promoted through the unit’s remote sensing capabilities. It allows providers to limit the number of on-site visits required to check meters and tend to customers’ needs (OFGEM 2006). Also, its remote sensing will improve security due to its advanced ability to detect theft and fraud (OFGEM 2006).

With its many positive attributes there remain some concerns associated with the use of HEMS. The complexity and cost of the technology may alienate some users (Owen and Ward 2006). Information and communication technology is a rapidly developing industry, leading to the potential for expensive HEMS technology to become obsolete after a couple of years (LaMonica 2007). It may be misused, allowing people to over consume energy or to reduce energy use below healthy levels (Owen and Ward 2006). Lastly, there are concerns about security and the “Big Brother” aspect of the technology that provides ‘outsiders’ with information about who and what is in the home (Owen and Ward 2006). The information from these devices can reveal what appliances and electronics are in the home, along with an idea of when the occupants are out of the home (Owen and Ward 2006).

Some utilities in the United States have launched or are in the process of launching conservation and demand management initiatives with HEMS technology being the primary intervention. Boulder, Colorado, is the home of one of the more current and high profile projects. Boulder’s *Smart Grid City* project involves a variety of ‘smart technologies’ (ie. automated technologies), that will hypothetically create a more reliable electricity system. Included among these ‘smart technologies’ will be HEMS that allow consumers to automate and remotely control the home’s thermostat, lighting, and select appliances (Xcel Energy 2008). Another pilot that has incorporated HEMS technology is the *LG&E Responsive Pricing and Smart Metering Program*. Starting January 2008 approximately 2000 Louisville, Kentucky, LG&E customers received a HEMS that will provide electricity consumption feedback and allow for the automation of the home’s central air conditioners, heat pumps, electric water heaters and pool pumps. Like the *Smart Grid City* project the LG&E project has been designed with the intent to encourage load shifting (LG&E 2008). Local electricity distributors in Oregon, Washington, Texas, California, New Jersey, and Missouri have more established projects that involve the use of HEMS related technology. In Oregon and Washington, LDCs Bonneville Power and Portland General Electric, in cooperation with IBM and Pacific Northwest National Laboratory (PNNL), created the *Gridwise* project. This was a voluntary program where customers received a HEMS that allowed them to automate their home’s thermostat, clothes dryer, and water heater through the use of a web portal. The criteria for participation in the study were that all of the aforementioned appliances be electrically powered (Faruqui and Sargici 2008). The utility would be able to control the HEMS during critical peak periods. However, the control could be overridden by the customer if they chose to do so (Carey 2008). This technology was found to reduce participants’ on-peak electricity consumption by 30% (Faruqui and Sargici 2008). In December 2007, Houston’s LDC CenterPoint Energy, along with Energy solutions firm Comverge INC and Direct Energy INC initiated a 500 home study pilot that measures the effect of HEMS technology on electricity consumption, results are pending. The California demand response study completed by PG&E involved a less elaborate system than the previously mentioned HEMS. The technology in this study involved a smart thermostat that informed consumers about consumption, encouraging them to adjust consumption during on-peak periods, and allowed the LDC to have remote control over the home’s heating and air conditioning usage. In New Jersey, PSE&G’s *myPower Connection* study used technology similar to the previously discussed California study and achieved 22% reductions in their on-peak electricity consumption (Faruqui and Sargici 2008). Smart thermostat technology was also used in the *Missouri-Amerenue*

Critical Peak Pricing study. During the first summer the study's participants were only able to achieve slight reductions in on-peak electricity use. However, in the second year of the study the participants achieved statistically significant reductions using the same technology (Faruqui and Sargici 2008). A smart thermostats is not a HEMS; however, the demand response focus of these studies makes them worth recognizing.

The previously mentioned utilities, along with others, may be pursuing 'smart technology' solutions like HEMS with the hopes of creating a smart grid. A smart grid is an electricity grid with a variety of capabilities including the ability to recognize power supply concerns and communicate with the home's HEMS, having it power down or turn off usage, thus, avoiding potential outages and system failures (LaMonica 2007). With groups like the Smart Grid Forum forming, and the existence of Smart Grids becoming increasingly plausible, HEMS technology has experienced a rise in popularity throughout North America and has become an area of increased research interest.

Section 2.10- Gaps in the Literature

The home energy management system is an innovative technology that has been the subject of a limited number of behavioural analysis studies. Therefore, there are a number of gaps in the literature when one considers the effect HEMS will have on residential electricity consumption in the Southern Ontario environment.

The primary literature gap that this study hopes to address is how HEMS will influence residential electricity consumption in a TOU pricing environment. This study will help determine if the synergy of feedback and automation will assist consumers in altering their total and on-peak electricity consumption. To date, researchers have been only able to guess what the effects maybe, hypothesizing that the combination of these two interventions could allow for a virtuous cycle of electricity conservation (Grønli and Livik 2001). The closest comparison to this would be the PNNL's *Gridwise* project; it had similar technology and pricing system, but its socioeconomic and physical environment is different from Southern Ontario.

In answering its primary question, 'Do home energy management systems influence residential electricity consumption behaviours?', this study may also expand the literature related to profiling consumers that have success reducing and/or shifting electricity consumption through the use of HEMS. This topic has been the focus of a variety of energy conservation studies, but has yet to be the focus of one that has used HEMS as the primary intervention.

With feedback being one of the primary functions of the HEMS, the study's findings may help rebuild a research area that has been ignored up until recently. These sentiments are supported by Parker et al. (2006) who argued that feedback research has not been done in recent years and there is a need to revitalize this research area.

Finally, the feedback provided by the study's participants relating to functions and effectiveness of the HEMS can begin to address many unknowns related to the capabilities of HEMS. Studies similar to this one have focused on end results- reductions and shifts in electricity consumption- and have failed to evaluate the capabilities of HEMS.

Chapter 3- Methodology

The methodology selected for this research was a case study. This methodology is ideal for the study of people in natural settings. It gives detail about a certain time in history allowing future researchers to examine continuity and change in human thought and action. Lastly, it encourages and assists the practice of theoretical innovation and generalization (Feagin et al. 1991). Following Yin's (2003) criteria for case studies this research asks exploratory questions like how and why, focuses on contemporary events, and has no control over behavioural events.

Due to the uniqueness of this study and to expand upon the findings of previous studies it has been deemed prudent to make this a single case study (Yin 2003). This project is unique because it is the first Canadian case study that studied HEMS in a TOU pricing environment (Grønli and Livik 2001).

In an effort to address problems associated with construct validity, this case study triangulated its methods of analysis. This involved the use of a literature review, surveys, and archival analysis. Triangulating methods made it easier to also triangulate data sources. This further legitimizes the study's findings (Yin 2003).

In an effort to achieve methodological transparency the following sections will elaborate on the physical and population boundaries of this study. It will then provide details about why the previously mentioned methods were selected and how they were used to conduct this research. The chapter will conclude by recognizing the study's methodological limitations.

Section 3.1- Location

The location of this study was based on three criteria. The first criterion was that the study should be in an area with a progressive local distribution company (LDC) that was willing to assist when possible and provide necessary electricity consumption data. Second, the presence of a pilot study that required the monitoring HEMS influence on household electricity consumption was also critical. Thirdly, to address some of the previously mentioned gaps in the literature it was important to have a location that had begun to implement smart metering and TOU RPP, so that interval electricity consumption data could be accessible and a dynamic pricing system could be present.

The Milton, Ontario location met these criteria (see Figure 3.1 for geographic location). Milton Hydro Inc. was welcoming and eager to assist. Bell Canada Enterprises Inc. and Direct Energy Ltd. had a scheduled pilot study intended to test the effects of HEMS on residential electricity consumption. Lastly, Milton Hydro Inc. had begun installation of smart meters and the implementation of a TOU RPP prior to 2006, therefore interval consumption data and a dynamic pricing environment were available.

Figure 3.1- Location of Milton, Ontario

Courtesy Town of Milton

Section 3.1.1 Study within a Study

This case study represents only a portion of a larger study being completed by the previously mentioned stakeholders. The larger study began July 14, 2007, and is to be completed in September of 2008. The study consists of 201 homes that were recruited and had their HEMS installed between the months of July 2007 and March 2008.

For the purpose of this case study only households that had the system installed between August 1, 2007 and October 31, 2007 were considered for evaluation. This was done to ensure that every participant had the system installed in their home for a minimum of three months prior to this study's January 31, 2008 completion date. As a result, the population of the sample group was 151 households. This number was reduced to 108 participants to ensure that the number of participants that were on TOU pricing prior to the study's baseline months (August 2006- January 2007) was equal to the number of participants that started TOU pricing after the baseline months. This was done to help control for the influence that TOU pricing may have had on the participants' electricity consumption (see Figure 3.2).

The monitoring of participants' household electricity consumption began on the first day of the month following the participant's HEMS installation (see Table 3.1). Any technical complications that participants had with the system were addressed by Bell Canada Enterprises Inc. and/or Direct Energy Ltd.

Figure 3.2- Study within a study.

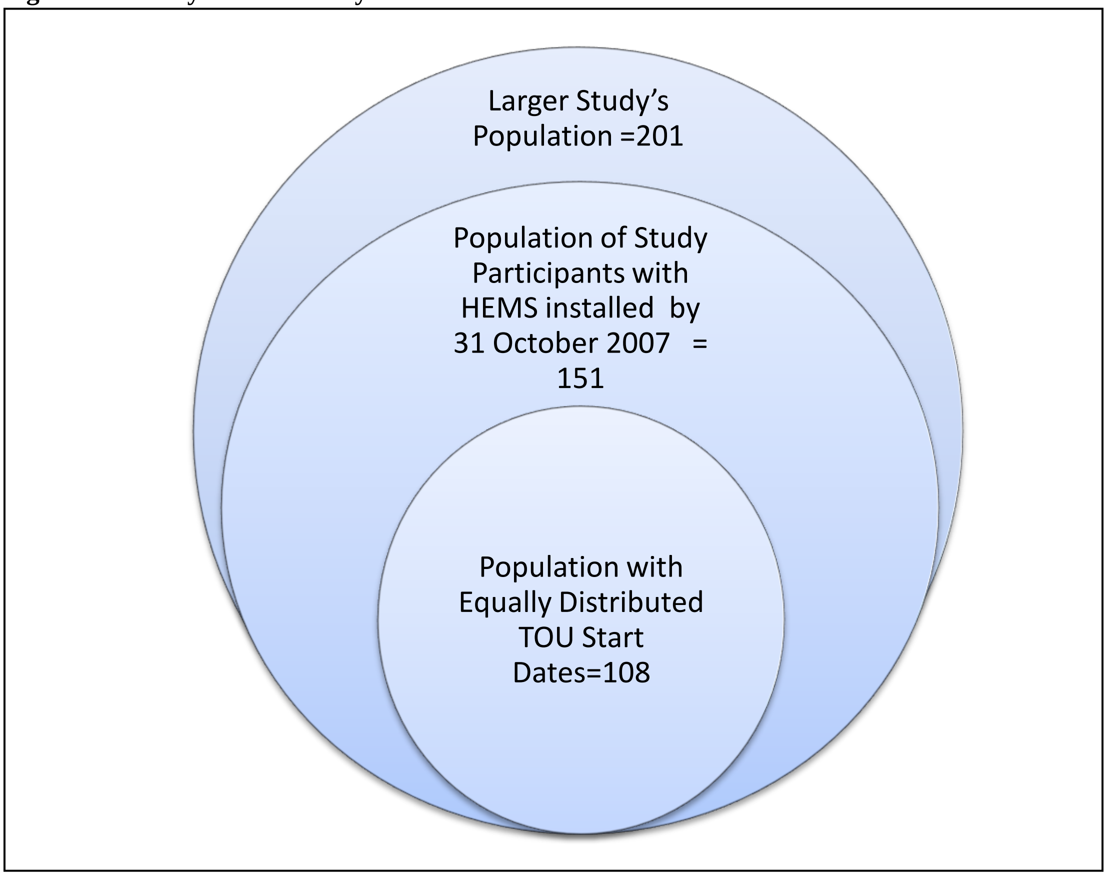


Table 3.1- Evaluation start dates.

Participant (n)	HEMS Installation Month	Evaluation Start Date
7	July 2007	01 August 2007
14	August 2007	01 September 2007
49	September 2007	01 October 2007
38	October 2007	01 November 2007

Section 3.2- Recruitment

Prior to the dispersion of the study's surveys, the study's participants were recruited using the following procedures.

Section 3.2.1-Sample group

The recruitment of sample group participants, those who will be having an HEMS installed, was the responsibility of Bell Canada Enterprises Inc. and Direct Energy Ltd. This involved a telephone campaign and a mailing campaign that included the distribution of flyers with Milton Hydro Inc. customer's billing information. To preserve the quality of research all potential participants were required to meet a set of criteria. This included the following: must be over 18 years of age, have lived in the home for at least one year and intend to live there for the remainder of the study, be willing to complete two surveys, and allow Milton Hydro Inc. to share customers electricity consumption data with the University of Waterloo researchers. For legal and technical reasons two additional criteria were required: ownership of the home and access to broadband internet. In an effort to encourage participation in the study, Bell Canada Enterprise Inc. and Direct Energy Ltd. gave the HEMS to participating households at no cost. All Milton residents who met these criteria had equal opportunity to participate in the study

Those who expressed interest in participating were asked to register online. All qualified participants were contacted by a Direct Energy Ltd. representative and installation appointments were scheduled. Participants were contacted chronologically based on the order that they registered. This process began in the middle of July 2007 and finished at the end October 2007. Any technical questions that participants had pertaining to the use of the HEMS were directed to, and handled by, Bell Canada Enterprises Inc and Direct Energy Ltd.

Section 3.2.2- Control Group- Recruitment

To increase the confidence that the study's intervention, the HEMS, was responsible for the study's findings, a control group was included in the study's research design. In an effort to limit cross-contamination between the sample group participants and control group participants, measures were taken to isolate the two groups from each other. As was the case with the sample group, the control group's primary units of analysis were Milton households and the units of data collection were the households' primary energy manager.

The process of recruiting control group members began in October 2007. At this time 69 sample group baseline surveys had been returned and the geographical locations of the 108 sample group homes were known. Equipped with this knowledge efforts were taken to replicate the characteristics of the sample group within the control group. This process began by using ArcGIS to map the locations of the 108 sample homes. The number of homes found in clusters within subdivisions was calculated and assigned percentages (see Figure 3.3). The percentage of sample group homes in an area would be matched by the percentage of potential control group members for that area. Potential control group members are those who received a control baseline survey. Other criteria used to create the list of potential control group members were based on visual estimation of the structural form, age, and size of potential control group homes. Lastly, Milton Hydro Inc. assisted in ensuring that all those selected to be on the potential control group list had at least one year of interval electricity consumption data.

If the potential control group member were to decide to participate in the study they would be required to have owned their home for the previous year with intentions of remaining there throughout the course of the study. They would also be expected to complete the study's baseline and follow-up surveys. In total 300 households were selected and received the control baseline survey. This number was based on the capacity of the study's available resources and the hope of having a survey response rate above 20%, thus, making the number of controls respondents equal to the number of sample group respondents. All potential control group homes had the survey hand delivered to ensure that the previously mentioned criteria were being met. An opportunity to win a $100 gift certificate was made available to all those who completed and returned this survey.

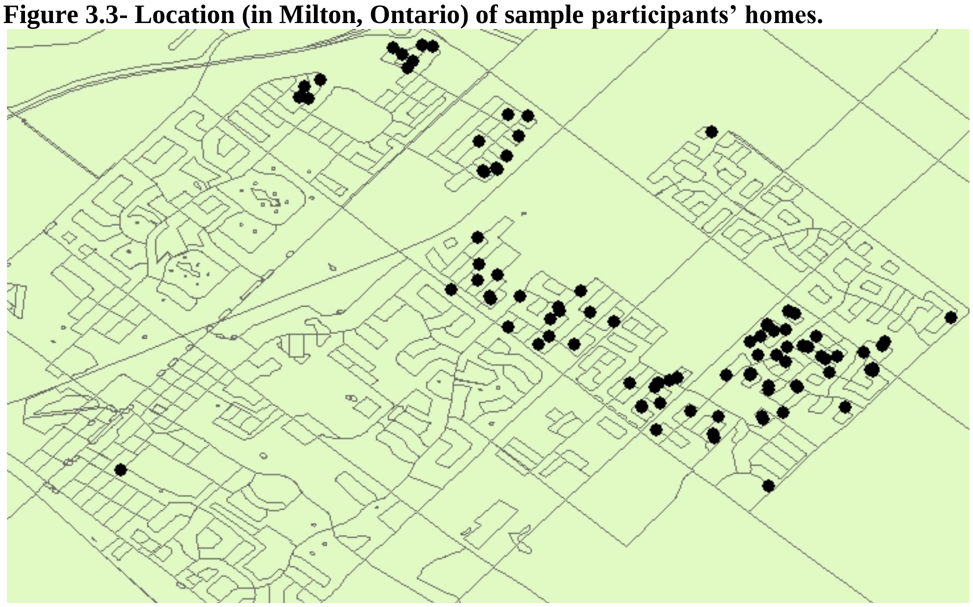
Of the 300 potential control group participants, 23 responded to the control baseline survey. Those who responded were placed immediately into the control group. With 23 respondents, an additional 85 households were required to meet the target group size of 108, a population equivalent to the sample population. To achieve the target, 85 homes were selected from the remaining 277 households from the list of 300 potential control group participants. It had been anticipated that additional control household groups were going to be selected in this manner. However, it was hoped that the response rate (8%) would have been higher, thus, making the number of households selected in this manner less.

The primary criterion of the control group selection process was ensuring that a sample group participant was matched with a control group participant that had started using TOU rates during the same year. (Half of the sample group participants had been put on TOU rates in 2005, while the other half was put on TOU rates in 2007. To control for the effect of TOU pricing both groups had to have an equal number participants that started TOU pricing in 2005 and 2007.) Therefore, the list of 277 households was divided into those that had TOU pricing in 2005 (n=111) and those that had TOU pricing in 2007 (n=166) They were then matched with participants from the sample group that had the same TOU pricing start dates through the procedure described below.

After the TOU groups were established the selection of additional control group members was based on a combination of the household's total and on-peak electricity consumption for February and June of 2007. This was done by finding each sample group participant's and potential control group participant's sum of total electricity consumption and total on-peak electricity consumption for February 2007 and June 2007. With these totals the 108 sample group participants were then matched with potential control group participants based on those that best fit the aforementioned criteria – absolute total and on-peak consumption. To determine these best fits the total consumption of a given sample group participant was matched with the total consumption of potential control group participants. Then, the on-peak consumption of the potential control group participants that had similar total consumption was matched with the sample group member. The potential control group participant whose total and on-peak electricity consumption came closest to the sample participant's total and on-peak electricity consumption was selected as a member of the control group. This was done after the 23 respondents that completed the control baseline survey were matched with members of the sample group following the same procedure (see Figure 3.4 for location of control group homes). (See Figure 3.5 for a diagram of the control group selection process).

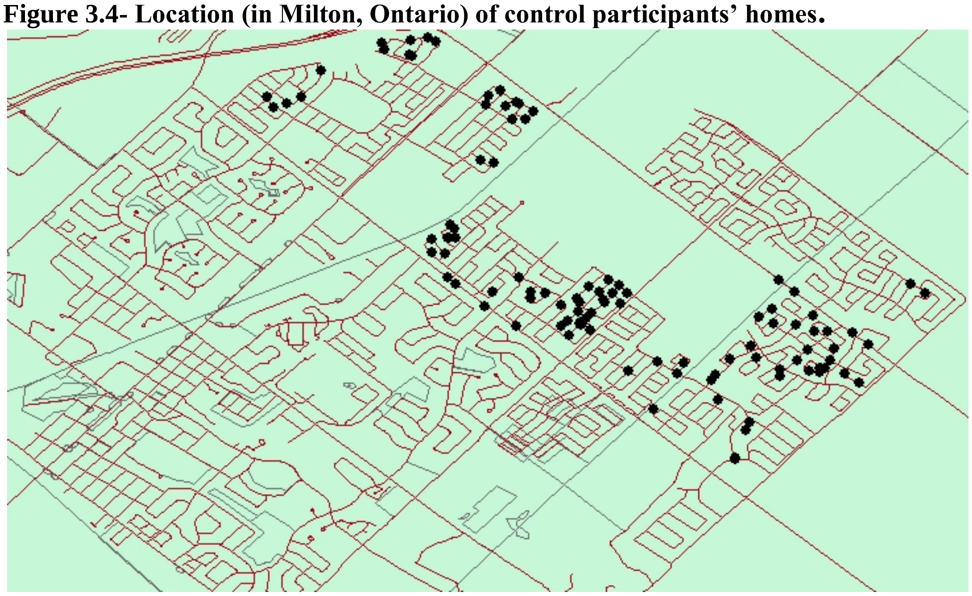
February and June's summed total electricity consumption and on-peak consumption was chosen as the criteria for selecting the control group due to the study's focus on evaluating reductions and shifts in total and on-peak electricity consumption. These months were chosen to get an indication of the participants' consumption habits in both winter and summer months, while avoiding the use of months that fall into the study period.

Figure 3.3- Location (in Milton, Ontario) of sample participants' homes.



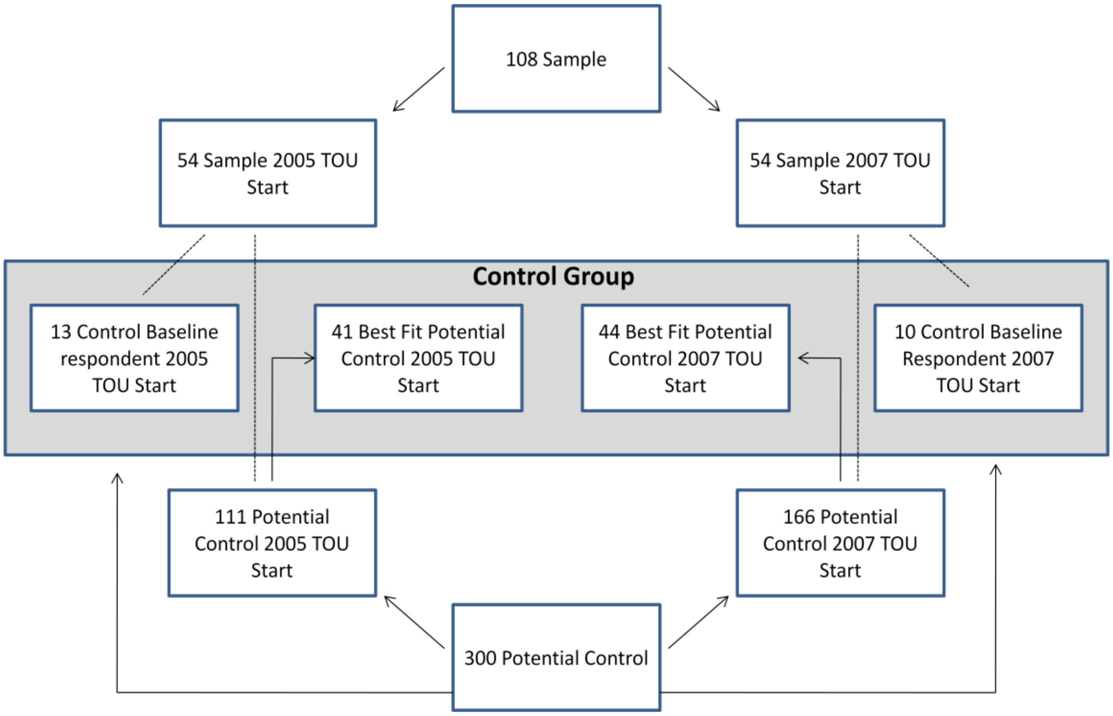
Courtesy ArcMap Version 9.2

Figure 3.4- Location (in Milton, Ontario) of control participants' homes.



Courtesy ArcMap Version 9.2

Figure 3.5- Control group selection diagram.



Section 3.3- Intervention- Home Energy Management System

The study's intervention is a HEMS, referred to by the study's stakeholders as the Direct Energy Smart Home Energy Conservation Kit. It is believed that this can be a conservation and demand management tool that will assist residential electricity consumers in reducing and/or shifting electricity consumption behaviours. This belief is based on the synergy of the system's two primary functions: home automation and electricity consumption feedback.

Using X10 communication signals the HEMS's thermostat, light switches, and control nodes communicate with the Homebase Gateway; the Homebase Gateway being the primary communication unit between the computer and remote devices. The X10 capabilities allow the devices to communicate with the Homebase Gateway wirelessly. The Homebase Gateway is then connected to the modem that communicates with the home's computer. When these connections are established participants are able to control their thermostat, light switches, and control nodes through their HEMS's web portal.

The aforementioned control nodes are plugged into the home's electrical outlets and then have electrical units plugged into them. When an electrical unit is plugged into the control node it becomes part of the HEMS and can be controlled wirelessly through the web portal.

The HEMS web portal is online and can be accessed through a range of online devices including home and office computers, and wireless hand held units (eg. a Blackberry). When logged into the web portal the user can automate all the HEMS devices through the use of the system's modes. The modes allow the user to set their electricity consumption behaviours for specific events. These events include being at home, being away from home, going on vacation, and sleeping. Conservation and cost saving modes are included to coincide with the user's moods and attitudes. In the cost saving mode the user can create an electricity consumption design that will allow them to achieve their ideal cost saving; this will likely involve load shifting and reductions in on-peak electricity use. The conservation mode is meant to achieve reductions in electricity consumption with less attention paid to TOU periods and cost savings. This mode would likely have greater reductions in total electricity consumption. The final mode is the demand response mode. This would be the mode that the LDC would switch the home into if a demand response event was to occur. This mode was necessary for Milton Hydro Inc. to have the HEMS as their peaksavers program solution. Within each mode users can schedule the use of each HEMS device. These schedules are based on hourly intervals. At any time the user can override a specific mode and have manual control of their home's electricity use (see Figure 3.6).

The other primary function of the web portal is providing the user with feedback on their household's electricity use. In a variety of temporal settings (daily, weekly, monthly), the user is able to view their current electricity consumption, along with their historic and expected electricity consumption (see Figure 3.7). Upon completion of the study a zigbee radio was communicating with the household's smart meter, thus, allowing the home to receive consumption feedback in one minute intervals. The provision of this feedback allows the user to monitor their electricity consumption in real-time.

Also included in the web portal is an educational section entitled 'details'. This section provides the user with information about Ontario's electricity generation. It also provides details about Ontario's smog and greenhouse gas levels (see Figure 3.8).

Figure 3.6- Home energy management system's mode control.

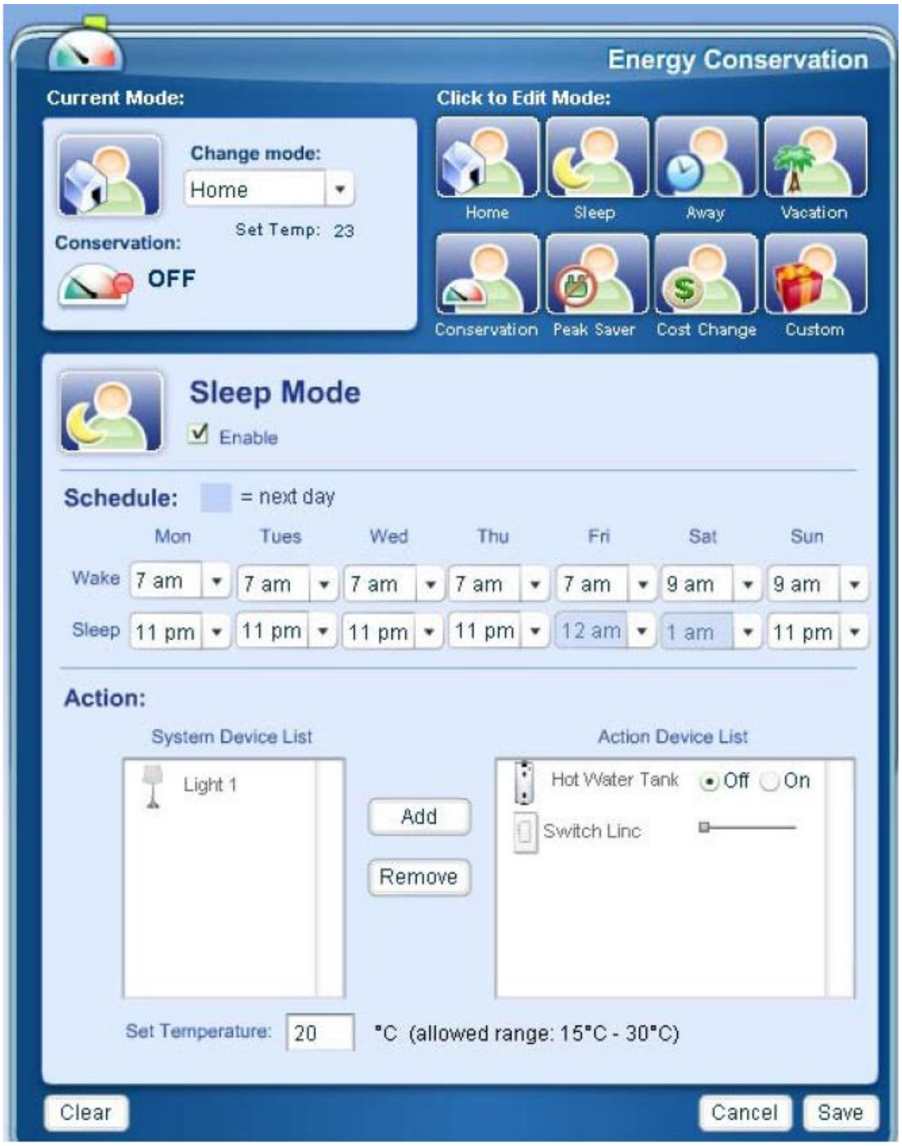


**Image Courtesy Direct Energy 2007*

Figure 3.7- Home energy management system's web portal consumption feedback.

**Image Courtesy Direct Energy 2007*

Figure 3.8- Home energy managements system's detail section.

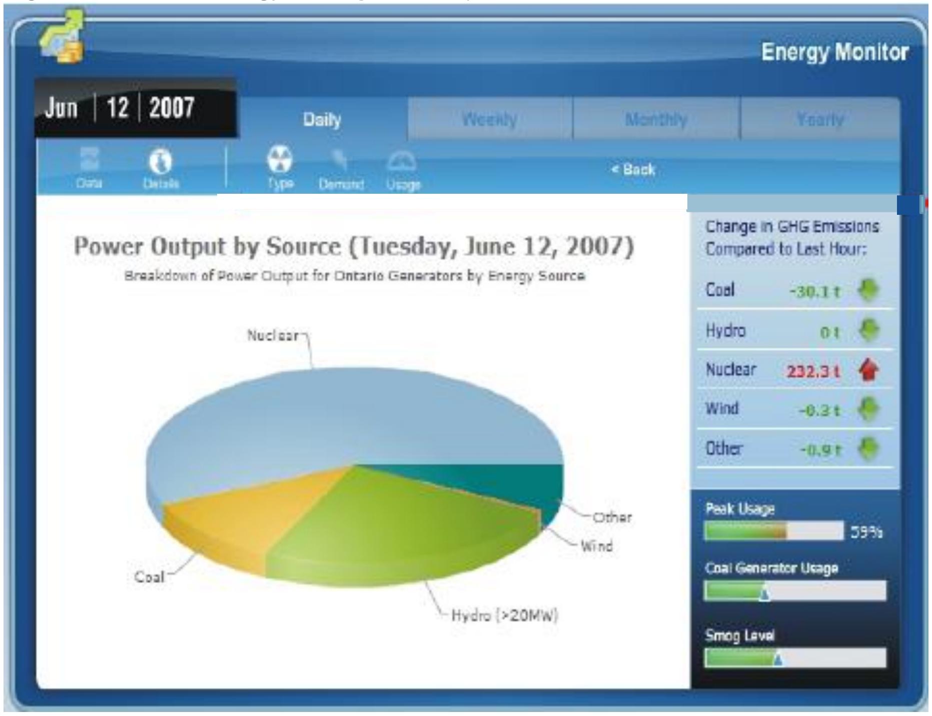


**Image Courtesy Direct Energy 2007*

Section 3.4- Literature Review

A thorough literature review was important to this study for a variety of reasons. It allowed for the creation of hypotheses and the discovery of gaps in the literature. It also helped improve the legitimacy of the study's other methods, whether it was through assisting in the development of surveys or providing documentary sources to verify the archival data. The majority of materials in the literature review have come from peer reviewed sources. However, due to the innovative nature of the technology being reviewed, newspaper and online sources were used due to their ability to provide current information about this newly emerging research area. This approach has resulted in a literature review that covered a diversity of topics ranging from the theoretical such as behavioural theories, to more applied topics such as the effectiveness of smart metering, time of use pricing, and home energy management systems (see Chapter 2). Upon completion of the literature review there appeared to be a bimodal distribution of the referenced articles publication dates, with many being written during the late 1970's and early 1980's followed by inactivity until a recent (post-2000) revival. This has been attributed to the energy crisis of the 1970's and the rising concern surrounding global change and renewed energy crises in the 21st century (Faruqui and Sergici 2008, Abrahamse et al. 2005). Fortunately, the findings of studies from both time periods tend to be similar. Therefore, it was determined that the content of the older articles are still relevant for this research.

Section 3.5- Surveys

This study has employed the use of multiple surveys to develop a better understanding of the study participants' electricity consumption behaviours, attitudes and knowledge of electricity conservation, the structural make-up of residences, and applicable demographic information.

Section 3.5.1- Baseline Survey

The baseline survey was the study's initial survey. The intention of this survey was to understand the conditions in the home prior to the study's intervention- that is the installation of the home energy management system.

After the installation of the HEMS, participants were given access to the HEMS's web portal that enabled participants to engage the system. Upon logging into the web portal the participants were routed to a web page with a letter from Milton Hydro Inc. President Don Thorne (see Appendix I.A). This letter explained the purpose and importance of the study, along with the participant's role and rights within the study. The letter included the web address to the study's first survey, along with an attachment of the first survey. From here participants would be introduced to the baseline survey. They had the option to complete the survey or to skip it and go straight to the web portal. In either case the participant would be prompted to complete the survey the next time they logged into the portal. This prompting continued until the participant indicated that they had completed the survey. Those who did not want to complete the survey could skip it by falsely indicating the survey's completion.

The nature of the study guided the decision to make the survey primarily an online medium. This was the result of having knowledge of who was in the study and the criteria for participation (particularly broadband internet access). Having knowledge of who is participating in the study limited the effects of commonly cited negatives associated with online surveys, such as deception, netiquette, and internet access (Palys 2003). It also allowed for the positive aspects of online surveys to be realized, such as improved respondent anonymity and accessibility (Frankell & Siang 1999), increased speed of data acquisition (Swoboda et al. 1997), and limited human influences, like input errors and interview bias (Schaffer & Dillman 1998). Those who did not feel comfortable completing the survey online had the option to complete the survey attachment and email it to miltonconserve@fes.uwaterloo.ca, or to mail it to the offices of Milton Hydro Inc.

The online version of the survey was 26 screens, the equivalent to a seven page 8½" by 11" paper version of the survey. The survey consisted of five sections, an 11 item structural section, a seven item behavioural section, a seven item attitudinal section, an eight item knowledge section, and a 10 item demographic section (see Appendix I.B). Each section was designed to assist in determining the effect that the system had on individuals and what type of individual's conservation effort benefited most through the use of the system. The information obtained from these sections assisted in testing the study's hypothesis and answering the study's research questions.

The types of questions asked in this survey were influenced greatly by similar surveys that had been employed in previous studies. This list includes the Milton Hydro Residential Customer Survey (Robinson 2007), the OPA's Consumer Usage and Attitude Market Research Survey (Neuman 2007), the Survey of User Behaviour in Energy Efficient Homes (Pett and Guertler 2006), the EIA's Residential Electricity Consumption Survey (EIA 2001), and the Residential Conservation Service Survey (Neiman 1987). In an effort for quality control this survey was reviewed by the study's stakeholders, researchers in energy related areas, the University of Waterloo's Office of Research Ethics, and consumers of electricity that had little knowledge of the study or its topic area. Many suggestions were considered and implemented prior to the survey's final draft. It was hoped that some of the study's participants would have been able to review the baseline survey prior to its dispersion, however, this was not possible due to the timelines of the stakeholders.

Section 3.5.2- Control Baseline Survey

The intention of the control group baseline survey was to gain an understanding of the control group participants behaviour, attitudes, and knowledge as they relate to electricity consumption, along with the home's structural characteristics and the household's demographic characteristics. This is of importance because it can help determine if there are differences between the sample and control group, other than the HEMS, that may influence consumption behaviours of respondents.

The design of the control baseline survey replicated the sample baseline survey with the exception of one question in the attitudinal section (see Appendix I.C). Question C1, an open-ended question pertaining to why respondents took part in the study, was removed from the control baseline study due to a lack of applicability. (The question related to the HEMS). This was the only difference in content between the two surveys; however, in some cases the phrasing of question had been altered slightly to suit the context of the control group.

Though the content of the two baseline surveys are alike, the medium of distribution was different. An online version of the survey was not made available to the potential control group participants because there was not sufficient knowledge about the potential participants. There was less confidence that the previously mentioned limitations and drawbacks of online surveys could be minimized. Therefore, all potential participants received a hand delivered hard copy of the survey.

Section 3.5.3- Sample Follow-up Survey

The sample's follow-up survey was used primarily as a tool to measure self-reported changes that may have occurred during the course of the study. The behavioural, attitudinal, and knowledge sections were used to measure changes that may be due to the use of the HEMS. The structural and demographic sections of the survey were intended to detect changes in the home that may also be responsible for changes in the household's electricity consumption behaviours during the study period. The other role of the sample's follow-up survey was to gain a better understanding of how respondents used the HEMS and how they felt about the system. For quality control purposes, the follow-up survey's introductory paragraph asked that the respondent of the follow-up survey be the same person that completed the baseline survey.

With these objectives in mind a 20 screen online survey, the equivalent of a five page 8.5" by 11" paper survey, was created. This survey consisted of six sections: a structural section (five items), a behavioural section (four items), an attitudinal section (five items), a knowledge section (four items), a Direct Energy Smart Home Energy System section (10 items), and a demographic section (three items). It began with a letter from Milton Hydro President Don Thorne, similar to the letter provided in the baseline survey, and ended by providing respondents the opportunity to elaborate on any of their experiences and opinions of the HEMS (see Appendix I.E). With the exception of the questions in Direct Energy Smart Home Energy System section, all questions in this survey were similar to the questions asked in the baseline survey. Due to the uniqueness of this study the questions from the Direct Energy Smart Home Energy System section were not inspired from any previous studies. They were the product of discussions with the study's stakeholders. To ensure the quality of this survey, it went through a review process similar to what was described in Section 3.5.1.

Following the approach and reasoning described in Section 3.5.1, the dispersion of follow-up surveys began on January 29 2008. This allowed for a period of three to six months between the completion of the baseline survey and the follow-up survey. This theoretically gave the system time to influence the behaviours, attitudes, and knowledge of the participants.

Only those who completed the baseline survey (69 households) received the follow-up survey. This was done because the completion of the baseline survey was necessary to acquire the data required to make the comparisons that the follow-up survey was intended to achieve. These 69 households were prompted to complete the follow-up survey in the same manner that they were asked to complete the baseline survey.

Section 3.5.4- Control Follow-up Survey

Coinciding with the completion of the sample's follow-up survey was the control's follow-up survey. The control's follow-up survey had similar questions to the control's baseline follow-up survey only fewer. In total the control survey was four pages long (see Appendix I.G) In addition to the survey, respondents received a letter from Don Thorne of Milton Hydro Ltd., which was similar to the letter that recipients of the sample's follow-up survey received (see Appendix I.H).

The sample and control's follow-up surveys were completed simultaneously to control for temporal variables that may influence responses. For the same reasons cited in Section 3.5.3, only the control group members who completed the baseline survey were asked to complete the follow-up survey. The applicable control group members received a hard copy of the survey in the mail. Postal delivery was the chosen method of distribution due to the lack of need to verify the location and characteristics of the home and the smaller population (23 households) receiving surveys made this approach affordable. As a gesture of appreciation to all those who completed the baseline survey, a five dollar bill was included with each survey.

Section 3.6- Archival Analysis

The final method used in this study was an archival analysis. Milton Hydro Inc. provided metered interval electricity consumption data for the 216 participants in the sample and control groups. These data were then formatted so that the sum of each participant's electricity consumption for separate TOU periods could be calculated. This process was completed for each baseline month (August 2006-January 2007) and each study month (August 2007-January 2008). The consumption data of sample participants would be analyzed only if the HEMS had been installed the month prior to the month of analysis. For instance if a HEMS was installed in a home in July, analysis of that household's consumption data began with the applicable August months (see Table 3.2). As mentioned in Section 3.2, all control group participants were paired with a sample group participant that had similar electricity consumption behaviours. As a result, a control group participant's electricity consumption would not be analyzed prior to its paired sample group participant. The installation of HEMS occurred between July 2007 and October 2007. This has meant that the analysis of participants' electricity consumption has been staggered over the months of August to October (see Table 3.2).

When the sample and control groups' total baseline and study months' consumption was found, calculations were completed to find the percentage change in electricity consumption for each TOU period in each month. This was in addition to finding percentage changes in total consumption for each month. The calculation for percentage change in consumption was completed using the average result of the following two equations. The first equation involved finding the group's total consumption for a paired baseline and study month, for instance August 2006 and August 2007. The delta was then found by subtracting the baseline month's consumption from the study month's consumption. To find the percentage change in consumption the delta was divided by the applicable baseline month's consumption. This process was repeated to find the similar results for the on-, mid-, and off-peak consumption totals of each month. This approach will be referred to as the group percentage change and its equation can be found below.

Equation 1- Group Percentage Change Equation

Group's study month X consumption – Group's baseline month X consumption

= X group delta

X group delta/ Group's baseline month X consumption

= X group percentage change

The second equation used to find change in consumption will be referred to as the individual percentage. This involved finding the consumption delta for each participant. Using the consumption delta the percentage change in consumption was found by dividing the individual's delta by the individual's baseline month's consumption. All the individual percentage changes were summed, the mean was found, and referred to as the individual percentage change. The equation for this approach can be found below.

Equation 2- Individual Percentage Change Equation

Individual's baseline month X consumption - Individual's study month X consumption

= X individual delta

X individual delta/ Individual's baseline month X consumption

= X percentage change

Sum of X percentage change / Number of participants

= X individual percentage change

Each of these equations is necessary to address the variation in the results the other equation produced. The calculation of the group percentage change gives greater value to the results of the participants that were high consumers in the baseline months, whereas, the individual percentage group equation gives greater value to the lower baseline consumers. To address this skewness in the data the means for both these approaches were averaged to produce a result referred to as the average percentage change. (see equation below).

Equation 3- Average Percentage Change Equation

X month group percentage change + X month individual percentage change / 2

= X average percentage change

The average percentage change was found to determine the percentage change in total consumption and on-, mid-, and off-peak consumption for all the months in the study.

Finding the participants' percentage changes in consumption was necessary to help answer the study's primary question, which is, 'Do home energy management systems influence the total and on-peak electricity consumption behaviours of participating households in Milton, Ontario?' Finding the change in consumption for each month was important in determining if there was a seasonal or temporal setting when the HEMS was most effective. Deltas for total consumption and on-, mid-, and off-peak consumption were found to determine if these changes in behaviour involved reductions or shifts in electricity consumption.

To determine the direction of shifts in electricity consumption the following equation was completed for each TOU period in each of the study's months. It involved calculating changes in the applicable TOU periods' consumption ratio. These ratios were created using the calculations from the group percentage change equation. To determine these changes the Z TOU period's consumption ratio for X baseline month was subtracted from the Z TOU period's consumption ratio for X study month. The X month's Z TOU period consumption shift was then divided by the X month's Z TOU period percentage of total baseline consumption, to get the X month's Z TOU percent shift (See equation below).

Equation 4- TOU Shift Equation

X month's Z TOU period baseline consumption/ X total month baseline consumption
= X month's Z TOU period baseline consumption ratio
X month's Z TOU period study consumption/ X total month study consumption
= X month's Z TOU period study consumption ratio
X month's Z TOU period baseline consumption ratio – X month's Z TOU period study consumption ratio
= X month's Z TOU period consumption shift
Z TOU period consumption shift/ X month's Z TOU period total baseline consumption percentage
= X month's Z TOU percent shift

Documenting the different TOU periods' consumption shift provides insight into how participants consume during designated TOU periods. It also gives a sense of how load shifting has occurred among study group participants.

Section 3.7- Methodology's Limitations

The prominent limitations within this study's methodology relate to the sampling method, survey respondent deception, and the weather normalization of consumption data.

The sampling method employed by Direct Energy Ltd. when recruiting participants was random. It allowed all members of the Milton population who met the study criteria an equal opportunity to participate. However, the procedure that was used to solicit the sample allowed for systematic error. This is an error that 'commonly occurs when the sampling procedure acts in a consistent, systematic way to make some sampling element more likely to be chosen for participation.' (Palys 2007: 113). Direct Energy Ltd.'s sampling procedure was a self-selection process that advertised the study as a conservation initiative. As a result, there was a pro-conservation bias among participants. This limits the generalizations that can be made about the study's results and will likely limit the reduction and shifts seen in the study's findings.

The second limitation relates to the anonymity of the online survey. This anonymity increases the possibility for respondent deception to occur. This means that participants can falsely identify themselves in the survey. This creates multiple problems for the findings of this study. During the baseline survey it was possible for the respondent to falsely identify themselves as the household's energy manager, the study's assigned unit of data collection. It can also be a problem if the respondent falsely identifies themselves during the follow-up survey as the respondent of the baseline survey, thus, making comparisons between the two surveys void. Like with many surveys it was possible for respondents to deceive the researcher by responding in a manner that they believe to be socially desirable and not necessarily the way they feel. This has been a problem that has arisen in previous electricity conservation studies (Kantola et al. 1984).

In electricity consumption studies that compare year-over-year consumption results it is a common practice to have the data weather normalized. This process adjusts the consumption data to account for abnormal weather patterns that may have occurred during the reviewed years. Though there were attempts to do so, scheduling conflicts and a lack of resources did not allow for weather normalization to be completed for this study. As a result, conclusions can not be reached based on the sample participants' absolute consumption. All conclusions were based on consumption relative to the control participants' consumption, with the assumption that the presence of the control group will control for any abnormal weather that may have occurred during the baseline and study months. Since the members of both groups were exposed to the same weather patterns.

Chapter 4- Results

This chapter will present the results of this study's primary methods of data collection: baseline survey, follow-up survey, and archival data. It should be noted that there has been no attempt to analyze these results; such efforts will be completed in the following chapter (Chapter 5-Discussion).

Section 4.1 will describe the context of the study, its geographical and population boundaries, and the sampling procedures. It will then elaborate on the questions and results of the sample's and control's baseline survey. This will involve a comparison of findings between the two study groups and with the greater Milton and Ontario populations. It will also highlights potential variables that may influence comparisons of year-over-year electricity consumption results.

Section 4.2 will present an overview of the recipients of the sample and control follow-up surveys. This will be followed by the presentation of the follow-up survey results. This will include comparisons of the sample and control groups' follow-up survey responses and the results of the Direct Energy Smart Home Energy System section, which depicts the respondents use and opinion of their HEMS. The section will conclude with the results pertaining to variables, other than the HEMS, that may have influenced household electricity consumption and conservation attitudes.

Section 4.3 will cover all results related to the electricity consumption data of the sample and control groups. This will include the group's and individual's totals that relate to baseline and study period's electricity consumption. Also, included will be the total, on-, mid-, and off-peak delta results (change in consumption between the baseline month and its applicable study month, e.g. August 2006 and August 2007) for each applicable month. To determine the statistical significance of these consumption results repeated measures of ANOVA tests were run on the sample group's and control group's totals. These results will be provided along with the results of the chi square tests that were run to measure the influence particular variables had on the effectiveness of the HEMS. In the cases where these tests did not render significant results, descriptive statistics were used to build upon the study's findings.

Section 4.1- Baseline Survey Results

The study had two versions of a baseline survey: one given to sample group participants and one given to control group participants. In the case of the sample group, the108 participants that had their HEMS installed in their home prior to October 31, 2007 were given the opportunity to complete the baseline survey. These 108 households will be referred to as the sample participants (SP). Sixty-nine of the SP responded to the provided baseline survey. These 69 households will be referred to as the sample respondents (SR). This was a 64% response rate. In the case of the control group's baseline survey 300 households were selected to receive the baseline survey. Twenty-three of the 300 households responded to the survey, which was equal to an 8% response rate. The 23 households that did complete the survey are referred to as the control respondents (CR). Using the approach described in Section 3.2.2 an additional 85 households were added to the 23 households in the CR to create a group of 108 households that will be referred to as the control participants (CP).

Due to the substantial difference in size between the SR and the CR, comparisons between these two groups will be based on percentages, rather than frequency of response.

4.1.1 Structural and Demographic

The results given for the structural and demographic sections of the survey only pertain to the sample and control respondents. For the variety of reasons stated in Section 2.5, it was deemed important to have an idea of the structural and demographic characteristics of the sample and control groups. The content of these sections were the same for both surveys. The purpose of the sample's baseline survey was to have an understanding of who was in the group and to determine if there were variables, other than the HEMS, that may have an influence on the respondent's electricity consumption behaviour. The purpose of the control's baseline survey was to determine the similarities and differences between the two groups prior to the installation of the HEMS. This was necessary to assess the appropriateness of the control group.

With these purposes in mind the structural and demographic sections contained a number of multiple choice and yes/no questions designed to gain a better understanding of the structural and demographic make-up of the home and its occupants. Many of these questions included an open-ended option for those who could not find a suitable answer from the options provided or when additional information was necessary. The following are examples of some typical questions for this section that follow the aforementioned format.

Example #1

A9. Have you changed from using an electric to a gas appliance in the past year?
Yes ☐ No ☐ What Appliance #1: ____________________ In What Season: ____________________
What Appliance #2: ____________________ In What Season: ____________________

Example # 2

E3. Please indicate the highest level of education that you have completed (check only one)

Some grade or high school	☐	University Bachelors Degree	☐
High school diploma	☐	Graduate Degree	☐
College or Technical Diploma	☐	Other: ____________________	☐

As previously mentioned, each question in this survey serves one of the following three purposes:

1) Establish a baseline for comparison with the follow-up survey results.
2) Determine if a change has occurred that may be responsible for changes in year-over-year electricity consumption.
3) Determine if particular characteristics of the respondent or household allow for optimal use of a HEMS.

The purpose of each structural and demographic question is described in Tables 4.1 and 4.2. (The purposes are given numbers that are associated with the three purposes listed above.) The surveys in their entirety can be found in Appendix I.B.

Table 4.1- Types and purposes of structural questions

Types of Questions	Purpose
Housing Age	3
Housing Size	3
Programmable Devices	3
Thermostat	3
Appliance Power Source	3
Appliance Age	3
Change in Power Source	2
Purchase of Appliances/Electronics	2

Table 4.2- Types and purposes of demographic questions

Types of Questions	Purpose
Gender	3
Age	3
Education Level	3
Total Household Income	3
Employment Status	3
Number of Occupants	2,3
Free Time	3
Residents for More than One Year	N/A
Vacations	2
Change in Income	2

The results of the structural portion of the baseline survey were fairly similar among the majority of the SR and CR. This was particularly evident with respect to the age of the homes: 91% of SR reported having a home less than four years of age, and no respondent had a home older than seven years. The CR had similar results: 83% reported that they had homes less than four years of age, and no respondent had a home older than seven years. Table 4.3 depicts additional structural variables that the majority of respondents had in common-within 15 percentage points (see Appendix II.A for sample and Appendix II.B control baseline results).

Table 4.3- Similar structural characteristics

Structural Characteristic	Respondent Group	Percentage
Homes with electrically powered clothes dryers.	Sample Respondents	85%
	Control Respondents	96%
Homes with electrically powered oven.	Sample Respondents	70%
	Control Respondents	82%
Homes with gas powered water heaters.	Sample Respondents	72%
	Control Respondents	60%
Homes with gas powered heating source.	Sample Respondents	70%
	Control Respondents	77%

The SR's and CR's household appliances, like the homes they were found in, were all relatively new. With the exception of the household freezer, which in 86% of households was less than ten years of age, 95%-100% of all other households appliances were less than ten years old. The SR's and CR's furnaces and air conditioners were always found to be less than ten years old. These percentages do not consider households that were unsure of the appliance's age or did not indicate an answer for the question. Table 4.4 describes the percentage of appliances that were found to be less than ten years old and appliances reported to be ENERGY STAR certified.

Table 4.4- Appliance age

Appliances	Respondent Group	Appliances less than 10yrs/old (%)	ENERGY STAR Appliance (%)
Oven	Sample Respondents	100	32
	Control Respondents	100	45
Washer	Sample Respondents	98	46
	Control Respondents	100	55
Dryer	Sample Respondents	97	39
	Control Respondents	100	62
Dishwasher	Sample Respondents	100	38
	Control Respondents	100	59
Fridge	Sample Respondents	95	52
	Control Respondents	100	29
Freezer	Sample Respondents	86	26
	Control Respondents	87	13
Fridge/Freezer Combo	Sample Respondents	100	44
	Control Respondents	100	50

With the exception of the freezer, which was owned by 54% of the SR and 65% of the CR, all the listed appliances had ownership ranging from 91%-97% among both groups. In addition to the listed appliances, 100% of the SR reported having heating and air conditioning, 4% indicated that they had a swimming pool, 22% said they had a whirlpool, and 9% said they had a hot tub. Whereas, 100% of the CR reported having heating and air conditioning, 4% indicated that they had a swimming pool, 9% said they had a whirlpool, and no respondent reported having a hot tub.

When asked if respondents in either group had changed the power source of a major appliance or electronic in the previous year, 4% of the SR reported changing from an electrically powered appliance to a gas powered appliance; no CR reported such a change. Eleven percent of the SR and 13% of the CR reported purchasing a product in the last year that they believed would alter their electricity consumption. (For list of electricity altering products see Appendix III.)

Responses to the demographic section were relatively less similar, the exception for both groups being respondent's employment status and income level. At least 90% of respondents from both groups reported being employed: 95% of the SR and 90% of the CR. With respect to income, at least 75% of respondents reported that their household taxable earnings were greater than $100,000: 75% of the SR and 87% of the CR. With a population that was 75% male, the SR was predominately male, while the CR was more evenly divided: 52% male and 48% female.

For both groups responses to the number of occupants in the household were dispersed relatively evenly among most potential responses. Age group responses were also relatively evenly dispensed among the younger cohort (under 50 yrs old). Within the SR group level of educational attainment was also relatively evenly dispersed among most potential responses. This was not the case within the CR where the majority reported college and tech diplomas being the highest level of educational attainment. (See Figures 4.1, Figure 4.2, and Figure 4.3 for percentages.)

Figure 4.1- Participants age groups (age in years).

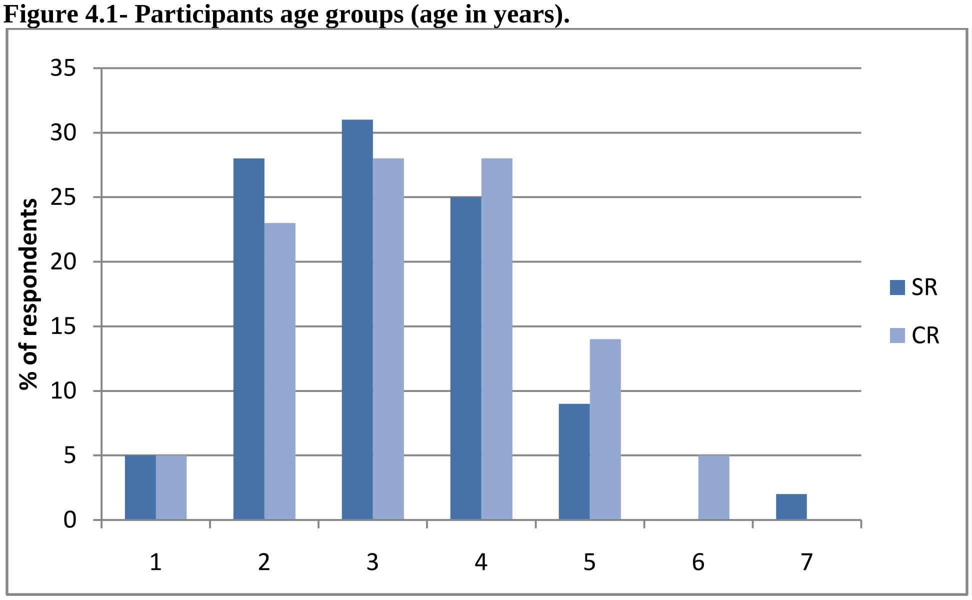


Figure 4.2- Number of occupants in households at start of study.

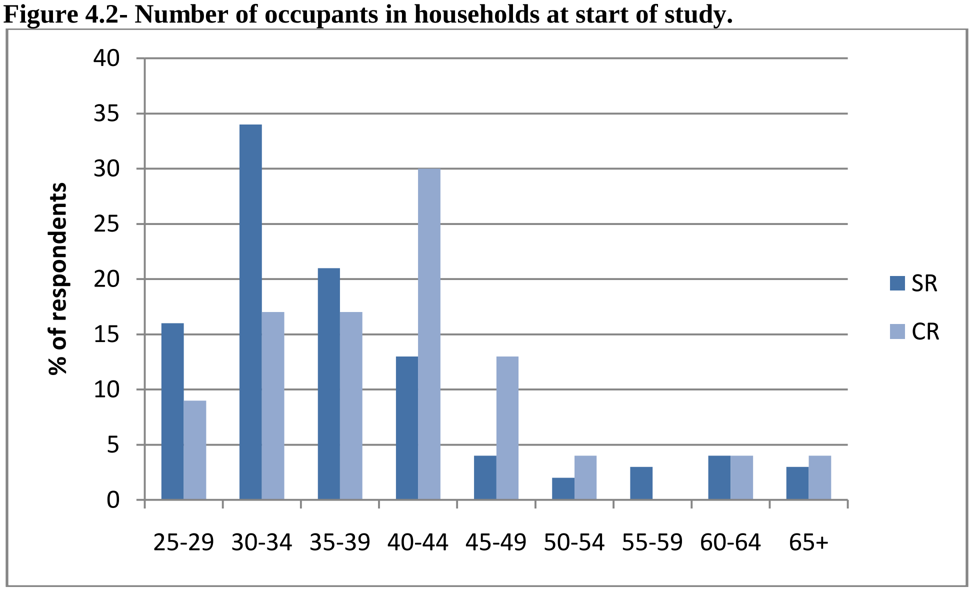
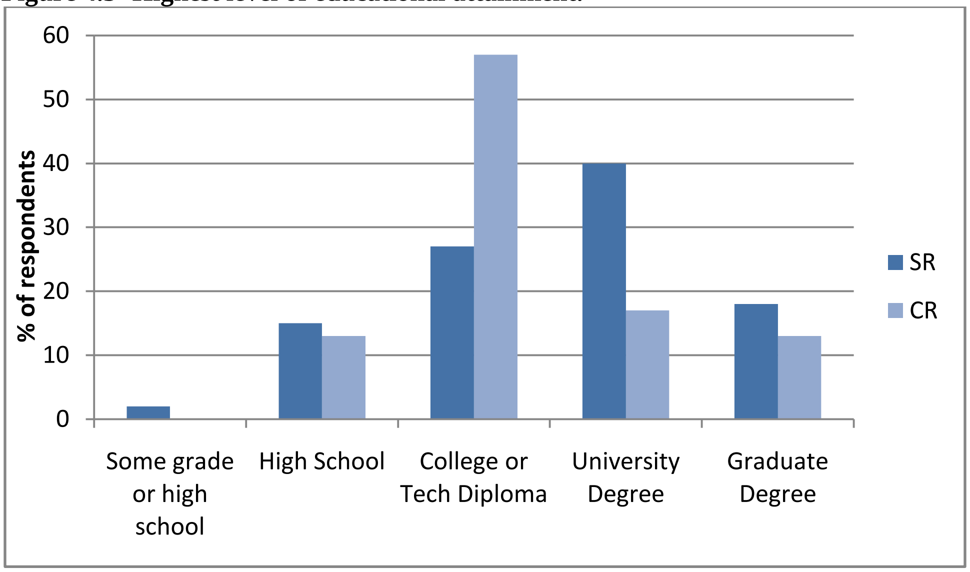


Figure 4.3- Highest level of educational attainment.



As has been previously mentioned, the sampling methods used in this case study do not allow for generalizations about Milton's or Ontario's residents. However, to further set the context and the relevancy of this study's findings, Table 4.5 compares the 2006 Canadian Census results with the study's baseline survey results.

Table 4.5- Census and baseline survey results comparison

Variables		Ontario (2006 Census)	Milton (2006 Census)	Baseline Sample Respondents	Baseline Control Respondents
Population		12,160,282	53,939	69	23
Number of Private Residential Dwellings		4,972,869	18,448	69	23
Dwelling Ownership (%)		71%	88%	100%	100%
Gender (Male% /Female %)		49%/51%	50%/50%	75%/25%	52%/48%
Median Age		39	34	35	41
Average number of Household Occupants		2.6	2.9	3.1	3.3
Gross Household Income Median		60,001-$80000 (Median-$72,734)	$80,001-$100,000 (Median-$87,739)	$100,001-$150,000	$100,001-$150,000
Employment Status		Employed- 94%	Employed- 96%	Employed- 95%	Employed- 90%
Household's Highest Level of Education		[1]University- 26% College/Trade-31%	[1]University- 28% College/Trade-34%	[2]University- 47% College/Trade-27%	[2]University- 30% College/Trade-57%
Lived in same Residence a year ago		87%	80%	96%	87%
Housing Type (%)	Detached	56%	65%	60%	82%
	Semi-detached	6%	11%	18%	18%
	Rowhouses	8%	15%	22%	0%

[1] Only consider those 25yrs-65 yrs of age.
[2]Accounts for the respondent's highest level of education

Section 4.1.2 Attitudinal and Knowledge

As was the case in Section 4.1.1, the results given in this section only pertain to the SR and CR. With the exception of one question, relating to why participants wanted a HEMS, the attitudinal and knowledge sections of both surveys were the same. The purpose of these sections was to record respondents' electricity consumption attitudes and knowledge at the time of the HEMS installation. Likert scales were used for the majority of the section's questions. This made it possible for respondents to provide self-assessments of their attitudes toward, and knowledge of, electricity conservation. Due to a technical error in the online survey coding, question C.4 on the importance of conservation did not record the SR's responses. Due to this technical error this question was not included among the CR's results. Using the numbering system provided in section 4.1.1, Tables 4.6 and 4.7 present the purposes of asking the questions in the attitudinal and knowledge sections.

Table 4.6- Types and purposes of attitudinal questions

Types of Questions	Purpose
Reasons for Participation	1, 3
Electricity Consumption Awareness	1, 2, 3
Moral Obligation to Conserve	1, 3
Importance of Conservation	1, 3
Ranking Conservation Importance*	1, 3
Family and Friends Conservation Outlook	3
Opinion of Electricity Prices	3

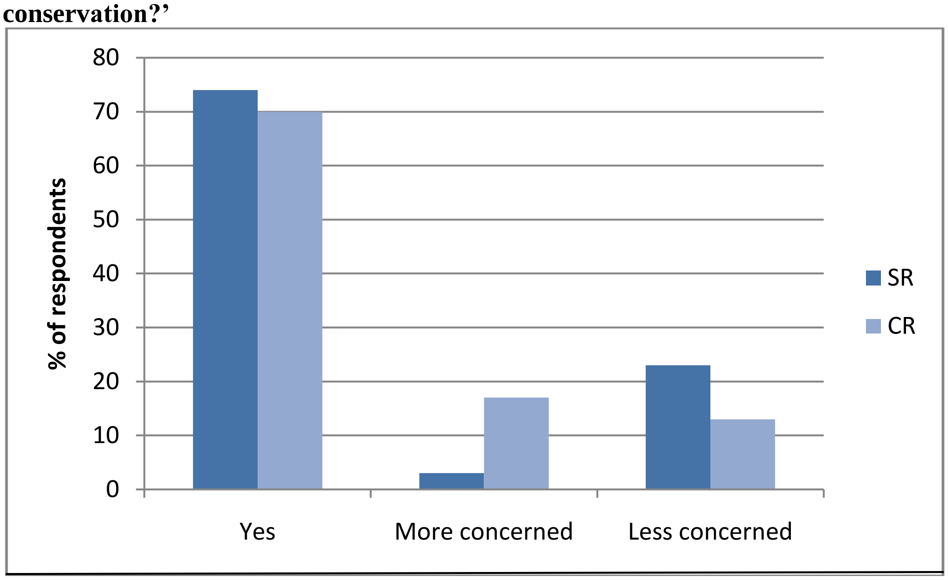
*Due to a coding error the SR and CR results were not recorded.

Table 4.7- Types and purposes of knowledge questions.

Types of Questions	Purpose
Potential of Conservation	1, 3
Information Needed to Improve Conservation Efforts	3
Attention to Electricity Bill	1, 3
Electricity Use and Your Children	1, 3
Media's Influence	3
Media's Presence	2
Technological Competence	3

The results of the baseline surveys' attitudinal sections revealed the range of feelings and opinion that the study's respondents had about electricity conservation. In many cases the same range of opinions were felt among the SR and CR. This was evident with the responses given for questions regarding electricity consumption awareness and electricity prices. Respondents felt that they are more aware of electricity prices now than a year ago: 71% of the SR and 70% of the CR. Similar majorities felt that the price of electricity in Ontario is too high: 80% of the SR and 87% of the CR. In some cases there was no diversity in response among either group. This was the case with the question pertaining to the importance of electricity conservation. In both groups it was almost unanimously agreed that electricity conservation was an important issue: 97% of SR agreed, 96% of CR agreed. However, as seen in Figure 4.4, responses between groups were not always similar; this was case with the question about family and friends' outlook on electricity consumption. Though the majority of respondents in both cases felt that they shared similar outlooks on electricity as their friends, 74% of the SR and 70% of the CR, the secondary responses differed. More people in the SR felt that they were less concerned about electricity conservation than their friends, while those in the CR believed that they were more concerned about electricity conservation than their friends.

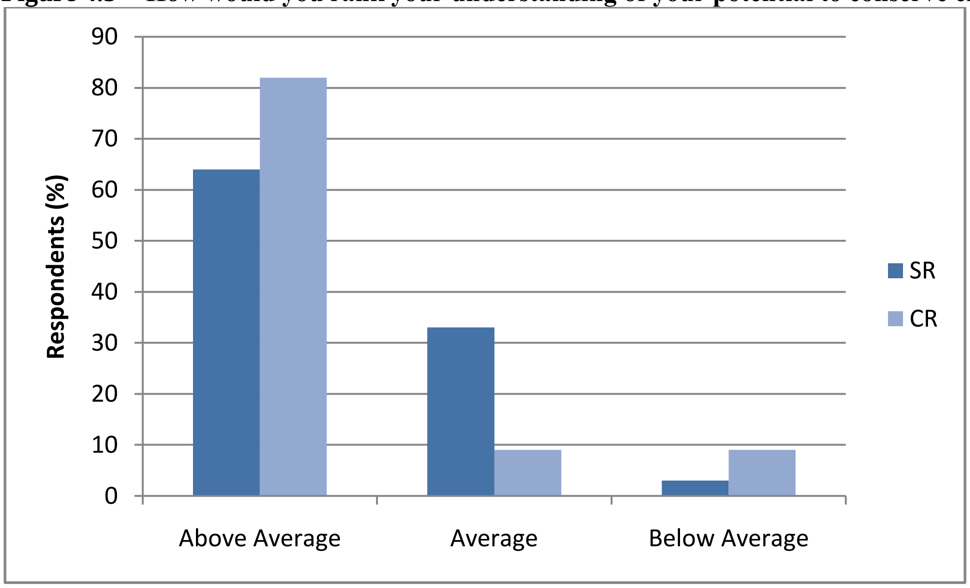
Figure 4.4- 'Generally, do you feel that your family and friends share your outlook on electricity conservation?'



Similar to the attitudinal responses, the knowledge responses had questions where the primary response was similar among both groups, but the secondary response differed. This was the case with the questions pertaining to respondents' self assessment of the media's influence on their decision making. In both groups approximately 40% of the respondents believed that the media's influence on them was average. However, the trend deviated as a greater percentage of SR believed that the media had an above average influence on their decision making (39%), whereas, a similar proportion of the CR group believed that the media's influence on them was below average (35%).

Discrepancies in responses between groups were greater for the questions regarding respondent's potential to conserve. As seen in Figure 4.5, 64% of SR respondents believed that they had an above average understanding of conservation, compared to the 82% of CR that had this belief. In addition, 33% of SR felt that they had an average understanding, while 9% of the CR felt this way.

Figure 4.5- "How would you rank your understanding of your potential to conserve electricity?'



Section 4.1.3- Behavioural Section

The fifth section of this study's baseline survey was the behavioural section. This section was included as a means to gain information about how the household occupants used electricity in the home. This portion of the survey consisted primarily of multiple choice and Likert scale questions. The questions in this section were included for the three purposes mentioned previously in Section 4.1.1. Table 4.8 describes the types of questions asked in this section and their purpose. Each question is assigned a number or numbers that is/are associated with the purposes identified previously.

Table 4.8- Types and purposes of behavioural questions

Types of Questions	Purpose
Thermostat Setting	1, 3
Laundry Behaviour	3
Lighting Behaviour	3
Weekday Appliance/Electronics Usage	1
Weekend Appliance/Electronics Usage	1
Conservation Initiatives	3
Effort to Reduce Electricity Consumption	1,3

As was the case with prior sections, the responses of the SR and CR for the behavioural section in most accounts were similar. For instance, when asked about lighting usage, responses were evenly distributed among the three most popular answers for both groups (see Figure 4.6). When asked about potential conservation initiatives that participants may be interested in adopting, the majority of respondents indicated in each case, that it was not necessary to pursue the initiative (see Appendix II.A&B). Lastly, participants were asked to report the seasonal temperature settings of their thermostats. As seen in Table 4.9 the SR preferred slightly higher average interior temperatures in the winter and summer months. The range between minimum and maximum thermostat settings within the SR for each season/event was consistently larger than the CR's range.

Figure 4.6- Which of the following statements best describe your household's usage of lights

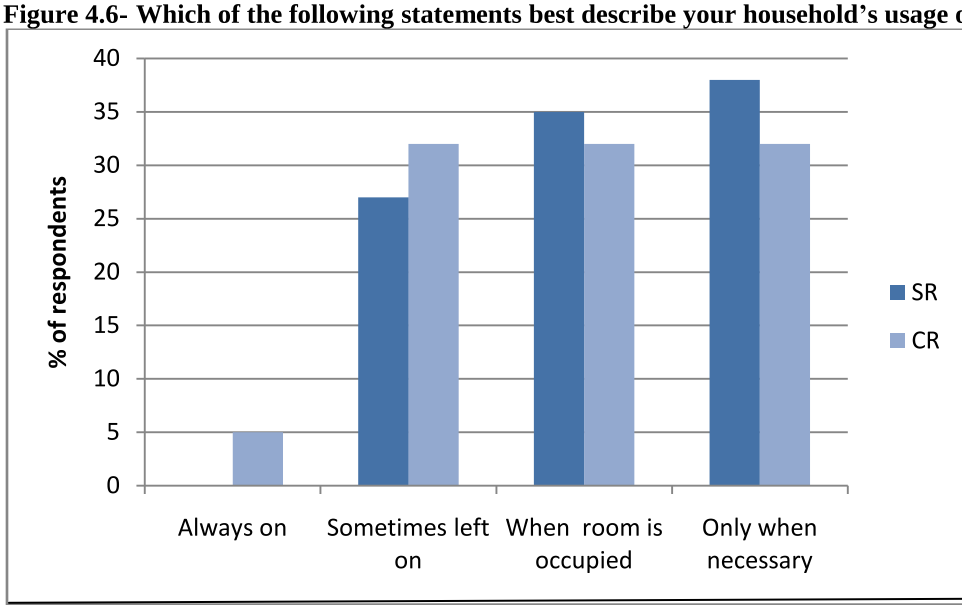


Table 4.9- Thermostat settings in degrees Celsius (°C)

	Sample Respondents (SR)			Control Respondents (CR)		
Season/Event	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
Winter /at home	22°C	12°C	28°C	21°C	18°C	25°C
Winter/asleep_away	20°C	14°C	27°C	19°C	16°C	21°C
Summer/at home	23°C	15°C	32°C	22°C	18°C	25°C
Summer/asleep_away	25°C	15°C	30°C	23°C	17°C	28°C

Question 4 of the behavioural section asked participants of both groups to 'indicate the total number of hours that are spent at home from Monday to Friday using the listed appliances and during what timeframe the appliance is used/left on.' Responses to this question ranged from using a particular appliance for ten minutes to ten hours. There appeared to be a misunderstanding by some respondents who may have responded to this question citing the number of hours they use the appliance each day rather than the total number of hours used during the five day work week. This problem was also present with question 5, which was a similar question pertaining to weekend usage (see Appendix I.B). Unfortunately, due to these erratic responses it cannot be known for certain how the respondent interpreted these questions. Therefore, the results of these questions will be used minimally in the subsequent analysis.

Section 4.2- Follow-Up Survey

In an effort to account for changes that may have occurred during the course of the study and allow participants a medium to provide feedback, a follow-up survey was included in the study's research design. The follow-up survey also had structural, behavioural, attitudinal, knowledge, and demographic sections. Each of these sections had questions similar to those that were asked in the baseline survey. In addition to these sections the follow-up sample survey had a ten question section pertaining to the HEMS. This section was intended to allow participants to comment on their use and the effectiveness of the HEMS. Again there was a sample survey and a control survey. The difference was that the control follow-up survey did not have the HEMS section. (See Appendix I for sample and control follow-up surveys.)

The sample and control follow-up survey recipients were only those who had completed the baseline survey. This was due to the need to have the respondent's baseline responses in order to account for changes that may have occurred during the study. This meant that there were 69 eligible recipients of the sample follow-up survey and 23 eligible recipients of the control follow-up survey. From this, 24 recipients responded to the sample follow-up survey and 18 recipients responded to the control follow-up survey, this was a response rate of 35% and 78% respectively. The 24 respondents of the sample follow-up survey will now be referred to as the SFR and the 17 control follow-up survey respondents will be referred to as CFR. The limited number of respondents to both surveys limits the substance of these results. However, these responses can reveal trends and stories that may allow for advancement in this research.

Section 4.2.1- Follow-up Structural and Demographic Results

The follow-up survey was implemented to measure change of two types, change that was the result of the HEMS and change that was due to factors other than the HEMS. The questions in the structural and demographic sections were intended to address the latter changes. These sections found that the respondents of both groups did not change the source of power for any major electricity consuming appliance and both groups had similar, minor changes, with regard to new appliances and renovations, income, changes in occupancy, and vacation patterns (see Appendix II.C for details). Therefore, based on this limited amount of information, it is assumed that influential structural and demographic variables other than the HEMS are controlled.

Section 4.2.2- Follow-up Behaviour, Attitudinal, and Knowledge Results

The follow-up survey's behaviour, attitudinal, and knowledge sections measured changes that may have been due to the HEMS. Such measurements are possible by comparing the responses of both surveys for both the respondent groups. These comparisons are then evaluated against each other to determine if the patterns are alike.

The behavioural section's results indicated limited changes in behaviours with respect to adopting conservation initiatives and efforts to conserve electricity (see Appendix II.C for follow-up survey results and measurements of change).

The follow-up survey detected changes associated with lighting use within and between the groups. Within the SFR the percentage of respondents reporting that they sometimes left their lights on increased from 29% to 50% during the course of the study, the CFR group did not experience such a change (29% to 22%). Like the behavioural section the attitudinal section displayed limited changes in response. The few SFRs that did not believe that conservation was important at the start of the study experienced a change in attitude during the course of the study (91% to 100%), while the CFRs' responses to this question remained constant (94%). The questions pertaining to one's moral obligation to conserve and opinion of Ontario's electricity prices remained relatively constant within and between groups' respondents (see Figure.4.7 and Figure 4.8).

Figure 4.7- Belief in being morally obligated to reduce electricity consumption.

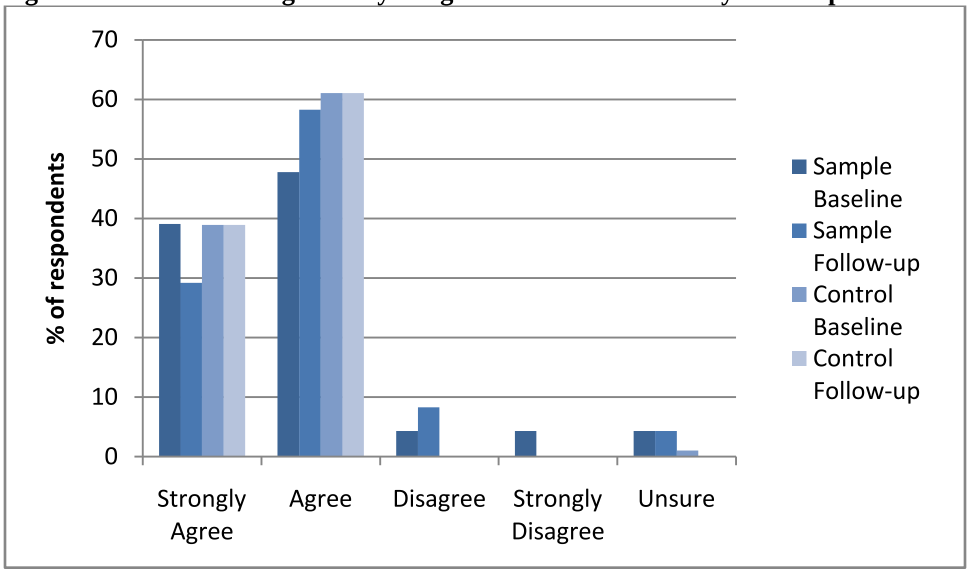
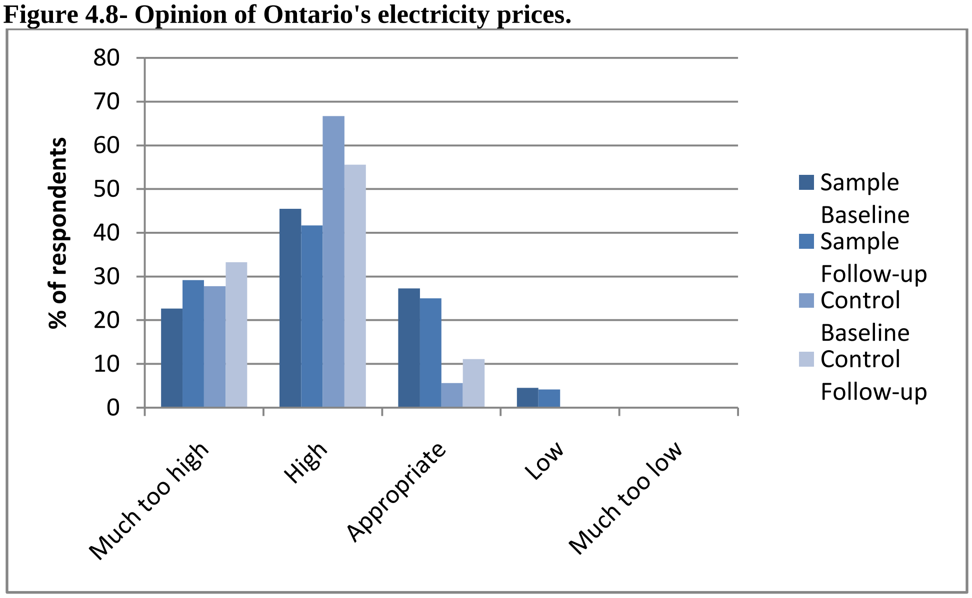


Figure 4.8- Opinion of Ontario's electricity prices.



When asked if the participants talked about electricity conservation with their children, 90% of SFR did at the start of the study and 72% said they did at the end. The CFR had similar results; 90% said they did at the start of the study and 64% said they did at the end of the study. The pattern of response to the questions regarding one's understanding of their potential to conserve electricity and the amount of attention participants pay to their electricity bill followed similar trends within each group. As displayed in the Figures 4.9 and 4.10, the respondents of both groups had similar results at the start of the study. However, while the SRF's responses remained relatively constant throughout the study, the CRF's responses declined with regard to their self-perceived potential to conserve and their awareness of their electricity bill.

Figure 4.9- Understanding of potential to conserve

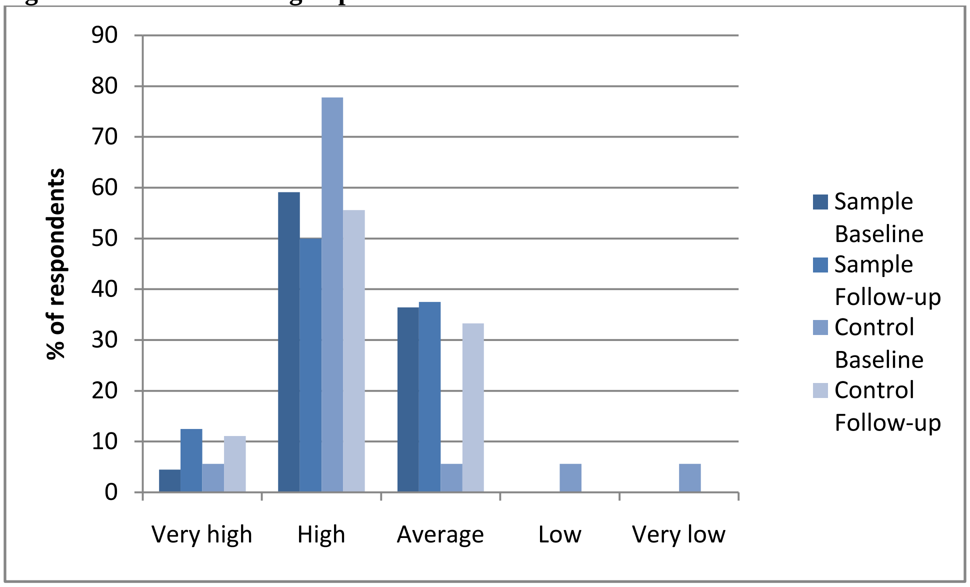
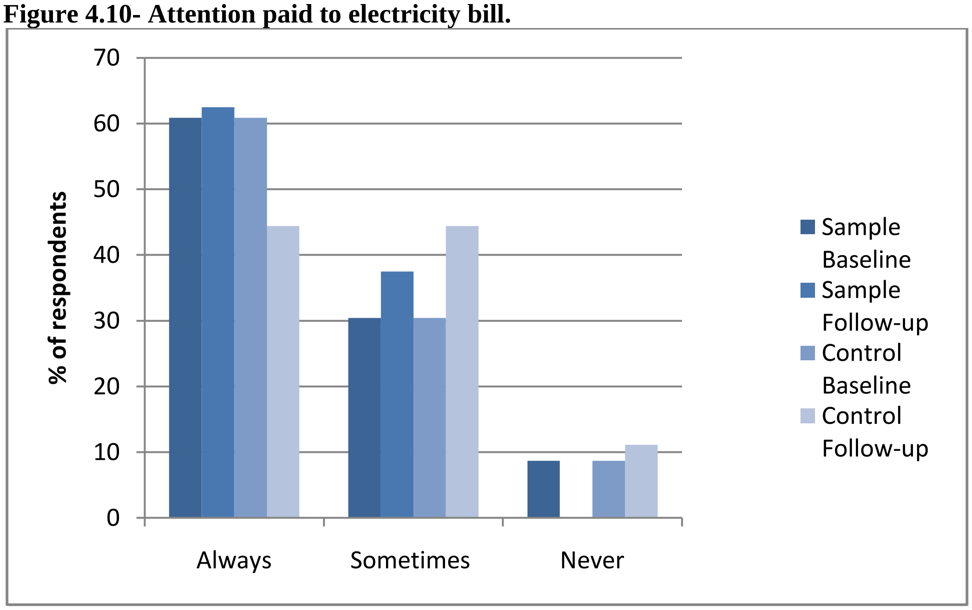


Figure 4.10- Attention paid to electricity bill.



Section 4.2.-3 Home Energy Management System Results

The intention of the 'Direct Energy Smart Home Energy System' section was to provide the SFR with a medium to communicate information about their experiences with the HEMS. As a result, the majority of questions in this section used a Likert scale, allowing respondents to rate the effectiveness of the system's features. Due to the HEMS focus of this section, these questions were only made available in the sample follow-up survey.

The primary focus of this section was to determine how different participants used the HEMS. Fifty percent of respondents reported logging into their HEMS on a weekly basis. Fifty-four percent of the respondents reported using the feedback feature less frequently than they did at the start of the study, while 38% of the respondents reported using the programmable features less frequently than they did at the start of the study. When respondents did use the HEMS, 71% acknowledged using the detail section of the web portal. This section provided the respondent with information about Ontario's electricity generation. Responses to what temporal setting users preferred to view showed feedback split with 54% preferring the daily setting and 38% preferring the weekly setting. When asked the preferred visual setting for viewing their consumption feedback, the majority of respondents (58%) reported using the bar chart setting instead of the line and 3D graph settings.

As displayed in Figure 4.11 and Figure 4.12 there was no consensus on what feature or features catalyzed respondents to change their behaviour and reduce or shift their electricity consumption. There was greater agreement on the effect that feedback had on the respondent's outlook on their electricity consumption: 72% of respondents reported that their electricity consumption feedback was what they expected, while 4% of respondents reported that their feedback indicated higher than expected electricity consumption levels and 24% indicated that their electricity consumption was lower than expected.

Lastly, this section asked participants what they believed was the primary function of the HEMS. The following were the provided possible responses; convenience, education tool, electricity conservation, home security, monetary savings, none of the above, and other. As shown in Figure 4.13, the responses were distributed fairly evenly among convenience, education tool, and electricity conservation.

Figure 4.11-'Which of the following Direct Energy Smart Home Energy System features do you feel helps you reduce your total electricity consumption?' (n=24)

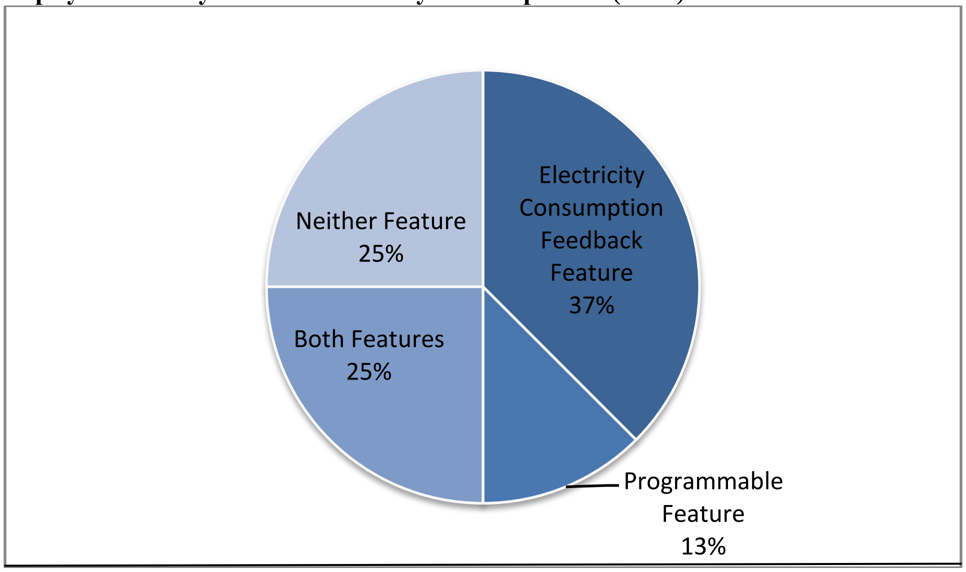


Figure 4.12- Which of the following Direct Energy Smart Home Energy System features do you feel helps you shift your electricity consumption from on-peak use? (n=24)

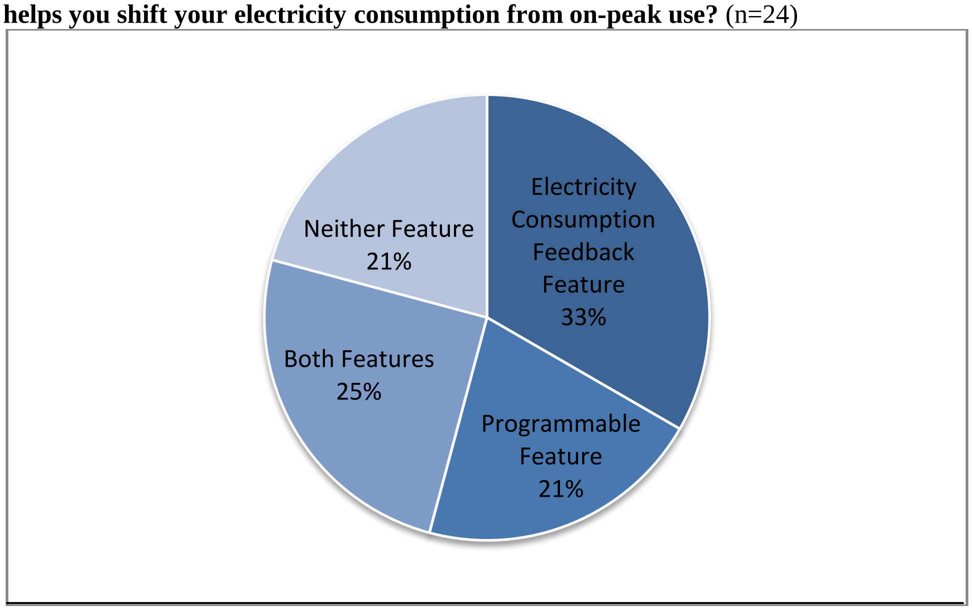
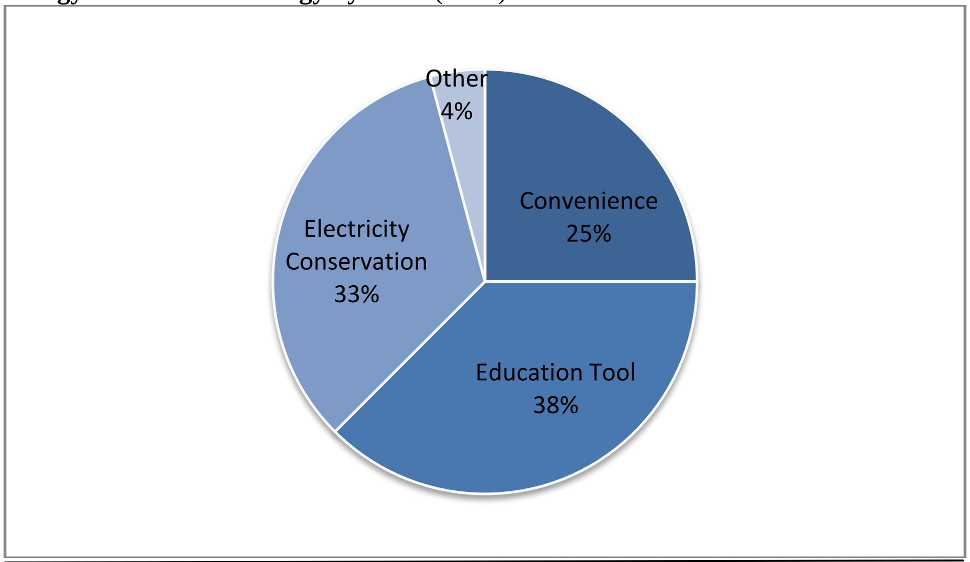


Figure 4.13- Which of the following do you feel best describes the primary function of the Direct Energy Smart Home Energy System? (n=24)



Section 4.3- Consumption Results

The results that have come via the baseline and follow-up surveys provide important insights into participants' electricity consumption behaviours. However, these are self-reported accounts of their behaviours that, for a variety of reasons, can be inaccurate. Therefore, it was also important to consider participants' metered interval electricity consumption data when making assessments about changes in electricity consumption behaviours. Likewise, it was important to account for the factors addressed in both surveys to limit the likelihood of the intervention, the HEMS, being wrongly accredited for changes in consumption. The inclusion of both these methods along with the study's literature review allows for a triangulation of data collection that addresses problems associated with construct validity (Yin 2003).

The following section will use parametric tests, non-parametric tests, and descriptive statistics to communicate any changes that may have occurred to the participants' electricity consumption behaviours during the course of the study. As was the case with the previous sections, this section will not attempt to analyze these results.

Section 4.3.1- 'The Data'

Throughout the course of the study Milton Hydro Inc. provided the metered interval electricity consumption data of the study's SP and CP. All consumption data from May 2006 to January 2008 were made available. Having data for this time period assisted in selecting an appropriate control group and allowed for comparisons of consumption between the baseline and study months.

When the data were received it had not been weather normalised. As mentioned in Section 3.6, attempts were made to have the data weather normalised. Unfortunately, due to time and resource constraints this was not possible. This limitation was addressed by altering the study's analytical approach from absolute electricity consumption comparisons to relative consumption comparisons.

In addition to not being weather normalised there were five occasions when a household's meter did not read the home's electrical consumption. For these events the means of the household's prior and following week's consumption were calculated and substituted. For instance if the meter misread a household's interval electricity consumption for October 19, 2007, the means for that interval period on October 12, 2007 and October 26, 2007 would be calculated and substituted. This was the only type of alteration that was made to the data.

Section 4.3.2 Consumption Totals

The focus of this study is on both the reductions and shifts in electricity consumption. In order to analyze these reductions and shifts in electricity consumption the totals for each time-of-use period was calculated for the baseline months (August 2006, September 2006, October 2006, November 2006, December 2006, January 2007) and the study months (August 2007, September 2007, October 2007, November 2007, December 2007, January 2008). This was done following the equations described in Section 3.5 (see Appendix IV.A). It should be noted the consumption of all the SP and CP were not considered in the August, September, and October month's calculation. To ensure that the participant had the system in their home for the month being evaluated only households that had the system installed in a month prior to the evaluated month had their consumption data considered (see Table 3.1).

In Figures 4.14 and 4.15. the total November 2006 to January 2007, and November 2007 to January 2008 consumption of the sample and control groups' participants is presented. (These months were selected because during these months all 216 sample and control participants were participating.) Figures 4.16 and 4.17 display similar information pertaining to on-peak consumption. In all four figures the right tail of the curve is elongated indicating that there are some high consuming outliers in each group for both consumption periods. The most visible changes in total consumption appeared to have occurred among both groups' conservers- those participants whose three month total consumption ranged from 500 to 2000 kWh.   For both groups it appeared that the conservers' study months' consumption increased when compared to the baseline months. Changes in on-peak consumption have also appeared to occur among both groups' on-peak conservers- those that consumed between 100 to 400 kWh during the three months. For both groups the level of on-peak consumption grew among the conservers, however according to Figures 4.16 and 4.17 the rate of growth appeared to be larger among the control's conservers when compared to the sample's conservers.

Figure 4.14- Sample participants' total consumption (kWh).

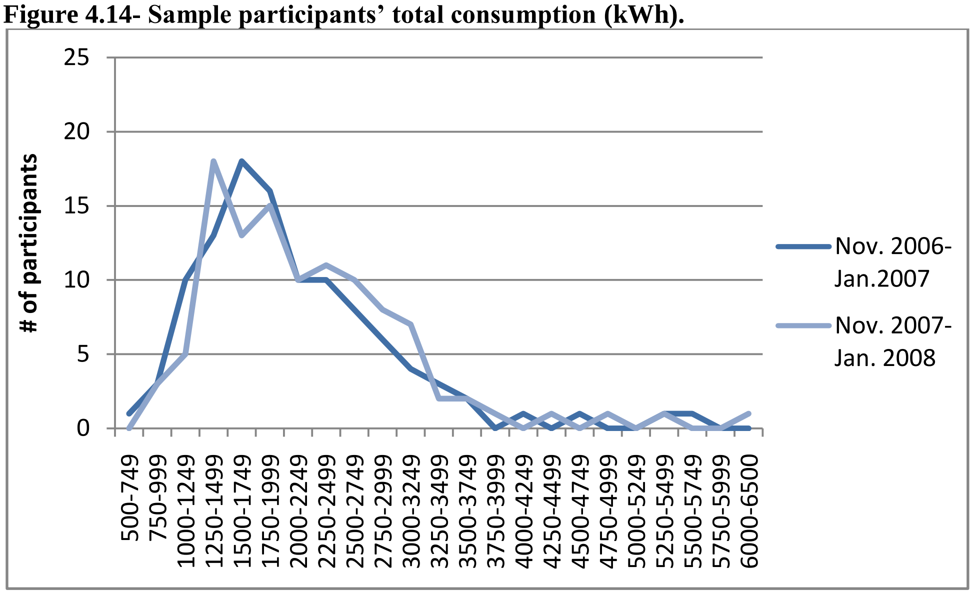


Figure 4.15- Control participants' total consumption(kWh).

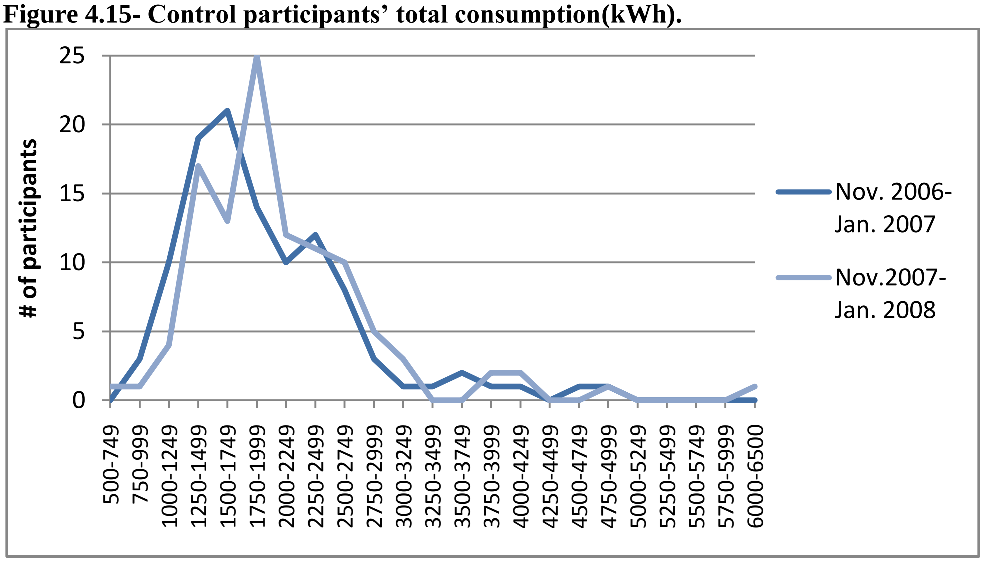


Figure 4.16- Sample participants' on-peak consumption (kWh).

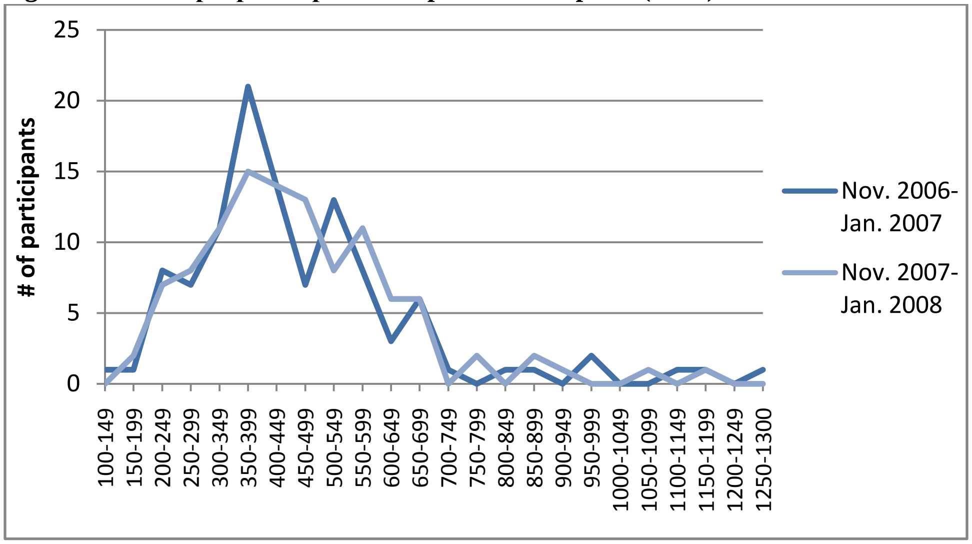
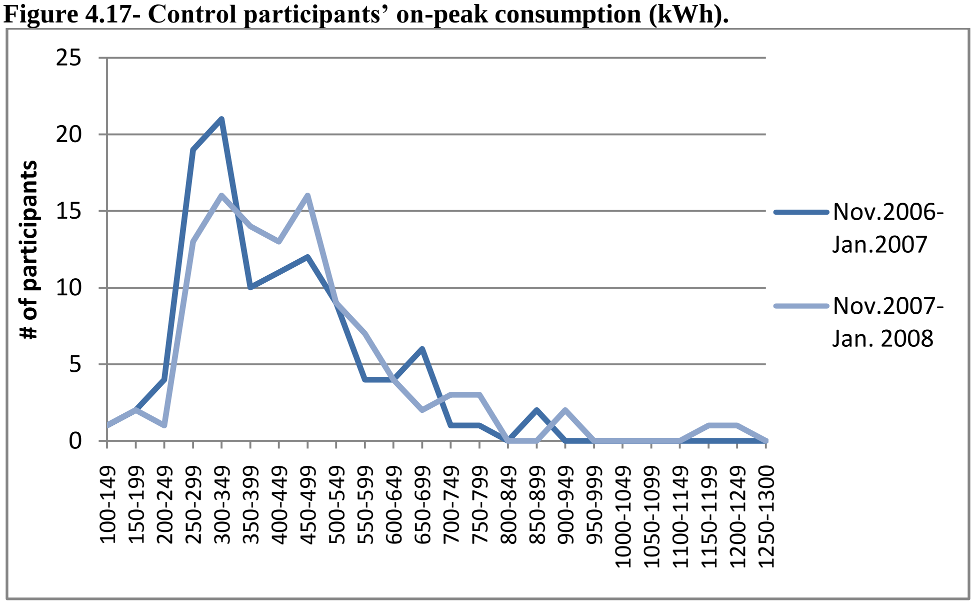


Figure 4.17- Control participants' on-peak consumption (kWh).



As seen in Table 4.10 the total and on-peak consumption means, for both the sample and control group participants, follow the same trend over the baseline and study months, with the sample group having a higher consumption mean for all months except August 2006. The highest total consumption mean for both groups occurred in August 2007 (sample 1074.7 kWh and control 1047.9 kWh) and the lowest consumption means occurred in September 2006 (sample 612.6 kWh and control 511.0 kWh). The sample group's total consumption standard deviation ranged from 150.2 kWh during August 2006 to 306.3 kWh during December 2006. The control group had a similar range in standard deviation with a standard deviation as low as 159.9 kWh in August 2006 and as high as 285.0 kWh in December 2007. Among the sample participants the on-peak consumption mean was highest in August 2006 (196.2 kWh) and lowest in October 2007 (91.2 kWh). The control participants highest on-peak consumption mean occurred during August 2007 (257.0 kWh) and the lowest on-peak consumption mean occurred in September 2007 (77.2 kWh). During on-peak periods the sample group's greatest standard deviation occurred during November 2006 (69.9 kWh) and lowest standard deviation occurred during August 2007 (33.0 kWh). The control group had a similar range in standard deviation, the greatest occurring during August 2007 (73.9 kWh) and the lowest occurring during September 2006 (28.2 kWh).

Table 4.10- Monthly consumption means and standard deviations (kWh).

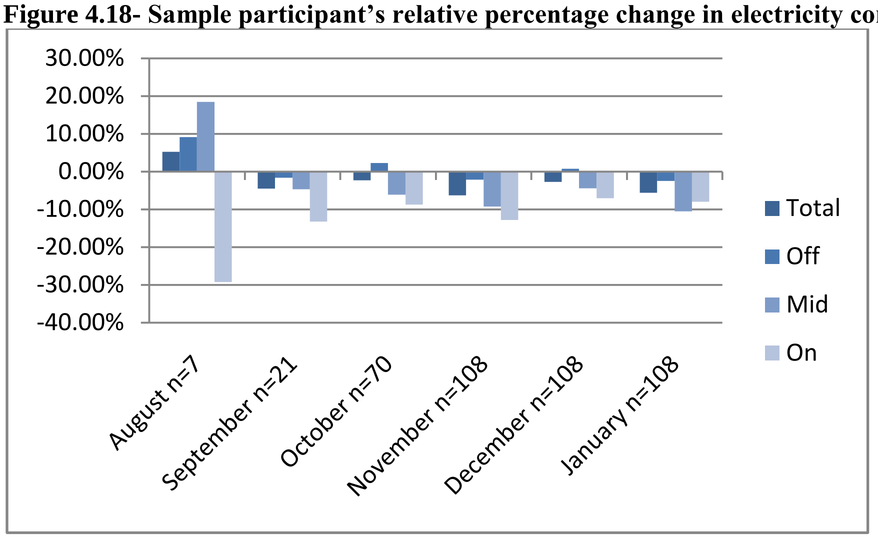
Month	Period	Sample Mean	Sample Standard Deviation	Control Mean	Control Standard Deviation
August n=7	Total Baseline	997.6	150.2	1016.7	159.9
	Total Study	1074.7	157.7	1047.9	185.2
	On-peak Baseline	196.2	39.0	205.0	69.5
	On-peak Study	192.5	33.0	257.0	73.9
September n=21	Total Baseline	583.4	151.0	486.6	165.2
	Total Study	680.7	183.9	593.1	226.0
	On-peak Baseline	88.0	37.2	73.5	28.2
	On-peak Study	100.3	40.0	96.6	47.1
October n=70	Total Baseline	617.6	267.1	598.4	282.1
	Total Study	655.8	297.3	619.1	284.0
	On-peak Baseline	91.2	47.8	85.5	53.1
	On-peak Study	100.5	53.1	97.1	56.3
November n=108	Total Baseline	638.5	284.9	579.6	237.4
	Total Study	665.4	266.0	620.9	228.2
	On-peak Baseline	150.5	69.9	133.3	57.8
	On-peak Study	153.8	64.0	148.4	60.4
December n=108	Total Baseline	751.0	306.3	702.4	271.3
	Total Study	764.9	278.4	736.1	285.0
	On-peak Baseline	147.6	66.1	135.9	56.3
	On-peak Study	146.3	60.0	142.6	57.9
January n=108	Total Baseline	723.4	299.7	652.6	217.2
	Total Study	724.4	279.5	688.4	265.9
	On-peak Baseline	165.5	62.4	148.1	51.0
	On-peak Study	161.2	63.9	154.9	64.8

Figure 4.18 displays the SP's average percentage change in total consumption and the average percentage change in consumption for each time-of-use period relative to the CP's results. The time-of-use periods in this study go in accordance to the description given by the OEB, provided in Figure 2.2. The period that is of primary focus in this study is the on-peak period when province-wide demand for electricity is at its highest.

With the exception of August's total, off- and mid- peak consumption periods and October's off -peak consumption, the average percentage increase in consumption between baseline and study month was greater for the control group than the sample group (see Appendix IV.B).

For the entire study (August 2007- January 2008) the SP experienced a 2.9% relative reduction in total electricity consumption and a 13.2% relative reduction in on-peak electricity consumption. Total relative reductions improve to 4.9% while relative reductions in on-peak electricity decrease to 9.3% when only the months that had full participant participation were considered (November 2007-January 2008). As seen in Figure 4.18 the largest difference in total consumption between the SP and CP occurred during the month of November while the smallest difference occurred in October. August's 29% reductions were the most impressive on-peak relative reduction.

Figure 4.18- Sample participant's relative percentage change in electricity consumption.



Section 4.3.3 Consumption Shift

In addition to finding electricity consumption reductions, it is of interest to this research to determine if the HEMS encouraged shift in participants' electricity consumption behaviours. In order to determine if the aforementioned results for a given time-of use period were reductions and not shifts in consumption the TOU shift equation, explained in Section 3.5, was completed.

According to Table 4.11, the sample's greatest relative shift away from on-peak electricity consumption occurred during August. Each month experienced a relative shift away from on-peak consumption. The size of the shift decreased as the study progressed. It was found that for all of the sample's study months there was a relative shift toward off-peak consumption. There was less consistency with the shifts experienced during mid-peak periods.

Table 4.11 Relative Shifts in Electricity Consumption.

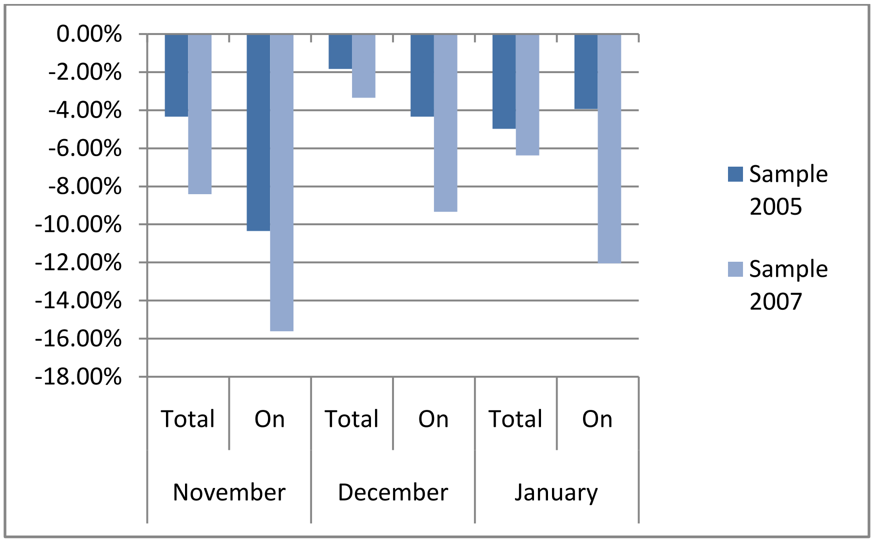
Month	Off-peak	Mid-peak	On-peak
August	4.30%	13.31%	-30.47%
September	2.62%	0.14%	-10.16%
October	3.35%	-3.23%	-7.34%
November	4.00%	-11.31%	-4.84%
December	1.46%	-1.95%	-2.24%
January	2.23%	-3.02%	-1.98%

Section 4.3.4- Consumption and TOU Pricing

Further calculations were completed to determine if respondents' experiences with TOU pricing prior to the study influenced their ability to effectively use the HEMS. To determine this both the sample and control groups were divided among those that started on a TOU RPP in 2005 and those that started on a TOU RPP in 2007. Within the sample group there were 54 participants that went on a TOU RPP in 2005; they will now be referred to as sample TOU 2005. The remaining 54 went on a TOU RPP in 2007, and will be referred as sample TOU 2007. The same division occurred within the control group; the 54 control participants who started a TOU RPP in 2005 will be referred to as control TOU 2005 and the 54 control participants who started a TOU RPP in 2007 will be referred to as control TOU 2007. Following the same approach described in Section 4.3.2, the relative percentage change in total consumption and each TOU period was calculated for the sample TOU 2005 and the sample TOU 2007. In this case November, December, and January were the only months considered, due to the need for full participation of the sample group.

According to the results presented in Figure 4.19, the sample TOU 2007 consistently had total and on-peak relative reductions that were greater than the sample TOU 2005's relative reductions. The sample TOU 2007's greatest total and on-peak relative reduction occurred during November, 8.4% and 15.6% respectively. For the three reviewed months the sample TOU 2005 group on average experienced 3.7% relative reductions in total consumption and 6.2% relative reduction in on-peak consumption. During the same period of time the sample TOU 2007 on average experienced a 6.0% relative reduction in total consumption and a 12.3% relative reduction in on-peak consumption.

Figure 4.19- Relative percentage change in consumption among TOU groups



Section 4.4- Parametric and Non-Parametric Test Results

Using the results from the calculations in the previous section, a set of parametric and non-parametric tests were completed to determine if the HEMS had a statistically significant influence on the consumption levels of the study's participants. After consulting with Erin Harvey of the University of Waterloo Statistical Consulting Service the following tests were determined to be most suitable for this research question: an independent sample t-test, repeated measures of ANOVA, and chi square tests.

The first test completed was an independent sample t-test done to determine if the baseline consumption of the sample and control groups were significantly different. To have a representation of the summer and winter season's consumption, the sums of the sample and control groups' February and June 2006 total and on-peak consumption were used as baselines. These months were selected because they were not used in the study. The total and on-peak results were then tested for normal distribution using the Kolmogorov-Smirno (K-S) test. The results were found not to be normally distributed so a logit transformation computation was completed to alter the data to a normally distributed state. This was followed by the independent sample t-test. The results indicated that the null hypothesis was true and that there was not a statistically significant difference between the sample's and control's baseline consumption. This finding supports the appropriateness of the control group's selection.

When it was established that the baseline consumption of the two groups was not significantly different the repeated measures of ANOVA tests were completed. These tests were carried out to determine if the sample's year-over-year consumption trend was significantly different from the control's trend. It was also completed to determine if the year-over-year consumption of the TOU 2005 groups and the TOU 2007 groups were statistically different. This test was run on both groups' total and on-peak consumption results for the August-January months. The data for these months were not normally distributed so a logit transformation computation was completed prior to the running of the ANOVA tests. In total, 24 tests were run and there was no statistically significant difference between the consumption of sample and control groups or between the TOU groups for any of the months during either period (see Appendix V.A). This indicates that the presence of the HEMS was not responsible for any statistically significant ($p<0.05$) changes in electricity consumption.

Another statistical test run in this study was a chi square test. This was done to determine if there were significant relationships between those SRs that achieved the greatest total and on-peak reductions using the HEMS (ie. the study's conservers), and any of the characteristics asked about in the baseline survey. This would help determine if there were ideal households for HEMS. Since responses to the baseline survey were required to run this test only the SR were considered. From this group the top 50% of households that had the greatest percentage increase in absolute consumption for the months of November, December, and January were labeled the consumers (n=34)- these participants had increases in total consumption greater than 3%. The remaining 34 participants were labeled the conservers- these participants experienced reduction in consumption or had increases less than 3%. The participant at the median was not considered for this analysis. This labeling of conservers and consumers differs from the labeling completed in Section 4.3. This is due to the focus on the SR rather than the entire study population. Every variable asked about in the baseline survey, with the exception of those pertaining to appliance age and use, was run in a chi square test. Through this testing, one significant finding ($p<0.05$) was found. It was that those who set their thermostats manually prior to the beginning of the study were more likely to be conservers. (For the results of all other chi square test see Appendix V.B.)

Chi square tests were run a second time using the same approach but substituting the respondents' percent change in total consumption with the respondents' percent change in on-peak consumption. All consumers experienced a greater than 1% increase in on-peak consumption. The conservers experienced a reduction or an increase in on-peak consumption that was less than 1%. These tests were completed to determine if there were particular household characteristics that allowed the HEMS to reduce on-peak electricity consumption. The significant finding ($p< 0.05$) that came from these tests was that those with electrically powered heating were likely to be an on-peak electricity conserver. According to the chi square tests the remaining variables did not have a significant influence on the ability of the participant to effectively use their HEMS in order to reduce/shift on-peak electricity consumption.

Section 4.5- Descriptive Statistics

Having found limited statistically significant results through the use of repeated measures of ANOVA and chi square testing, the exploratory nature of this study called for the use of descriptive statistics to reveal stories and trends that may have gone unnoticed using the previously mentioned statistical tests (Dytham 2003). The following section will compare the SR's November-January average baseline and study month consumption and percentage changes in total and on-peak electricity consumption with the average consumption and percentage changes in total and on-peak electricity consumption of SR's sub-groups. The November-January months were chosen because they were the months that all SRs had a HEMS in their home.

As seen in Table 4.12, the average total electricity consumption of the SR for the November-January baseline months was 2177.86 kWh and study months 2243.07 kWh respectively. There was a 3.0% average increase in total electricity consumption from the baseline to the study months. The on-peak consumption for the same baseline months was 479.17 kWh and the on-peak consumption for same study months was 479.36 kWh. There was a 0% average increase in on-peak electricity consumption between the baseline and study months.

Table 4.12. Sample respondents average total and on-peak Consumption and percent change.

	Baseline[1] Month Total	Study Months[2] Total	Change %	Baseline Month Peak	Study Month Peak	Change %
Survey Respondent Group	2177.86	2243.07	2.99%	479.17	479.36	0.02%

Using the SR's total and on-peak electricity consumption means as a point of reference, comparisons of subgroups were done to determine if there are any interesting stories or trends that may have been missed due to the lack of statistical significance. Only sub-groups that had a response frequency greater than five were considered. This section highlights some of the greatest differences between the group and subgroups percentage change in electricity consumption (see Appendix IV.C).

Within the structural sections results it was found that those living in 3000-3999 sq.ft. homes had reductions well above the overall groups average for both total consumption (18.3%) and on-peak consumption (21.2%). These individuals also had above average baseline total and on-peak consumption. Within the housing type group single detached home owners were the only subgroup that achieved above average reduction in total (1.2%) and on-peak (3.0%) consumption.

Within the behavioural and attitude sections one question that had a notable difference within respondent's consumption related to respondent's effort to reduce electricity consumption. Those who responded that they are, 'doing most of what they can do but can do more' had above average total (0.1%) and on-peak (1.7%) consumption reductions. When asked why the SR chose to participate in this study those who responded to 'increase knowledge' and 'save money' had above average reductions in total consumption (knowledge= 6.4%, save money= 5.0%) and on-peak consumption (knowledge= 13.8%, save money= 6.3%). Both respondent groups had below average baseline total and on-peak consumption. This is the inverse of those who responded to 'address electricity issues' and get 'new technology'. These respondents had above average total and on-peak baseline consumption and above average increases in

[1] Baseline Months= November 2006- January 2007

[2] Study Months= November 2007- January 2008

consumption (see Appendix IV.E). For the question pertaining to the price of Ontario's electricity those who responded it was 'too high' or 'appropriate' had above average reductions in total and on-peak electricity consumption, with 'appropriate' respondents having the greatest reductions, 2.4% reductions in total consumption and 5.5% reductions in on-peak consumption. Those who responded that prices were 'high' had above average increases in total consumption (5.8%) and on-peak consumption (2.9%).

The knowledge section found that people who had a very high understanding of their potential to conserve had above average total (2.5%) and on-peak (12.3%) consumption reductions. The rate of reduction decreased as respondents reported being less aware of their potential to conserve (see Appendix IV.E).

Finally, according to this method of data exploration, some demographic characteristics may have also influenced respondents' ability to conserve electricity during the study period. Female respondents had above average total (1.7%) and on-peak (2.5%) reductions, while male respondents did not experience reduction in total or on-peak electricity consumption during the study period. There was no trend with regards to respondent's age and their ability to conserve electricity. However, the greatest reduction was among those in the 40-44 year age group; they were able to reduce their total consumption by 10.0% and their on-peak consumption by 12.8%. Another demographic variable that was considered was education. It was found that SR who reported high school being their highest level of educational attainment had above average reductions in total and on-peak consumption, 3.8% and 10.1% respectively. Those who reported university being their highest level of educational attainment had below average baseline consumption but had above average increases in total and on-peak consumption, 6.6% and 4.0% respectively. Lastly, responses to one's self assessment of free-time found that those who felt they had a lot of free time were able to achieve above average reductions in total (1.3%) and on-peak (4.2%) consumption. The respondents who reported having little free time had less than average total and on-peak reductions: 5.5% increase in total consumption and a 0.1% increase in on-peak consumption.

Chapter 5- Discussion

In the previous chapter (Chapter 4- Results) the results of the study's baseline survey, follow-up survey, and participants' monthly consumption were tabulated and presented. It is the intent of this chapter to analyze these results and ground them within the literature presented in Chapter 2. This analysis will be completed through the following five sections.

Section 5.1 will compare the results of the study's sample and control baseline surveys to assess the similarities and differences between the two groups. This will be done to determine the appropriateness of the study's control group.

Section 5.2 will analyze the results of the study's parametric and non-parametric tests. This section will address the possible reasons for the findings that were and were not found to be statistically significant.

Section 5.3 will reflect upon the descriptive statistical findings that the parametric and non-parametric tests may have overlooked. This will involve analyzing the participants' total and on-, mid-, and off- peak monthly electricity consumption in an effort to explain the reductions and shifts that may or may not have occurred. This section will also evaluate the possible influence that the synergy of HEMS and TOU pricing had on electricity consumption.

Section 5.4 will look more closely at the electricity consumption of the sample survey respondents (SR). The intention is to determine if there were any structural, behavioural, attitudinal, knowledge, or demographic characteristics that may have been valuable in helping participants achieve improved conservation results.

Section 5.5 will review the results of the follow-up surveys to determine if the presence of the HEMS resulted in self-reported behavioural and attitudinal changes among SR. This section will also review the responses to the follow-up survey's Direct Energy Smart Home Energy System section. This was done to gain a better understanding of how the HEMS worked in participants' homes.

Section 5.1- Sample and Control Groups- Compare and Contrast

Since the majority of this study's results are based on the sample group's electricity consumption relative to the control group's electricity consumption, it is important to determine the differences and similarities between the two groups. It is desirable to have a control group that mimics its sample group in as many aspects as possible. This will allow all variables that may influence electricity consumption to be controlled and the influence of the intervention, the HEMS, can then be determined (Katzev and Johnson 1987).

To determine the appropriateness of this study's control group, the results of the sample's baseline and follow-up surveys will be compared with the results of the control's baseline and follow-up surveys. Within these groups, 64% of the sample group's and 21% of the control group's participants responded to the baseline survey. Though it would have been ideal to have a 100% response rate for both these surveys, this was not achieved; therefore, the results that have been obtained will be extrapolated over both groups' populations. This approach has its limitations, but is still beneficial to further the analysis.

As displayed in Table 5.1, the two groups shared a variety of characteristics. These included many structural characteristics of the home, the participants' behaviours and attitudes regarding electricity use, knowledge of conservation, and demographic characteristics such as age, education, and number of household occupants. Having similarities in these areas allows for a greater degree of confidence in the control group's ability to control for influential variables. Unfortunately, not all of the groups' characteristics were alike, and those that were not are thus potentially not 'controlled'. Table 5.2 lists the differences between the study's two groups. This list includes some of the literature's more commonly reviewed variables such as housing size, understanding of conservation, gender, and education. The level of educational attainment was a variable that shared commonalities and differences between the two groups. The lowest level of educational attainment between both groups was similar, while the highest level of educational attainment was dissimilar.

From a sample population of 69 and a control population of 23 response rates for the follow-up survey were 25% and 74% respectively. The results of these surveys do not necessitate changes being made to Tables 5.1 or 5.2. However, they do further support the appropriateness of the control group by displaying similar changes between both groups during the course of the study. These results include renovations, vacations, changes in number of occupants and changes in income (see Appendix II.C).

Table 5.1-Similarities between sample and control groups

Structural	
Housing Age	- 80% of homes four years old or less. (S=91%, C=83%)
Programmable Device Use	- Approximately 65% of homes have programmable devices. (S=64%, C=68%)
Program Thermostat	- 60% of participants use programmable thermostats. (S=63%, C=59%)
Power Sources	- 70% do not use electricity to heat home. (S=70%, C=77%) - 85% use electricity for clothes dryer. (S=85%, C=95%) - 70% use electricity to power oven. (S=70%, C=80%)
Behavioural	
Light Usage	- Responses to question were evenly distributed across both groups.
Conservation Upgrades	- Over 70% of respondents were not interested in completing any upgrades. (S=70%, C=75%)
Attitudinal	
Electricity Consumption Awareness	- Compared to last year approximately 70% of respondents are now more aware of their electricity consumption. (S=71%, C=70%)
Moral Obligation	- A minimum of 95% of respondents agree that they are morally obligated to reduce electricity consumption. (S=96%, C=97%)
Importance of Conservation	- Approximately 95% of participants believe conservation is important (S=95%, C=96%).
Sharing Outlooks	- Approximately 70% of respondents share same outlook on electricity conservation as their friends. (S=74%, C=70%)
Electricity Prices	- Over 80% of respondents believe the price of electricity is too high. (S=80%, C=87%)
Knowledge	
Children and Electricity	- Close to 50% of respondents do not have children between the ages of 4-18. (S=54%, C=44%) - Over 70% of respondents that do have children between the ages of 4-18 talk to them about electricity conservation. (S=75%, C=71%)
Conservation Test	- Respondents averaged a score of 2. (S=1.8, C=1.9)
Media's Influence	- Similar views about role of media, approximately 40% believe its influence on them is average. (S=42%, C=39%)
Media and Conservation	- Approximately 90% of respondents have seen or heard a media advertisement promoting conservation. (S=88%, C=92%)
Demographic	
Age	- Approximately 70% of respondents are between the ages of 30 and 45. (S=70%, C=69%)
Education	- Approximately 15% of respondents' highest level of education achieved was a high school education. (S=15%, C=13%)
Income	- Over 75% of households earned more than $100,000. (S=76%, C=87%)
Number of Occupants	- Approximately 80% of homes have 2-4 occupants. (S=84%, C=77%)

Table 5.2- Differences between sample and control groups.

Structural	
Housing Size	Sample - 60% of houses under 1999 sq ft. Control - 39% of houses under 1999 sq ft.
Power Sources	Sample - 73% do not use electricity to power water heater Control - 55% do not use electricity to power water heater
Number of Fridges	Sample - 80% of respondents have more than one fridge Control - 45% of respondents have more than one fridge
Behavioural	
Winter Thermostat	Sample - 57% of respondents keep thermostat setting at 22°C. Control - 77% of respondents keep thermostat setting at 22°C
Summer Thermostat	Sample - 45% of respondents keep thermostat setting above 23°C. Control - 29% of respondents keep thermostat setting above 23°C
Knowledge	
Understanding Conservation	Sample - 65% felt they have a good idea about how to conserve electricity. Control - 82% felt they have a good idea about how to conserve electricity.
Technological Competence	Sample - 80% believe it to be high. Control - 52% believe it to be high.
Demographic	
Gender	Sample - 76% male, 24% female Control - 52% male, 48% female
Education	Sample - 50% have a university degree. Control - 30% have a university degree.

Section 5.2- Significance of Results

The study's statistical tests revealed a limited number of statistically significant results ($p<0.05$). The independent sample t-test revealed no significant difference in the baseline consumption of the sample and control group. In addition to the findings described in section 5.1, the independent t-test's lack of significance increases the legitimacy of comparing the electricity consumption behaviours of these two groups. Like the independent sample t-test, the repeated measures of ANOVA test did not reveal significant findings. Such a result implies that the HEMS did not have a significant influence on the study participants' electricity consumption behaviours. However, this result may have been predetermined by the presence of the following conditions: sampling method, modern housing and technology, influence of TOU pricing, system malfunctions, user error and misuse, and non-HEMS related variation.

As explained in Section 3.5, the recruitment of the sample's participants was done on a 'first come, first serve' basis by the study's stakeholders. As a result, the participants are considered the 'early adopters' of this technology. Roger's Diffusion of Innovation

Theory argues that early adopters tend to share personality traits such as being less dogmatic, less fatalistic, having higher aspirations, and more empathy, than those who are not early adopters (Rogers 1983). Considering the common personality traits of early adopters and the pro-conservation focus of the study's recruitment strategy, it is reasonable to believe that the participants of this study likely have pro-conservation behaviours and attitudes. This belief is further supported by the results of the study's surveys (see Appendix II). Due to these factors it is believed that the participants within this study had already started to adopt electricity conservation behaviour prior to the start of the study, thus, making it more difficult to reduce and/or shift additional electricity usage during the course of the study.

Another factor that may be limiting the HEMS's ability to have a significant influence on the participants' electricity consumption is the modernity and efficiency of the participants' housing and technology. Responses to the study's baseline survey indicated that 91% of respondents had homes four years of age or less, and all participants lived in homes that were less than eight years old. The vast majority of participants' appliances were less than ten years old and on average 35% of the respondents' appliances[3] were Energy Star certified. According to Brandon and Lewis (1999) newer homes have many built in efficiencies that reduce electricity consumption. Energy Star appliances have also been responsible for average energy savings ranging from 13% to 50% (Webber et al. 2000). It is possible that the predominance of these homes and appliances within the sample group made it difficult for participants to achieve additional conservation, therefore making it difficult for the study's HEMS to achieve significant changes in electricity consumption.

According to the 'Smart Price Pilot' (IBM 2007) and studies completed by Herbelein and Warriner (1983) and Sexton et al. (1987), the presence of a TOU pricing structure encourages shifts and/or reductions in the electricity consumption. In this study, half of the participants were under a TOU RPP prior to the study's baseline year. In addition to this many participants responded that expenditures on electricity were a concern to them. In an open ended question about participants' reasoning for participating in this study the most popular response was potential costs savings. Disdain

[3] Appliances include fridges, freezers, ovens, dishwashers, washing machine, and clothes dryer.

for the current price of electricity was also evident among the 80% of sample participants and 87% of control participants who felt that the current price of electricity was too high. Based on these responses it is reasonable to believe that many of the 108 participants that had TOU pricing prior to the beginning of the study likely started to make alterations to their consumption habits before the baseline year. (These sentiments will be further supported in Section 5.3). Again, these pre-existing conservation behaviours would likely make it difficult to achieve further reductions in electricity consumption, thus explaining the HEMS's inability to have a greater influence on the participants' electricity consumption.

One of the primary purposes of a pilot study is to pre-test potential research instruments (Baker 1994). Therefore, it can be expected that the research instrument may have some technical issues during the course of the pilot. Van Teijlingen and Hundley (2001) believe that these technical difficulties are why many pilot studies fail to produce statistically significant results. This may help to explain the lack of significant results found in this study. According to participants' responses to the follow-up survey (see Appendix III) and input on an independently run web-based 'blog' (see Appendix III) there were a variety of complications that occurred with some participants' HEMS during the course of the study. Most of these malfunctions were addressed at the beginning of the study; however, their presence could have influenced the significance of the study's results.

Early in the study it was reported on the web based 'blog' that the users' electricity feedback was not being displayed in the systems portal. This was addressed by the end of August; however participants continued to sporadically report feedback malfunctions throughout the rest of the study. There were also complications with the system's automation features. Participants reported that signals within the system were being crossed, resulting in reported temperature increases when the lights were to go on. There were also reports of the HEMS's clock not being synchronized with the participants' clocks. This led to automated actions occurring earlier than they were intended. One participant reported a 20 minute discrepancy resulting in her lights being on 20 minutes longer than intended. Synchronization was also a problem with regard to the interior temperature of the home. Some thermostats were not properly calibrated resulting in a discrepancy of up to three degrees Celsius.

Unfortunately, only a limited number of participants used these media (surveys and blogs) to provide feedback and it is to be expected that those who chose to provide such feedback are more likely to leave negative, rather than positive, comments (Ofir and Simonson 2001). Therefore, it is difficult to accurately determine what proportion of participants had technical issues with their HEMS.

Another possible factor that could limit the HEMS's ability to achieve significant results is user error and misuse of the system. Again, feedback received through the follow-up survey and 'blog' revealed a variety of user errors that occurred during the study that may have been at least partially responsible for non-statistically significant results. The most popularly cited error was the misinterpretation of interface icons. Many participants believed that the 'snowflake icon', intended for the use of the air conditioner, was meant to be used in the winter, and the 'sun icon' intended for the use of the furnace, was meant to be used in the summer. Users also had difficulty enabling the system's modes (ie. home mode, away mode, etc.) resulting in modes not switching according to the schedule set by the user. Also adding to user error was the misinterpretation of the provided feedback. Multiple participants felt that electricity consumption feedback for individual appliances and electronics would have assisted their use of the HEMS. These errors were exacerbated by poor customer service and troubleshooting options. One participant wrote; 'My ability to turn on and off the lights ceased working months ago and I could never locate a help button to get them to work. Just the assistant who was [expletive]!' (see Appendix III.A). By 'assistant' the participant is likely referring to the avatar that updates the user when they are viewing the portal. Similar sentiments were expressed by other users who had difficulty with the system. This lack of assistance compounded by the previously mentioned system malfunctions likely resulted in some participants no longer actively using the system. Nearly half of the SFR reported logging into the system monthly or less (39%). Due to the sample survey being made available through the web portal, this figure does not take into account the participants who no longer used the system and therefore did not know there was a follow-up survey to complete. This could result in a greater number of participants who may have behaved in the same manner as the participant who wrote, 'Between you and me… I'm not really using the system.'(See Appendix III.A)

It is also possible that non-HEMS related variation may be partly responsible for the lack of statistically significant findings. The sample's baseline and follow-up surveys had a 64% and 22% response rate, respectively. Among the control group 21% of participants responded to the baseline survey and 17% responded to the follow-up survey. Attempts can be made to extrapolate these responses to the study's entire population; however it is likely that some information about the non-respondents will be missed. Therefore, it is possible that independent variables other than the HEMS may be responsible for alterations in electricity consumption (e.g., away on vacation, change in number of occupants, change in income, renovations). Respondents of the baseline survey may have experienced changes during the course of the study that have gone unknown due to their failure to complete the follow-up survey.

When analyzing the 'within households' consumption variation it becomes increasingly apparent that factors other than the HEMS could be responsible for changes in the household's electricity consumption. It has been found that within households there have been increases in monthly year-over-year total electricity consumption as large as 97%, while other homes have had reductions in monthly year-over-year total electricity consumption as great as 46%. These changes in electricity consumption far exceed previous findings or expectations of intervention like HEMS. This variation of consumption within the household carries over to variation of consumption within the group. This results in the creation of outliers that inhibit the ability for a parametric test to produce statistically significant results (Brandon and Lewis 1999).

The standard deviations for the sample and control groups' monthly consumption were displayed in Table 4.10. In every case the standard deviation was a greater percentage of the monthly consumption mean than the group's monthly percentage change. In most cases the standard deviation's proportion of the monthly consumption mean was twice as big as the percentage change in consumption a particular group would experience for that month (see Table 4.10). The presence of these relatively large standard deviations further explains why the repeated measures of ANOVA tests were unable to achieve statistically significant results.

Like the repeated measures of ANOVA, the chi square tests found a limited number of statistically significant results. In total the chi square test found two statistically significant results. The first significant relationship was between the study's total electricity consumption conservers and those who had historically manually set their thermostats. The significance of this relationship was likely the result of these participants taking advantage of the conservation abilities of HEMS's programmable thermostat. This coincides with the results of a recent New York study that found participants were able to make reductions in their total electricity consumption with the assistance of an internet-connected thermostat (Cohen 2002).

The other statistically significant result was the relationship between on-peak conservers and those who had electrically heated homes. Electrically powered heating is one of the main contributors of electricity use during winter months (Abrahamse et al. 2005). It is possible that the statistically significant result between these two variables was due to the participants' use of the HEMS's mode settings. This may possibly be due to programming the systems to limit the furnace's activity during on-peak periods. This finding again exemplifies the ability of the HEMS's internet-connected thermostat to reduce electricity consumption.

The possible reasons for the lack of significant chi square results are similar to why the repeated measure of ANOVA test did not achieve significant results.

Section 5.3- Descriptive Statistical Analysis- Consumption

The limited statistical significance of this study's finding does not justify concluding the analysis of this data with only those findings. The analysis of descriptive statistics may be able to reveal stories and trends that may have been missed in parametric and non-parametric tests. Therefore, the following sections will analyze the descriptive statistics to determine if there is additional information to be acquired about the influence HEMS have on participants' electricity consumption behaviours.

Section 5.3.1- Monthly Reductions

Over the course of the entire study a 2.9% relative reduction in total electricity consumption and a 13.2% relative reduction in on-peak electricity consumption was observed. The relative reduction in total consumption improved to 4.9% in the final three months, when all 108 study participants had the HEMS. Unfortunately, during this time the relative on-peak reduction declined to 9.3%.

Studies that involve feedback and in-home displays typically had total electricity reductions ranging from 5% to 12% (Darby 2006). The total consumption results for the entire study fall out of this range. Yet, the results for the months when all 108 participants had the HEMS fall in the low end of this range. However, HEMS do not only provide feedback, but also enable participants to automate their home, a feature that some have argued should achieve results greater than a typical feedback study (Gronli and Livik 2001). It should also be noted that the unknown criteria set for participation in the aforementioned studies that have achieved 5% to 12% reductions in electricity consumption may have been conducive to conservation. For instance in the *Gridwise* study all the participants were required to have electric dryers, water heaters, and HVAC systems. Additional reasoning for why the results of this study may have been lower than expected has been discussed in Section 5.2. In addition to these reasons, the absence of consumption data for the 108 participants in the summer months may also be responsible for lower than anticipated results. Perhaps, a closer look at the study's monthly consumption results can further explain the study's overall consumption findings.

The month of August had the greatest relative on-peak reduction of all the study months. This result goes in accordance with those that argue that the system will be most effective in summer months when the feedback and home automation functions can be used to reduce and shift the end use electricity consumption of air conditioners (Faruqui et al. 2007). However, August's increase in total consumption and the results to be discussed in Section 5.3.2 indicate that this finding is due to shifts from on-peak consumption rather than reductions. It should also be noted that the number of participants included in the August sample is relatively low (n=7). These results should be used cautiously; the small sample population allows any outliers from the August sample to have a stronger influence on the overall relative consumption for the month (Harvey 2008).

September was the first month that the participants experienced a relative reduction in total electricity consumption. However, this month also saw a decline in on-peak consumption. The relative reductions in total consumption indicate that the users may be becoming better acquainted with the technology. The web blog also indicates that some of the ‘glitches’ that the technology was experiencing in the first month have been addressed. Though the on-peak reductions declined the results are still impressive (13.3%). This supports those who believe in the increased potential to conserve electricity in summer months, due to the ability to ‘cycle down’ air conditioner use. In 2007, September’s maximum temperature mean was 24.3 C° which likely extended many of the participants’ season for air conditioning use, when compared to September 2006 that had a maximum temperature mean of 19.9 C° (MOE 2008). This belief is supported by an increase in the sample and control group’s electricity consumption during the month of September (see Appendix IV.C). However, the larger percentage increases in consumption experienced by the control group displays the HEMS ability to assist sample participants in managing their air conditioner and overall electricity usage. The number of participants that had HEMS in their home during this month grew to 21. This is still a relatively small sample size, but is more than twice the size of the August sample.

Second to August’s total consumption results, October had the poorest results of the entire study. Total relative reductions in consumption went from a 4.5% reduction in September to a 2.3% reduction in October. On-peak relative reduction also decreased during this month. There are a number of arguments as to why this increase may have occurred. It is possible that a ‘fall off’ effect may have begun for participants who had the HEMS for multiple months. It is also possible that the aptitude and interest of the additional 49 participants in the October group (those who had the system installed in September) may have been lower than the previous participants, resulting in these participants being unable to achieve the results that the participants had achieved in the previous month. This hypothesis coincides with those who believe there is a strong correlation between one’s understanding of electricity consumption and one’s ability to conserve (Pharnell and Larsen 2005, De Young 2000). It is also possible that these relatively poorer results may be due to October being on average cooler than September, making it less likely that air conditioners were being used as often as they were in previous months, but still too warm for electrically powered heating to be used, thus, making it difficult to reduce excess air conditioning or heating electricity consumption like participants may have done in the other study months. This hypothesis is supported by the sample group's October 2007 average monthly consumption being the lowest among all the study months (see Appendix IV.A). Finally, October's relative increase in total electricity consumption may have been the result of the system's malfunctions and user errors described in Section 5.2. These malfunctions resulted in cases in which participants were unintentionally and unnecessarily consuming electricity. Therefore, it is not surprising that October's relative consumption results were not as impressive as other study months. It should be noted that these malfunctions did occur in other study months, however, the frequency of reported incidents were not as high as they were in October (see Appendix III).

The November results included the data of all the study's participants. This month experienced the greatest relative reduction in total consumption. It is possible that this was partially the result of the HEMS's malfunctions being corrected. Along with improved technology, Bell Canada Enterprises Inc. and Direct Energy Ltd. had refined their system education methods potentially encouraging improved use of the system with limited errors. This could be further assisted by the additional November group participants having the capacity and will to use the HEMS more effectively. It is also possible that the 70 participants that had the system in previous months improved their use of the system and are perhaps adopting new habits as a result of the system (Van Houwelingen and Van Raaij 1989). However, like October, November's on-peak relative reduction did not exceed August's or September's results. This is likely the result of not being able to shed the excess electricity consumption associated with the use of air conditioning, rather than the participants experiencing 'fall off' or 'rebound' effects. This belief is based on November's on-peak relative reductions being an improvement on October's on-peak relative reduction.

The month of December's total and on-peak relative consumption increased compared to the previous months. Again, it is possible that this may be the beginning of a fall off effect, though this is not supported by the January results. It may be more likely that activities surrounding the holidays may occupy the free time that participants used in previous months to process the HEMS feedback and make the appropriate adjustments to its automation features. This can be supported by the finding discussed in section 4.5

which highlights the improved conservation results achieved by participants that have reported having a lot of free time.

In January, the relative percentage change in total consumption returned to levels similar to those achieved in November. This may be the result of similar schedules that people maintain over the course of these two months (eg. school, work). This leveling out of on-peak electricity consumption may signify how much electricity Milton, Ontario residents are willing and able to conserve during winter months. It is also possible that participants may have become disinterested in their HEMS and subsequently use their system less often, allowing the programmable features to maintain a constant reduction in on-peak electricity use, with little effort from the participants. However, this argument goes counter to the results of the follow-up survey that indicated that the majority of respondents are logging into the system weekly and using the system's feedback and programmable features with the same regularity as they did at the start of the study. As it has already been alluded to, the results of the follow-up survey should be used cautiously, since only those participants who use the system would have known of the existence of the follow-up survey. Therefore, those who did not use the system would not have completed the survey.

For each study month reductions in on-peak electricity consumption were greater than the reductions of total electricity consumption. This was likely the result of participants recognizing that reducing and shifting away from on-peak electricity consumption allowed for the greatest monetary gains. This coincides with rational economic theorists who believe that people's behaviours are dependent on their economic self-interest (Mckenzie-Mohr 1996). However, in the final months of the study, December and January, reductions in on-peak electricity consumption are decreasing. This trend may be going in accordance with the findings of 'OEB Smart Price Pilot', where participants did not feel that the monetary incentives were sufficient to encourage them to reduce their electricity consumption in a TOU pricing structure (IBM 2007). This finding still coincides with rational economic theory.

Section 5.3.2- Consumption Shifts

Along with analyzing the participants' electricity consumption reductions, it is important to consider the electricity consumption shifts that may have occurred between monthly TOU periods. The study's average relative shift away from on-peak consumption was 9.5%. All the study months experienced a relative shift away from on-peak consumption. These shifts decreased in size as the study progressed. This is likely indicative of participants no longer being able to shift their air conditioning use or participants experiencing the onset of the fall off effect. It should also be noted that these shifts are in addition to shifts that may have already occurred due to the presence of TOU pricing prior to the start of the study. It should also be reiterated that the August and September months had relatively small populations, nine and 21 respectively. Therefore, it is possible for the outliers in these groups to have a greater influence on results, thus making the shifts for these months much larger than the remaining four months.

Section 5.3.3- Influence of TOU Pricing

According to studies completed by the Herbelein and Warriner (1983) and IBM (2007) it can be anticipated that shifts in consumption will occur when a TOU pricing structure is present. To help determine the relationship that TOU pricing had with the HEMS a comparison of the relative percentage changes in consumption was completed between the sample TOU 2005 group and the sample TOU 2007 group. It was found that during the months when all 108 participants had the HEMS (November, December, January) the relative reduction in on-peak consumption for the sample TOU 2007 group was greater than the relative on-peak reductions of the sample TOU 2005 group. These results are likely due to the sample TOU 2007 group having not yet adopted load management conservation habits prior to the study's baseline year. The difference in consumption between the sample TOU 2007 group and its control indicates that the presence of HEMS in households that have recently adopted TOU pricing have increased success at reducing their on- peak electricity consumption. The results of the relative percentage changes in total electricity consumption tended to show greater reductions for the sample TOU 2007 group, but not to the same degree as the relative on-peak reductions when compared to the sample TOU 2005 group. This is likely due to the shifts in on-peak consumption being partly responsible for the observed on-peak reductions.

Section 5.4- Descriptive Statistical Analysis- Consumption and Variable Comparison

In addition to doing a descriptive analysis of the study's consumption patterns, the limited statistically significant findings of the chi square tests justifies further analysis of the relationship between the participant's electricity consumption and their contextual and personal characteristics. The following are popularly cited variables from Section 2.5, which produced some interesting comparisons: they include gender, education, knowledge, number of occupants, and housing size.

Section 5.4.1 Gender

Among the sample respondents the women had total and on-peak electricity consumption means that were above the entire study group average, but were able to achieve above average reductions; the men's result were the opposite. These high levels of total and on-peak electricity consumption go counter to the argument that women are the more likely to conserve electricity (Straughan and Roberts 1999). Yet, their ability to achieve above average reductions appears to support this claim. However, it is possible that these above average reductions may have been due to the women's above average consumption, allowing them to shed excess electricity use more easily.

Section 5.4.2- Knowledge

Sample respondents who believed they had a very high understanding of their potential to conserve had below average total and on-peak consumption levels and had the greatest reduction in both total and on-peak consumption for this grouping. Both total and on-peak consumption increased as people reported being less aware of their potential to conserve electricity. This supports the assertions of Dwyer et al. (1993) and Stern (1992) who argued that those with a predisposed knowledge of electricity conservation have the greatest potential to succeed in electricity conservation initiatives.

Section 5.4.3- Education

Those who had the highest levels of education (university and graduate degrees) as a group had below average total and on-peak electricity consumption, but also had below average reduction in electricity consumption for both periods. Those with lower levels of education attainment were able to achieve higher than average reduction in total and on-peak electricity consumption, but had higher than average total and on-peak electricity consumption. The results related to electricity consumption support findings of Uitdenbogerd (2007) and Stern (1992) who argue that educated individuals are more likely to conserve electricity. However, this conservation is likely responsible for their inability to have above average reductions, since there is not as much excess electricity usage to shed.

Section 5.4.4- Number of Occupants

There appears to be no relationship between the number of occupants in the home and the effectiveness of the system. The two- or five- occupant homes had below average total and on-peak electricity consumption and above average total and on-peak reductions in electricity consumption. The households with three and four occupants had above average total and on-peak electricity consumption and below average reductions. This finding goes against Nielsen (1993), who argued that there is a relationship between the number of occupants in the household and the household's electricity consumption.

Section 5.4.5- Housing size

The study's smallest homes (1500 sq.ft.-1999 sq.ft.) had below average total and on-peak electricity consumption, but had below average reductions in consumption. The largest homes (3000 sq.ft.-3999 sq.ft.) had above average total and on-peak consumption, but had above average reduction in both total and on-peak consumption. It was also found that housing size was proportionate to the household income. These findings support Nielsen's (1993) and Stern's (1992) arguments that the larger homes consume a greater amount of electricity. This excess electricity use provides an opportunity for additional electricity consumption to be shed, thus, allowing for the previously mentioned above average reduction.

Section 5.5- Self-Reported Changes in Behaviours, Attitudes, and Knowledge

Through the use of the study's baseline and follow-up survey results and descriptive statistics, comparisons were drawn to determine if the respondents experienced any changes in their behaviours, attitudes, and knowledge as they relate to electricity consumption.

The variable that experienced the most substantial shifts within the behavioural section dealt with lighting usage. As reported in Section 4.2.2, the group of sample follow-up respondents (SFR) experienced a large increase in the percentage of respondents who indicated that they ‘sometimes’ left their lights on (29% to 50%). Unlike the control follow-up respondents (CFR) group who experienced an increase in the percentage of respondents who only use their lights when necessary (41% to 61%). The increase in ‘sometimes left on’ responses among the SFR may have been due to HEMS malfunction, resulting in the lights being left on sometimes. Again, rational economists may attribute these changes to the additional feedback on electricity consumption that allowed the SFR to conclude that the monetary incentive to turn off the lights was not sufficient, given lighting’s relatively small use of electricity, and therefore it was not in their economic self-interest.

Changes that did not occur can also say something about the influence of HEMS on behaviour. Throughout the course of the study, the SFR reported that they have maintained a high level of effort to conserve electricity, while the percentage of CFR who reported ‘doing little to reduce electricity consumption’ rose. This result may be due to changes in the CFR’s self perception. They possibly learnt more about electricity consumption and themselves during the course of the study and recognized that their effort to conserve electricity could be improved. This was likely not the case for the SFR, 54% of its respondents reported that their electricity consumption was what they had expected. This mindset is not conducive to the SFR reassessing their opinions of their effort to reduce electricity consumption. Also, it is possible that the presence of a HEMS in the SFR’s homes may provide them with the gratuitous feeling that they are maintaining a high level of effort to conserve electricity.

As was the case with SFR’s effort to reduce electricity consumption, the SFR’s self-reported ‘high to very high’ understanding of their potential to conserve electricity remained constant (64% to 63%), the CFR’s understanding of their potential to conserve electricity decreased (83% to 66%). This result exemplifies the potential for the HEMS feedback function to maintain, if not improve, its users’ understanding of electricity conservation. This is a belief that is shared by a variety of feedback theorists (Darby 2006).

Not all changes needed to be large to be substantial. This was the case with respect to the SFR’s responses to the question concerning the importance of electricity conservation. On the baseline survey, two of the SFR indicated that conserving electricity was not important. After the follow-up survey the opinions of these respondents changed and 100% of the SFR believed that conservation was important. Such a shift did not occur among the CFR who responded that conservation was not important. This shift, though small, may represent the potential of the HEMS to influence users' opinions about electricity use and supports the tenets of the value-basis theory (see Section 2.5.2).

Section 5.6- Living with a Home Energy Management System

In the 'Direct Energy Smart Home Energy System' section of the follow-up survey, questions were asked to gain better understanding of how the study's participants used the HEMS. The results reported in Section 4.2.3, have helped expand upon this understanding.

Prior to determining how the HEMS was used, it was important to have an understanding of what users believed was the purpose of the system. According to the responses received from the SFR the perceived function of the system was fairly evenly split among the following; act as an educational tool, assist with electricity conservation, and for convenience. This range of views was present in previous surveys where the consumers were to judge the purpose of similar technology (Green and Marvin 1994). This result could be a positive outcome for proponents of electricity conservation because it is possible that this technology could inadvertently encourage conservation among those who intended to use the HEMS for other purposes.

Another important factor in determining how the system was used was the frequency of use. According to the results of the follow-up survey the use of HEMS's feedback function experienced a 'fall off' effect during the study. This is troubling due to the study's relatively short time frame. This is also unexpected because most respondents indicated that it was the feedback function of the HEMS that assisted them most in their conservation efforts (see Appendix II.C). Not as many SFR indicated that the HEMS's programmable features helped them reduce and/or shift electricity consumption. Yet, this function did not experience the same 'fall off' effect that was experienced by the electricity consumption feedback feature. Assuming that the use of both these features was relatively equal at the beginning of the study, it is possible that some of the SFR felt that they had achieved maximum utilization of the HEM's electricity consumption feedback function and subsequently reduced its rate of use. Yet, due to the user errors and system malfunctions that occurred at the beginning of the study users may be continuing to use the HEMS's programmable features at the same rate, with the hopes of refining their approach and improving their conservation results.

According to the follow-up survey's results the SFR's preferred temporal setting for viewing their electricity consumption feedback was the daily setting; this was followed closely by the weekly setting. When feedback was provided to the recipients in the daily or weekly temporal settings, it was being provided at a scale that can allow the recipient to relate with what they are seeing and make the appropriate changes.   This was the same reason feedback studies that provide recipients with a high frequency of feedback tend to achieve greater conservation results (Darby 2006, Parker et al. 2006).

Another web portal section that was popular among the SFR was the detail section. This is a secondary HEMS feature that provides the user with some information about Ontario's electricity generation. However, its popularity among the SFR may exemplify participants' desire to synergize additional education with the electricity consumption feedback and the programmable features of the system. This coincides with the beliefs of those who argue that the synergy of additional interventions will further assist in the efforts of conservation initiatives (Van Houwelingen and Van Raaij 1989).

Chapter 6- Conclusions

It was the purpose of this research to determine the influence of home energy management systems on residential electricity consumption. This is made evident in the study's research question, 'Do home energy management systems influence the total and on-peak electricity consumption behaviours of participating households in Milton, Ontario?' Upon the completion of this study and having a greater understanding of the study's population, it could be argued that this question should be revised to say, **'**Do home energy management systems influence the total and on-peak electricity consumption of pro-electricity conservation households in recently built Milton, Ontario homes?' This narrowing of scope is not intended to undermine the study's results, but rather to highlight the potential for HEMS to assist in the conservation efforts of households that do not have pre-existing conservation habits.

The overarching response to the study's research question is that during the study months (August 2007 to January 2008), the HEMS enabled households to achieve a 2.9% relative reduction in total electricity consumption and a 13.2% relative reduction in on-peak electricity consumption. When only months with full participation are considered (November-January), the relative reduction in total electricity consumption improves 5.0%, while the relative reduction in on-peak electricity consumption declines to 9.3%.

Load shifting was another behaviour analyzed in an attempt to answer the study's research question. During the course of the study, the average relative consumption shift away from on-peak periods was 9.5%. When the months with full participation were only considered the shift from on-peak consumption declined to 3.0%. The reasoning for this is two-fold: the elimination of the summer months from the evaluation removes the months where participants could potentially shift the use of high electricity consuming systems like the air conditioner; the absence of these months also removes the potential for outliers in months with smaller populations to have an excessive influence on the results.

In addition to measuring the relative reduction and shifts between groups, the study completed a comparison within the sample to determine if being predisposed to TOU pricing affects one's ability to use the HEMS to reduce electricity consumption.

On average, those who had limited experience with the TOU pricing prior to receiving the HEMS had a 2.3% relative reduction in total electricity consumption and a 6.1% relative reduction in on-peak consumption when compared to sample group participants who did have prior TOU RPP experience. These findings exemplify the potential for a HEMS system in a community that recently or concurrently adopted a TOU RPP.

Section 6.1- Theoretical Applicability

Within this study a number of behavioural theories have been recognized for their potential to explain why electricity consumption behavioural changes occur. Included among these theories were the value basis theory, rational economic theory, self-efficacy theory, and cognitive dissonance theory. In the following section, these theories will be reviewed to determine if they have any applicability to this study's results.

The value-basis theorists argue that people will change their attitude toward a certain act and subsequently change their behaviour, if the act in question is negatively affecting something they value. Due to the pro-conservation results of the baseline survey and the below average baseline electricity consumption of many of the participants, this theory appears to have some validity. However, these conditions were present prior to the installation of the HEMS and have no relationship to the use of the system. The best indication of the value-basis theory having applicability to this study's results can be seen within the shift among two of the sample participants who, after using the system, acquired a positive outlook toward electricity conservation that corresponded with reductions in the electricity consumption. However, it is recognized that with such a limited number of observations, this is a weak indication at best.

The applicability of the rational economic theory to this study appears to be more concrete. It was apparent by the results of the study's baseline survey that many respondents participated in this study because they believed it to be in their economic self-interest. This theory could be further supported by the relative reductions and shifts in electricity consumption occurring during on-peak periods when monetary incentives are highest. However, it is possible that some of the study's participants were also aware of the positive implications that reductions in on-peak electricity consumption has on system-wide reliability and the environment, and acted accordingly.

Self-efficacy theorists believe that when people are informed about their behaviours they are enabled to make change. One of the primary functions of the HEMS was to inform participants about their electricity consumption through the provision of electricity consumption feedback. The self-efficacy theory can be supported by the study's results that found participants who received feedback achieved greater reduction in total and on-peak consumption relative to the participants who did not receive feedback. Moreover, this is supported by the results of the follow-up survey which found that the majority of respondents indicated that electricity consumption feedback assisted them in reducing and shifting their electricity consumption.

Unlike self-efficacy theory, cognitive dissonance theory does not appear to have the same applicability to the study's findings. An analysis of the study's electricity consumption trends does not indicate the gradual changes in electricity consumption that are associated with participants experiencing a state of cognitive dissonance. This can be explained by the follow-up survey results that found that a majority of sample respondents reported that their electricity consumption levels were what they expected.

Section 6.2- Potential Technological Improvements

Upon the conclusion of this study many of the previously mentioned technical and user errors (see Section 5.2) were being addressed and the Direct Energy Smart Home Energy Conservation System appeared to be functioning properly. However, if the focus of this system is to encourage electricity conservation among its users then maintaining the status quo is not an option; the Direct Energy Smart Home Energy Conservation System must continue to evolve. By reviewing relevant literature and listening to the feedback of study participants, a number of potential improvements come to light. These improvements focus mainly on the system's provision of electricity consumption feedback.

The frequency of the system's feedback cannot be improved, for as this study was being completed participants were receiving feedback in real-time. However, the manner in which feedback is framed can be improved. One way to do this is to frame the feedback so that social comparisons are formed. If done correctly this could incite competitive behaviours among recipients resulting in improved electricity conservation results. This could evolve into goal setting, where recipients of feedback set conservation targets that they strive to achieve. Again, when framed appropriately this is an approach that has had success in encouraging electricity conservation (Abrahamse et al. 2005, Dwyer et al. 1993).

Another recommendation that could improve the effectiveness of the system's feedback is increasing its synergy with other interventions. The reported popularity of the system's detail section exemplifies the thirst that the study's participants have for additional knowledge about electricity consumption and conservation. The detail section is a start in addressing this need, but the potential of such a section is still not being fully realized. One glaring omission is the absence of advice and tips about how participants can use their HEMS to further their conservation. It is again useful to recall the words of De Young (2000) when he wrote, "knowing what they should do and why they should do it is not enough, they need to know how" (519).

The final feedback related recommendation for the Direct Energy Smart Home Energy Conservation System comes from both the literature and participants' feedback. Household electricity consumption feedback is not enough; there is a need for additional feedback on the electricity consumption of the home's individual appliances. In doing this, the system allows the recipient to further conceptualize the consumption of electricity in the home making it possible for more informed behavioural changes. There has been success with similar feedback in other electricity consumption studies (e.g. Wood and Newboroughs 2003).

Aside from feedback, the innovation of this system can be improved by encompassing additional resources into the system's framework. Conservation in the household does not stop with electricity; there is potential for technology like this to incorporate resources like gas and water. These resources should not be viewed in silos for they are all connected within the household's daily activities. Being conscious of one's household electricity consumption, but failing to consider water conservation, will not fully address society's electricity supply or environmental concerns.

Section 6.3- Implications for Energy Policy

The Ontario government has made it clear that it believes that conservation and demand management (CDM) approaches are to play an important role in addressing Ontario's electricity challenges. They believe that by 2010 CDM will be responsible for reducing the province's total electricity consumption by 1,350 MW (OPA 2006). The three conservation and demand management approaches that were focused on in this study were demand response, load management, and curtailment. Unfortunately for this research, but fortunately for the Ontario electricity system, Ontario did not experience a critical peak event during the course of this study. Therefore, the potential for the HEMS to act as a demand response mechanism could not be assessed. However, in theory it remains a viable option. The potential for the HEMS to perform as a load management tool is still unknown; during months with full study participation the system encouraged average on-peak shifts equal to 3%. However, these months do not include summer months when the largest shifts are expected to be seen. Unfortunately, this study does not have enough data on these summer months, and therefore could not reach reliable conclusions. Lastly, the system's ability to perform as a curtailment mechanism has shown some promise. During off-peak months the system was able to achieve results common among many conservation studies. In theory these results should be improved when the system is used during peak summer months.

This study's results have exemplified the potential for HEMS to achieve rapid conservation when placed in communities that have recently adopted TOU RPP. This is a community profile that will become increasingly common by 2010 when all Ontario homes will have smart meters. This relationship of HEMS and TOU RPP could allow for a virtuous cycle of electricity conservation that could assist conservation in becoming a social norm and Ontario a 'culture of conservation'.

Finally, HEMS technology has provided an opportunity for energy policy makers to reach portions of society that may not have normally participated in energy conservation initiatives. This is a result of the multifaceted capabilities of HEMS that can attract individuals who may be interested in the system for reasons ranging from home security to convenience. These individuals may have limited CDM behaviours prior to their exposure to the HEMS, however, through the use of the system they may inadvertently adopt some of these behaviours, potentially resulting in habit formation and the internalization of conservation behaviours. However, if it is the intention of policy makers to reach 'untapped' electricity conservation markets, it is important that they do it covertly, and not make electricity conservation the focus of the HEMS marketing campaign.

Section 6.4- Recommendations for Future Research

This study has been an excellent venue to explore the potential of HEMS's ability to assist households with their electricity conservation efforts. However, a finite amount of time and resources limited this study's ability to address a variety of outstanding questions. Therefore, the first recommendation for future research is to extend the length of the study period to one year or longer. This length will allow researchers to have a better understanding of the trends in the system's use, allowing them to have an improved ability to recognize the occurrence of 'rebound' or 'fall-off' effects that tend not to occur in the early stages of these studies. An extended study period will also allow for conclusions to begin to be made about learnt behaviours and habit formation as they relate to the HEMS.

The second recommendation for future research is to ensure that summer month's electricity consumption is part of the study's data set. Due to the use of air conditioning, summer months tend to be the time when on-peak electricity consumption is highest among Ontario's residential electricity consumers. These high consumption rates provide an opportunity to view the HEMS's ability to assist in shedding excess electricity consumption. Summer months' high levels of electricity consumption also make the occurrence of critical peak events more likely. Seeing that the HEMS technology is considered to have demand response capabilities, it would be valuable to document how the system is used if such an event were to occur.

The final recommendation for future research is to utilize the wealth of data in the HEMS's database. The available data in this database ranges from the frequency of user logins to each user's mode settings. These data could potentially allow for a variety of correlations to be drawn without the need to rely on possibly inaccurate self-reported accounts of the participants' use of the HEMS.

The home energy management system is an innovative technology that is in the infancy stages of development. The results of this study may have been lower than some may have anticipated. However, the consistency of the total relative electricity reductions throughout the study and the system's ability to catalyze electricity conservation implies that the potential of this system has yet to be reached. With improvements in HEMS technology and the study's conditions (i.e. summer months, stratified sample) it is possible that additional shift and reduction in electricity use could be achieved, thus, assisting the province of Ontario in taking steps toward achieving its goal of becoming a 'culture of conservation'.

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Appendices

Appendix I

A. Sample's Milton Hydro Inc. Cover Letter

MILTON HYDRO

Milton Hydro Distribution Inc.

Dear Resident,

Today's rising electricity prices and the environmental concerns associated with electricity generation affect all Ontarians, including the residents of Milton. In an effort to understand the tools that Milton residents need to better conserve electricity, Milton Hydro has been working in partnership with researchers from the University of Waterloo. Over the next four months we will be conducting a collaborative study to determine whether providing households with in-home electricity displays and controls can be useful in helping residents conserve.

To complete this study we first need to determine some basic information about Milton Hydro's customer base, such as home sizes and appliance information. We also want to hear our customers' opinions regarding electricity issues. We have therefore developed the following survey, and would very much appreciate your participation. However, participation is voluntary, and your decision concerning participation will have no impact on services provided by Milton Hydro.

Those who choose to take part in this study are invited to keep the **Direct Energy Smart Home Energy System**, which you were provided with at the start of this study, as a token of our appreciation. The **Direct Energy Smart Home Energy System** is a web-based graphical interface that allows you to track and control the energy usage of your home.

The aforementioned survey will take approximately 20-25 minutes to complete. Most of the questions are specific in nature and use a multiple choice format. You may skip any questions that you prefer not to answer. All the information that you provide will be considered confidential, and will be used only for research purposes. Your name will not appear in any reports, publications, or presentations pertaining to this research. The survey file will be password protected, and kept indefinitely on a password protected network. As such, there are no known anticipated risks with participating in this study. However, if after reading this letter there remains questions about the survey or you would like additional information to help you determine if you would like to participate in the study feel free to contact Mary-Jo Corkum at Milton Hydro at 905-878-3483 ext. 236, or Dr. Ian Rowlands at the University of Waterloo at 519-888-4567 ext. 32574 or irowland@fesmail.uwaterloo.ca .

If you choose to complete the online survey it can be found at http://survey.uwaterloo.ca/sw/wchost.asp?st=miltonuw&cn=jjschemb. **It must be completed using Internet Explorer**. Alternatively, fill out the attached file email to miltonconserve@fesmail.uwaterloo.ca or mail it to: Milton Hydro Distribution Inc., ATTN: **Direct Energy Smart Home Energy System** Study, 55 Thompson Road South Milton, Ontario, L9T 6P7.

Lastly, I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. Should you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519-888-4567 ext. 36005, or ssykes@admmail.uwaterloo.ca

Thank you in advance for you interest in this project

Yours Sincerely,

D.R Thorne, P.Eng.
President/CEO

B. Sample Baseline Survey

Milton Residential Electricity Consumption Survey
This survey was developed by researchers at the University of Waterloo to gain a better understanding of the needs of residential electricity consumers. In order to do so we ask that you consent to allowing Milton Hydro provide the University of Waterloo with data related to your household electricity consumption. The data acquired through this survey will be kept confidential and be used only for the research purposes.

By checking the following box you are providing your consent for Milton Hydro to share you electricity consumption data (check here) ☐

This survey should be completed by the household member responsible for setting the home's level of electricity usage. **By checking the following box you are confirming that you are the member within your household that best fits this description.** (check here) ☐

Please indicate your Direct Energy Smart Home Energy System username (username is name used to access your Direct Energy Smart Home Energy Conservation System account) ____________

STRUCTURAL- This section is intended to learn more about your home and how it uses electricity

A1. Please specify your house type. (check only one)
☐ Single detached house ☐Townhouse or rowhouse
☐ Semi-detached house ☐ Condominium
☐ Other (please specify)________________

A2. In what year was your house constructed? (check only one)
☐Before 1950 ☐1980-1989 ☐2001-2003
☐1950 -1969 ☐ 1990-1995 ☐ After 2004
☐ 1970-1979 ☐1996-2000 ☐ Unsure

A3. What is the approximate size of your home in square feet? (**excluding** the garage, attic, and unfinished basement) (check only one)
☐Less than 1000 ☐ 2,000-2,499 ☐4,000 or more
☐ 1,000-1,500 ☐ 2,500-2,999 ☐Unsure
☐1,500-1,999 ☐ 3,000-3,999
If you are unsure please indicate the number of bedrooms in your house ____________

A4. Are any devices in your home set on a programmable timer? (**excluding** video/ tv recorder, alarm clock) No ☐ Yes ☐ if yes please list what devices and how many of each ____

A5. How do you usually set the temperature on your thermostat? (check only one)
☐ Program it for different temperatures at different times of the day
☐ Manually set it for different temperatures at different times of the day
☐ Set it seasonally and leave it

A6. Please indicate if electricity is the predominant power source for the following appliances/equipment in your home?

Heat (e.g baseboard, furnace, space heater)	Yes ☐	No ☐	N/A ☐	Not Sure ☐
Clothes Dryer	Yes ☐	No ☐	N/A ☐	Not Sure ☐
Oven/Range	Yes ☐	No ☐	N/A ☐	Not Sure ☐
Hot Water Heater	Yes ☐	No ☐	N/A ☐	Not Sure ☐

A7. Please provide the following information about your appliances. LEAVE BLANK if you do not use or have appliance. Please check the box listed under ENERGY STAR if you have the ENERGY STAR version of this appliance.

Appliance		**Age (Years)**				**ENERGY STAR***
	Unsure	Less than 2	2 to 9	10 to 19	More than 20	Yes
Fridge	☐	☐	☐	☐	☐	☐
Combo fridge/freezer	☐	☐	☐	☐	☐	☐
Washing Machine	☐	☐	☐	☐	☐	☐
Clothes Dryer	☐	☐	☐	☐	☐	☐
Oven/range	☐	☐	☐	☐	☐	☐
Dishwasher	☐	☐	☐	☐	☐	☐
Microwave	☐	☐	☐	☐	☐	☐
Freezer	☐	☐	☐	☐	☐	☐
Hot water heater	☐	☐	☐	☐	☐	☐
Water cooler	☐	☐	☐	☐	☐	☐
Dehumidifier	☐	☐	☐	☐	☐	☐
Mini fridge	☐	☐	☐	☐	☐	☐
Pool	☐	☐	☐	☐	☐	☐
Hot Tub	☐	☐	☐	☐	☐	☐
Whirlpool bathtub	☐	☐	☐	☐	☐	☐
Central Air Conditioner	☐	☐	☐	☐	☐	☐
Window Air Conditioner	☐	☐	☐	☐	☐	☐
Furnace	☐	☐	☐	☐	☐	☐

* ENERGY STAR is a standard set for energy efficient appliances/equipment.

A8. Have you changed from using a gas to an electric appliance in the past year?

Yes ☐ No ☐ What Appliance #1: In What Season:

What Appliance #2: ________________ In What Season: ______________

A9. Have you changed from using an electric to a gas appliance in the past year?
Yes ☐ No ☐ What Appliance #1: ________________ In What Season: ______________

What Appliance #2: ________________ In What Season: ______________

A10. Other than the appliances listed in A8 and A9, have you purchased any other equipment/appliance that may have altered your electricity consumption in the past year?
Yes ☐ No ☐ If yes, could you please indicate what equipment/appliances and approximately when they were purchased ____

A11. Please provide the following information about your appliances

Appliance	**Total Number of Appliances in Use**			
	0	**1**	**2**	**3**
Fridges	☐	☐	☐	☐
Window Air Conditioner	☐	☐	☐	☐

BEHAVIOURAL- This section is intended to gain an understanding of how you and the occupants within your house use electricity.

B1. At what temperature do you normally set your thermostat during the winter and summer? (If you DO NOT have an air conditioner, check N/A and leave summer blank. If you do not adjust the temperature please leave the "Adjusted Temp" column blank)

		Regular Temp (e.g when active in home)	**Adjusted Temp** (e.g night time/ no one home)
	Winter	__°C	__°C
☐ N/A- We do not have an air Conditioner	Summer	__°C	__°C

B2. How often do you normally use hot water when doing a load of laundry?
Always ☐ Sometimes ☐ Never ☐

B3. Which of the following statements best describe your household's usage of lights?

Lights are always left on	☐
Lights are sometimes left on	☐
Lights are only on when someone is in the room	☐
Lights are only on when they need to be (no daylight present)	☐

B4. Please indicate the total number of hours that are spent at your home from **Monday to Friday** using the listed appliances and during what timeframe the appliance is used/left on?

Appliances			**Timeframe**		
	Don't have	7am-11am	11am-5pm	5pm-10pm	10pm-7am
Personal Computer	☐	__hrs	__hrs	__hrs	__hrs
Washing Machine	☐	__hrs	__hrs	__hrs	__hrs
Clothes Dryer	☐	__hrs	__hrs	__hrs	__hrs
Television	☐	__hrs	__hrs	__hrs	__hrs
Dishwasher	☐	__hrs	__hrs	__hrs	__hrs
Oven/Range	☐	__hrs	__hrs	__hrs	__hrs
Conventional T.V	☐	__hrs	__hrs	__hrs	__hrs
Plasma/LCD T.V	☐	__hrs	__hrs	__hrs	__hrs
Hot tub	☐	__hrs	__hrs	__hrs	__hrs
Whirlpool Bathtub	☐	__hrs	__hrs	__hrs	__hrs
Pool Heater	☐	__hrs	__hrs	__hrs	__hrs

B5. Please indicate the total number of hours that are spent at home during the **weekend** using the listed appliances and during what timeframe the appliance is used/left on?

Appliances			**Timeframe**		
	Don't have	7am-11am	11am-5pm	5pm-10pm	10pm-7am
Personal Computer	☐	__hrs	__hrs	__hrs	__hrs
Washing Machine	☐	__hrs	__hrs	__hrs	__hrs
Clothes Dryer	☐	__hrs	__hrs	__hrs	__hrs
Television	☐	__hrs	__hrs	__hrs	__hrs
Dishwasher	☐	__hrs	__hrs	__hrs	__hrs
Oven/Range	☐	__hrs	__hrs	__hrs	__hrs
Conventional T.V	☐	__hrs	__hrs	__hrs	__hrs
Plasma/LCD T.V	☐	__hrs	__hrs	__hrs	__hrs
Hot tub	☐	__hrs	__hrs	__hrs	__hrs
Whirlpool Bathtub	☐	__hrs	__hrs	__hrs	__hrs
Pool Heater	☐	__hrs	__hrs	__hrs	__hrs

B6. Do you intend on doing any of the listed home conservation upgrades during this coming study period, within two years following the study, or not at all?

Initiative	**During study (Oct- Dec 2007)**	**Two Years Following Study**	**No, too expensive**	**No, not necessary**

Purchase ENERGY STAR appliance	☐	☐	☐	☐
Upgrade heating and air conditioning	☐	☐	☐	☐
Upgrade attic/roof/ceiling insulation	☐	☐	☐	☐
Upgrade windows/doors	☐	☐	☐	☐
Have a home energy audit	☐	☐	☐	☐

B7. What is your assessment of your effort to reduce electricity use at home? (check only one)
Doing all I can possibly do ☐
Doing most of what I can do, but can do a little more ☐
Doing something, but could do more ☐
Doing very little ☐

ATTITUDINAL –This section is intended to be used to gain an understanding of your attitude about electricity consumption.

C1. What is it about the Direct Energy Smart Home Energy Conservation kit or this study that made you want to participate?____

C2. How would you rank your awareness of your household electricity consumption now compared to this time a year ago? (check only one)
A lot more ☐ More ☐ Same ☐ Less ☐ A lot less ☐ Unsure ☐

C3. Please indicate the degree to which you agree with the following, "As a responsible citizen I am morally obligated to reduce my electricity consumption." (check only one)
Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Unsure ☐

C4. Do you feel that electricity conservation is important?
Yes ☐ No ☐
If you answered no, could you please elaborate as to why you feel electricity conservation is not important? ____
____

C5. Please indicate how you would rank the following reasons as to why electricity conservation is important? (1 being most important and 3 being least important, DO NOT use same number twice)
Reduce demand/ensure adequate supply and reliability? __
Reduce environmental impact/ greenhouse gas emissions? __
Save money/ reduce energy costs __

C6. Generally, do you feel that your family and friends share your outlook on electricity conservation? (check only one)
No, they are more in favour of conservation ☐
No, they are less in favour of conservation ☐
Yes ☐

C7. Please indicate what best describes your opinion of Ontario's current electricity prices. (check only one)

Much too high ☐ High ☐ Appropriate ☐ Low ☐ Much too low ☐

KNOWLEDGE/FAMILIARITY- This section is used to gain an understanding of your household's awareness of electricity consumption.

D1. How would you rate your understanding of your potential to conserve electricity? (check only one)
Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

D2. What information can be provided to assist you in conserving electricity?
____

D3. Do you pay attention to your electricity consumption indicated on your electricity bill? (check only one) Always ☐ Sometimes ☐ Never ☐

D4. Do you talk about electricity use with your children between the ages of 4-18? (check only one) Yes ☐ No ☐ Don't have children that age ☐

D5. Which of the following conservation programs have you heard of?

Programs	Have heard of	Have not heard of
Every Kilowatt Counts	☐	☐
Summer Savings (10/10 program)	☐	☐
Beat the Meter	☐	☐
Peaksavers	☐	☐

D6. How would you rate the media's influence in informing you about electricity conservation? (check only one)
Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

D7. In the last year have you seen or heard any media advertisements promoting conservation?
Yes ☐ No ☐

D8. How would you rate your technological competence? (check only one)
Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

General Demographic Information- This section is intended to be used to gain an understanding of how particular demographic information relates to how electricity is consumed within the home. All information will be kept confidential.

E1. Your Gender: Male ☐ Female ☐

E2. Your Age: ____

E3. Please indicate the highest level of education that you have completed (check only one)

Some grade or high school	☐	University Bachelors Degree	☐
High school diploma	☐	Graduate Degree	☐
College or Technical Diploma	☐	Other: ______________________	☐

E4. What is your household's approximate annual income (before taxes)? (check only one)

Less than $20,000	☐	$60,001- $80,000	☐
$20,001- $40, 000	☐	$80,001- $100,000	☐
$40,000- $60,000	☐	$100,001- $150,000	☐
More than $150,000	☐		

E5. Please indicate what best describes your current employment status? (check only one)

Employed	☐	Unemployed	☐
Retired	☐	Student	☐
Government Assistance	☐	Other:____________	☐

E6. Please indicate the number of occupants living in your house for the majority of time during the following years 2006: __ 2007: __

E7. Please indicate the amount of free time you have in a week? (check only one)
A lot ☐ Some ☐ Not a lot ☐ None ☐

E8. As of August 1, 2007 have you lived in your current home for more than one year?
Yes ☐ No ☐
If no, what month did you move in?____

E9. Did you go away on vacation anytime between August and December of 2006? (including cottage)

Yes ☐ No ☐ August ☐ Total days: __ September ☐ Total days: __
October ☐ Total days: __ November ☐ Total days: __
December ☐ Total days: __

E10. Which of the following statements best describes your current total household income compared to your income during the summer of 2006:

2007 income has decreased	☐
2007 income has remained constant	☐
2007 income has increased	☐

If there is any additional information that you feel would be helpful to this study please indicate below:

____
____
____

C. Control's Milton Hydro Inc. Cover Letter

MILTON HYDRO

Milton Hydro Distribution Inc.

Dear Residents,

Today's rising electricity prices and the environmental concerns associated with electricity generation affects all Ontarians, including the residents of Milton. In an effort to understand the tools that Milton residents need to better conserve electricity, Milton Hydro has been working in partnership with researchers from the University of Waterloo. As part of this partnership, we are conducting a study over the next four months to determine the attitudes and actions of residents regarding electricity use in the home.

Participation in this study involves residents completing a baseline survey now, a follow-up survey in January, and allows Milton Hydro to share with the University of Waterloo information about your electricity consumption. At any time, you will have the option to withdraw from this study. Participation in this study is voluntary; your decision concerning participation will have no impact on services provided by Milton Hydro. Successful research in this area may help garner a better understanding of how to address rising electricity prices and problems associated with electricity generation.

First we will need to acquire some information about Milton Hydro's customer base, such as home sizes and appliance information. We would also like to hear our customers' opinions regarding electricity issues, as well as their experiences with electricity use in the home. We have therefore developed the following baseline survey, and would very much appreciate your participation.

This survey will take approximately twenty minutes to complete. Most of the questions are specific in nature and use a multiple choice format. You may skip any questions that you prefer not to answer. All the information that you provide will be considered confidential, and will be used only for research purposes. Your name will not appear in any reports, publications, or presentations pertaining to this research. The surveys will be securely stored at the University of Waterloo for one year and then confidentially destroyed. Electronic data files will be stored on a password protected University of Waterloo server. As such, there are no known or anticipated risks with participating in this study. However, if after reading this letter there remains questions about the survey or the broader research, feel free to contact Mary-Jo Corkum at Milton Hydro at 905-878-3483 ext. 236, or Dr. Ian Rowlands at the University of Waterloo at 519-888-4567 ext. 32574.

If you decide to complete this survey please send it in with the provided envelope to ATTN: Residential Electricity Consumption Survey, 55 Thompson Road South, Milton, Ontario, L9T 6P7 with postage courtesy of the University of Waterloo. Those who choose to participate in this study can have their name entered into a draw, for a chance to win a one hundred dollar gift certificate to a restaurant of their choice.
I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. Should you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519-888-4567 ext. 36005, or ssykes@admmail.uwaterloo.ca.

Thank you in advance for your interest in this project.

Sincerely,

Donald R. Thorne
President/CEO

D. Control's Baseline Survey

Milton Residential Electricity Consumption Survey
This survey was developed by researchers at the University of Waterloo to gain a better understanding of the needs of residential electricity consumers. In order to do so we ask that you consent to allowing Milton Hydro provide the University of Waterloo with data related to your household electricity consumption. The data acquired through this survey will be kept confidential and be used only for the research purposes.

By checking the following box you are providing your consent for Milton Hydro to share you electricity consumption data (check here) ☐

This survey should be completed by the household member responsible for setting the home's level of electricity usage. **By checking the following box you are confirming that you are the member within your household that best fits this description.** (check here) ☐

Please provide your Milton Hydro account number __________________________

STRUCTURAL- This section is intended to learn more about your home and how it uses electricity

A1. Please specify your house type. (check only one)
☐ Single detached house
☐Townhouse or rowhouse
☐ Semi-detached house
☐ Condominium
☐ Other (please specify)________________

A2. In what year was your house constructed? (check only one)
☐Before 1950
☐1980-1989
☐2001-2003
☐1950 -1969
☐ 1990-1995
☐ After 2004
☐ 1970-1979
☐1996-2000
☐ Unsure

A3. What is the approximate size of your home in square feet? (**excluding** the garage, attic, and unfinished basement) (check only one)

☐Less than 1000	☐ 2,000-2,499	☐4,000 or more
☐ 1,000-1,499	☐ 2,500-2,999	☐Unsure
☐1,500-1,999	☐ 3,000-3,999	

If you are unsure please indicate the number of bedrooms in your house ______________

A4. Are any devices in your home set on a programmable timer? (**excluding** video/ tv recorder, alarm clock) No ☐ Yes ☐ if yes please list what devices and how many of each ____

A5. How do you usually set the temperature on your thermostat? (check only one)

☐ Program it for different temperatures at different times of the day

☐ Manually set it for different temperatures at different times of the day

☐ Set it seasonally and leave it

A6. Please indicate if electricity is the predominant power source for the following appliances/equipment in your home?

Heat (e.g baseboard, furnace, space heater)	Yes ☐	No ☐	N/A ☐	Not Sure ☐
Clothes Dryer	Yes ☐	No ☐	N/A ☐	Not Sure ☐
Oven/Range	Yes ☐	No ☐	N/A ☐	Not Sure ☐
Hot Water Heater	Yes ☐	No ☐	N/A ☐	Not Sure ☐

A7. Please provide the following information about your appliances. LEAVE BLANK if you do not use or have appliance. Please check the box listed under ENERGY STAR if you have the ENERGY STAR version of this appliance.

Appliance	**Age (Years)**					**ENERGY STAR***
	Unsure	Less than 2	2 to 9	10 to 19	More than 20	Yes
Fridge	☐	☐	☐	☐	☐	☐
Combo fridge/freezer	☐	☐	☐	☐	☐	☐
Washing Machine	☐	☐	☐	☐	☐	☐
Clothes Dryer	☐	☐	☐	☐	☐	☐
Oven/range	☐	☐	☐	☐	☐	☐
Dishwasher	☐	☐	☐	☐	☐	☐
Microwave	☐	☐	☐	☐	☐	☐
Freezer	☐	☐	☐	☐	☐	☐
Hot water heater	☐	☐	☐	☐	☐	☐
Water cooler	☐	☐	☐	☐	☐	☐
Dehumidifier	☐	☐	☐	☐	☐	☐
Mini fridge	☐	☐	☐	☐	☐	☐
Pool	☐	☐	☐	☐	☐	☐
Hot Tub	☐	☐	☐	☐	☐	☐
Whirlpool bathtub	☐	☐	☐	☐	☐	☐
Central Air Conditioner	☐	☐	☐	☐	☐	☐
Window Air Conditioner	☐	☐	☐	☐	☐	☐
Furnace	☐	☐	☐	☐	☐	☐

* ENERGY STAR is a standard set for energy efficient appliances/equipment.

A8. Have you changed from using a gas to an electric appliance in the past year?
Yes ☐ No ☐ What Appliance #1: ____________ In What Season: ____________

What Appliance #2: ____________ In What Season: ____________

A9. Have you changed from using an electric to a gas appliance in the past year?
Yes ☐ No ☐ What Appliance #1: ______________ In What Season: ______________

What Appliance #2: ______________ In What Season: ______________

A10. Other than the appliances listed in A8 and A9, have you purchased any other equipment/appliance that may have altered your electricity consumption in the past year?
Yes ☐ No ☐ If yes, could you please indicate what equipment/appliances and approximately when they were purchased ____________________________________

A11. Please provide the following information about your appliances

Appliance	**Total Number of Appliances in Use**			
	0	**1**	**2**	**3**
Fridges	☐	☐	☐	☐
Window Air Conditioner	☐	☐	☐	☐

BEHAVIOURAL- This section is intended to gain an understanding of how you and the occupants within your house use electricity.

B1. At what temperature do you normally set your thermostat during the winter and summer? (If you DO NOT have an air conditioner, check N/A and leave summer blank. If you do not adjust the temperature please leave the "Adjusted Temp" column blank)

		Regular Temp (e.g when active in home)	**Adjusted Temp** (e.g night time/ no one home)
	Winter	__°C	__°C
☐ N/A- We do not have an air Conditioner	Summer	__°C	__°C

B2. How often do you normally use hot water when doing a load of laundry?
Always ☐ Sometimes ☐ Never ☐

B3. Which of the following statements best describe your households usage of lights?

Lights are always left on	☐
Lights are sometimes left on	☐
Lights are only on when someone is in the room	☐
Lights are only on when they need to be (no daylight present)	☐

B4. Please indicate the total number of hours that are spent at your home from **Monday to Friday** using the listed appliances and during what timeframe the appliance is used/left on?

Appliances		**Timeframe**			
	Don't have	7am-11am	11am-5pm	5pm-10pm	10pm-7am
Personal Computer	☐	__hrs	__hrs	__hrs	__hrs
Washing Machine	☐	__hrs	__hrs	__hrs	__hrs
Clothes Dryer	☐	__hrs	__hrs	__hrs	__hrs
Television	☐	__hrs	__hrs	__hrs	__hrs
Dishwasher	☐	__hrs	__hrs	__hrs	__hrs
Oven/Range	☐	__hrs	__hrs	__hrs	__hrs
Conventional T.V	☐	__hrs	__hrs	__hrs	__hrs
Plasma/LCD T.V	☐	__hrs	__hrs	__hrs	__hrs
Hot tub	☐	__hrs	__hrs	__hrs	__hrs
Whirlpool Bathtub	☐	__hrs	__hrs	__hrs	__hrs
Pool Heater	☐	__hrs	__hrs	__hrs	__hrs

B5. Please indicate the total number of hours that are spent at home during the **weekend** using the listed appliances and during what timeframe the appliance is used/left on?

Appliances		**Timeframe**			
	Don't have	7am-11am	11am-5pm	5pm-10pm	10pm-7am
Personal Computer	☐	__hrs	__hrs	__hrs	__hrs
Washing Machine	☐	__hrs	__hrs	__hrs	__hrs
Clothes Dryer	☐	__hrs	__hrs	__hrs	__hrs
Television	☐	__hrs	__hrs	__hrs	__hrs
Dishwasher	☐	__hrs	__hrs	__hrs	__hrs
Oven/Range	☐	__hrs	__hrs	__hrs	__hrs
Conventional T.V	☐	__hrs	__hrs	__hrs	__hrs
Plasma/LCD T.V	☐	__hrs	__hrs	__hrs	__hrs
Hot tub	☐	__hrs	__hrs	__hrs	__hrs
Whirlpool Bathtub	☐	__hrs	__hrs	__hrs	__hrs
Pool Heater	☐	__hrs	__hrs	__hrs	__hrs

B6. Do you intend on doing any of the listed home conservation upgrades during this upcoming study period, within two years following the study, or not at all?

Initiative	**During study (Oct- Dec 2007)**	**Two years after study**	**No, too expensive**	**No, not necessary**
Purchase ENERGY STAR appliance	☐	☐	☐	☐
Upgrade heating and air conditioning	☐	☐	☐	☐
Upgrade attic/roof/ceiling insulation	☐	☐	☐	☐
Upgrade windows/doors	☐	☐	☐	☐

Have a home energy audit ☐ ☐ ☐ ☐

B7. What is your assessment of your effort to reduce electricity use at home? (check only one)

Doing all I can possibly do ☐
Doing most of what I can do, but can do a little more ☐
Doing something, but could do more ☐
Doing very little ☐

ATTITUDINAL –This section is intended to be used to gain an understanding of your attitude about electricity consumption**.**

C1. How would you rank your awareness of your household electricity consumption now compared to this time a year ago? (check only one)

A lot more ☐ More ☐ Same ☐ Less ☐ A lot less ☐ Unsure ☐

C2. Please indicate the degree to which you agree with the following, "As a responsible citizen I am morally obligated to reduce my electricity consumption." (check only one)

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Unsure ☐

C3. Do you feel that electricity conservation is important?

Yes ☐ No ☐

If you answered no, could you please elaborate as to why you feel electricity conservation is not important (and skip C5)? ______________________________

____

C4. Generally, do you feel that your family and friends share your outlook on electricity conservation? (check only one)

No, they are more in favour of conservation ☐
No, they are less in favour of conservation ☐
Yes ☐

C5. Please indicate what best describes your opinion of Ontario's current electricity prices. (check only one)

Much too high ☐ High ☐ Appropriate ☐ Low ☐ Much too low ☐

KNOWLEDGE/FAMILIARITY- This section is used to gain an understanding of your household's awareness of electricity consumption.

D1. How would you rate your understanding of your potential to conserve electricity? (check only one)

Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

D2. What information can be provided to assist you in conserving electricity?

D3. Do you pay attention to your electricity consumption indicated on your electricity bill? (check only one) Always ☐ Sometimes ☐ Never ☐

D4. Do you talk about electricity use with your children between the ages of 4-18? (check only one) Yes ☐ No ☐ Do not have children that age ☐

D5. Which of the following conservation programs have you heard of?

Programs	Have heard of	Have not heard of
Every Kilowatt Counts	☐	☐
Summer Savings (10/10 program)	☐	☐
Beat the Meter	☐	☐
Peaksavers	☐	☐

D6. How would you rate the media's influence in informing you about electricity conservation? (check only one)
Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

D7. In the last year have you seen or heard any media advertisements promoting conservation?
Yes ☐ No ☐

D8. How would you rate your technological competence? (check only one)
Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

General Demographic Information- This section is intended to be used to gain an understanding of how particular demographic information relates to how electricity is consumed within the home. All information will be kept confidential.

E1. Your Gender: Male ☐ Female ☐

E2. Your Age: _______

E3. Please indicate the highest level of education that you have completed (check one)

Some grade or high school	☐	University Bachelors Degree	☐
High school diploma	☐	Graduate Degree	☐
College or Technical Diploma	☐	Other: ____________	

E4. What is your household's approximate annual income (before taxes)? (check one)

Less than $20,000	☐	$60,001- $80,000	☐
$20,001- $40, 000	☐	$80,001- $100,000	☐
$40,000- $60,000	☐	$100,001- $150,000	☐
More than $150,000	☐		

E5. Please indicate what best describes your current employment status? (check one)
Employed ☐ Unemployed ☐

Retired	☐	Student	☐
Government Assistance	☐	Other: ____________	

E6. Please indicate the number of occupants living in your house for the majority of time during the following years?
2006: ____________ 2007: ____________

E7. Please indicate the amount of free time you have in a week? (check one)
A lot ☐ Some ☐ Not a lot ☐ None ☐

E8. As of September 1, 2007 have you lived in your current home for more than one year? Yes ☐ No ☐
If no, what month did you move in? ____

E9. Did you go away on vacation anytime between August and December of 2006? (including cottage)

Yes ☐ No ☐	August ☐	Total days:	September ☐	Total days:
	October ☐	Total days:	November ☐	Total days:
	December ☐	Total days:		

E10. Which of the following statements best describes your current total household income compared to your income during the fall of 2006:

2007 income has decreased	☐
2007 income has remained constant	☐
2007 income has increased	☐

If there is any additional information that you feel would be helpful to this study please indicate below:____

Thank you for your time, your input is an integral part of this study.

Please use the postage-paid envelope provided to mail the completed survey to us by **October 31, 2007**, and you will be entered into a draw to receive a **$100 gift certificate to a restaurant of the winner's choice!** If you wish to be entered, please provide your name, address, and phone number below so that we may contact the winner.

Enter your name in the draw for a $100 gift certificate

Name: ____
Address: ____
____
Phone: ____

E. Sample's Follow-up Coverletter

MILTON HYDRO

Milton Hydro Distribution Inc.

Dear Resident,

I would like to thank you for your continued participation in the **Direct Energy Smart Home Energy System** study. We are aware that today's rising electricity prices and the environmental concerns associated with electricity generation affect all Ontarians, including the residents of Milton. In an effort to understand the tools that Milton residents need to better conserve electricity, Milton Hydro continues to work in partnership with researchers from the University of Waterloo. Your participation in this study has helped to provide us with valuable insights, and has been a great assistance in determining whether in-home electricity displays and controls can be useful in helping residents conserve.

As the new year begins, we ask that you update the information you provided us at the beginning of this study. This will require the completion of a shorter survey with similar questions pertaining to your electricity consumption behaviours, along with your knowledge of and attitude towards electricity conservation. The completion of this survey is voluntary, and your decision concerning participation will have no impact on services provided by Milton Hydro.

The aforementioned survey will take approximately 10-15 minutes to complete. Most of the questions are specific in nature and use a multiple choice format. You may skip any questions that you prefer not to answer. All the information that you provide will be considered confidential, and will be used only for research purposes. Your name will not appear in any reports, publications, or presentations pertaining to this research. The survey file will be password protected, and kept indefinitely on a password protected network. As such, there are no known anticipated risks with participating in this study. However, if after reading this letter there remains questions about the survey or you would like additional information to help you determine if you would like to participate in the study feel free to contact Mary-Jo Corkum at Milton Hydro at 905-878-3483 ext.

236, or Dr. Ian Rowlands at the University of Waterloo at 519-888-4567 ext. 32574 or irowland@fesmail.uwaterloo.ca .

If you choose to complete the online survey it can be found at http://survey.uwaterloo.ca/sw/wchost.asp?st=miltonfollowup&cn=jjschemb. **It must be completed using Internet Explorer**. Alternatively, you may fill out the attached file email it to miltonconserve@uwaterloo.ca.
Lastly, I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. Should you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519-888-4567 ext. 36005, or ssykes@admmail.uwaterloo.ca

Thank you again for your invaluable participation in this study.

Yours Sincerely,

Donald R. Thorne
President/CEO

F. Sample's Follow-up Survey

Milton Residential Electricity Consumption Follow-Up Survey
This survey was developed by researchers at the University of Waterloo to gain a better understanding of the needs of residential electricity consumers.

This survey should be completed by the household member responsible for setting the home's level of electricity usage. It should be the same person who completed this study's initial survey. **By checking the following box you are confirming that you are the member within your household that best fits this description.** (check here) ☐

Were you the person who completed the initial survey? Yes ☐ No ☐

Please indicate your Direct Energy Smart Home Energy System username (username is name used to access your Direct Energy Smart Home Energy System account)

____

STRUCTURAL- This section is intended to learn more about your home and how it uses electricity

A1. Have you changed from using a gas to an electric appliance since the installation of the **Direct Energy Smart Home Energy System**?
Yes ☐ No ☐ What Appliance #1: ________________ In What Month: ______________
What Appliance #2: ________________ In What Month: ______________

A2. Have you changed from using an electric to a gas appliance since the installation of the **Direct Energy Smart Home Energy System**?
Yes ☐ No ☐ What Appliance #1: ________________ In What Month: ______________
What Appliance #2: ________________ In What Month: ______________

A3. Other than the appliances listed in A1 and A2, have you purchased or discarded any other equipment/appliance that may have altered your electricity consumption since the installation of the **Direct Energy Smart Home Energy System**? Yes ☐ No ☐ If yes, please indicate if it was (purchased ☐ or discarded ☐), what it was and approximately when it was purchased or discarded. ________________________________
____

A4. Since the installation of the **Direct Energy Smart Home Energy System**, has your home had any additions or renovations that may have altered your home's electricity consumption? Yes ☐ No ☐ If yes, please indicate what it was and approximately when it occurred.

____

____

A5. What is the resource that you primarily use to heat your home? (check only one)
Electricity ☐ Gas ☐ Wood ☐ Other ☐ ______________________

BEHAVIOURAL- This section is intended to gain an understanding of how you and the occupants within your house use electricity.

B1. Which of the following statements describes your household's usage of lights? (check only one)

Lights are always left on	☐
Lights are sometimes left on	☐
Lights are only on when someone is in the room	☐
Lights are only on when they need to be (no daylight present)	☐

B2. For each timeframe please select the most appropriate response to the following statement, 'Compared to the beginning of this study, the number of hours that are spent at my home using the listed appliance has (been)…'(D=Decreased, U=Unchanged, I=Increased) (circle one per timeframe, SKIP appliance if you do not have/use one.)

Appliances	**Timeframe**				
	Mon.-Fri. 7am-11am	Mon.-Fri. 11am-5pm	Mon.-Fri. 5pm-10pm	Mon.-Fri. 10pm-7am	Weekend
Personal Computer	D U I	D U I	D U I	D U I	D U I
Washing Machine	D U I	D U I	D U I	D U I	D U I
Clothes Dryer	D U I	D U I	D U I	D U I	D U I
Dishwasher	D U I	D U I	D U I	D U I	D U I
Oven/Range	D U I	D U I	D U I	D U I	D U I
Conventional T.V	D U I	D U I	D U I	D U I	D U I
Plasma/LCD T.V	D U I	D U I	D U I	D U I	D U I
Hot tub	D U I	D U I	D U I	D U I	D U I
Whirlpool Bathtub	D U I	D U I	D U I	D U I	D U I

B3. Have you completed any of the following home conservation upgrades during the course of this study, or do you intend to following this study?

Initiative	**Since System Installed**	**Two year following study**	**No, too expensive**	**No, not necessary**
Purchase ENERGY STAR appliance	☐	☐	☐	☐
Upgrade heating or air conditioning	☐	☐	☐	☐
Upgrade attic/roof/ceiling insulation	☐	☐	☐	☐
Have a home energy audit	☐	☐	☐	☐

B4. What is your assessment of your effort to reduce electricity use at home? (check only one)

Doing all I can possibly do ☐
Doing most of what I can do, but can do a little more ☐
Doing something, but could do more ☐
Doing very little ☐

ATTITUDINAL –This section is intended to gain an understanding of your attitude about electricity consumption.

C1. How would you rank your awareness of your household electricity consumption now compared to the beginning of this study? (check only one)
A lot more ☐ More ☐ Same ☐ Less ☐ A lot less ☐ Unsure ☐

C2. Please indicate the degree to which you agree with the following, "As a responsible citizen I am morally obligated to reduce my electricity consumption." (check only one)
Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Unsure ☐

C3. Do you feel that electricity conservation is important? Yes ☐ No ☐
If you answered no, could you please elaborate as to why you feel electricity conservation is not important? ____
____

C4. Please indicate what best describes your opinion of Ontario's current electricity prices. (check only one)
Much too high ☐ High ☐ Appropriate ☐ Low ☐ Much too low ☐

C5. Please indicate your household's level of commitment to reducing its 'on-peak' electricity consumption. (check only one)

Very Committed ☐ Committed ☐ Somewhat Committed ☐
Minimally Committed ☐ Not Committed ☐ Unsure ☐

KNOWLEDGE/FAMILIARITY- This section is used to gain an understanding of your household's awareness of electricity consumption.

D1. How would you rate your understanding of your potential to conserve electricity? (check only one) Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

D2. Do you pay attention to your electricity consumption indicated on your electricity bill? (check only one) Always ☐ Sometimes ☐ Never ☐

D3. Do you talk about electricity use with your children between the ages of 4-18? (check only one) Yes ☐ No ☐ Don't have children that age ☐

D4. During the course of this study have you seen or heard any media advertisements promoting conservation? Yes ☐ No ☐

DIRECT ENERGY SMART HOME ENERGY SYSTEM- This section is intended to gain an understanding of how participants used the Direct Energy Smart Home Energy System.

E1. How often do you login to your Direct Energy Smart Home Energy System's web portal? (check only one)

Daily	☐	3-4 days a week	☐	Weekly	☐
Monthly	☐	Rarely	☐	Never	☐

E2. Which of the following Direct Energy Smart Home Energy System features do you feel helps you **reduce** your total electricity consumption? (check only one)

Electricity Consumption Feedback Features (ie. portal's graphs/charts)	☐
Programmable Features (ie. automated lighting)	☐
Electricity Consumption Feedback & Programmable Features	☐
No feature helps me reduce my electricity consumption	☐

E3. Which of the following Direct Energy Smart Home Energy System features do you feel helps you **shift** your electricity consumption from on-peak use? (please check one)

Electricity Consumption Feedback Features	☐
Programmable Features	☐
Electricity Consumption Feedback & Programmable Features	☐
No feature helps shift my electricity consumption	☐

E4. Please complete the following sentence, 'After first viewing the Direct Energy Smart Home Energy System's electricity consumption feedback features (eg. portal's graphs/charts) I found that I was…' (check only one)

Consuming less electricity than I thought	☐
Consuming as much electricity as I thought	☐
Consuming more electricity than I thought	☐

E5. Please complete the following sentence, 'Compared to the first month I had the Direct Energy Smart Home Energy System I now find myself using the **electricity consumption feedback features** _______.' (check only one)

More often	☐	Same	☐	Less often	☐

E6. Please complete the following sentence, 'Compared to the first month I had the Direct Energy Smart Home Energy System I now find myself using the **programmable features** (eg. automated lighting) _______.' (check only one)

More often	☐	Same	☐	Less often	☐

E7. Which of the following do you feel best describes the function of the Direct Energy Smart Home Energy System? (check only one)

Convenience	☐	Education	☐
Electricity Conservation	☐	Home Security	☐
Monetary Savings	☐	None of the above	☐

Other ☐ ____

E8. Did you ever use the 'detail' section (ie. pie chart on Ontario electricity generation) of the Direct Energy Smart Home Energy System portal? (check only one)
Yes ☐ No ☐ Unaware of section ☐

E9. In the Direct Energy Smart Home Energy System portal, which temporal setting did you prefer to view your **electricity consumption feedback**? (check only one)
Daily ☐ Weekly ☐ Yearly ☐ Did not use this feature ☐

E10. Which visual setting did you prefer to view your **electricity consumption feedback**? (check only one)
3D ☐ Bar ☐ Line ☐ Did not use this feature ☐

GENERAL DEMOGRAPHIC - This section is intended to gain an understanding of how particular demographic information relates to how electricity is consumed within the home. All information will be kept confidential.

F1. Have the number of occupants living in your house changed during the course of this study? Yes ☐ No ☐, If yes, by how many ___

F2. Was your family away from home between August 2007 and January 2008? (including cottage)
Yes ☐ No ☐ August ☐ Total days: __ September ☐ Total days: __
October ☐ Total days: __ November ☐ Total days: __
December ☐ Total days: __ January ☐ Total days: __

F3. Which of the following answers best describes your current total household income compared to your income at the beginning of this study: (check only one)
Decreased ☐ Remained constant ☐ Increased ☐

We would be delighted to hear any of your experiences and opinions with regards to Direct Energy Smart Home Energy System? (Please elaborate below, use back of page if necessary) ____
____
____
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____
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____

Thank you for your time, your input is an integral part of this study.

G. Control Follow-up Coverletter

MILTON HYDRO

Milton Hydro Distribution Inc.

Dear Resident,

I would like to thank you for your contributions to the Milton Residential Electricity Consumption study. We are aware that today's rising electricity prices and the environmental concerns associated with electricity generation affect all Ontarians, including the residents of Milton. In an effort to understand the tools that Milton residents need to better conserve electricity, Milton Hydro continues to work in partnership with researchers from the University of Waterloo. Your participation in this study has help to provide us with valuable insights. This has assisted Milton Hydro determine how we can best help Milton residents conserve electricity.

As the new year begins, we ask that you update the information you provided earlier. This will require the completion of a shorter survey with similar questions pertaining to your electricity consumption behaviours, along with your knowledge of and attitude towards electricity conservation. This will be the final survey of this study. The completion of this survey is voluntary, and your decision concerning participation will have no impact on services provided by Milton Hydro.

The aforementioned survey will take approximately ten minutes to complete. Most of the questions are specific in nature and use a multiple choice format. You may skip any questions that you prefer not to answer. All the information that you provide will be considered confidential, and will be used only for research purposes. Your name will not appear in any reports, publications, or presentations pertaining to this research. The surveys will be securely stored at the University of Waterloo for one year and then confidentially destroyed. Electronic data files will be stored on a password protected University of Waterloo server. As such, there are no known or anticipated risks with participating in this study. However, if after reading this letter there remains questions about the survey or the broader research feel free to contact Mary-Jo Corkum at Milton

Hydro at 905-878-3483 ext. 236, or Dr. Ian Rowlands at the University of Waterloo at 519-888-4567 ext. 32574.

If you decide to complete this survey please send it in with the provided addressed stamped envelope to ATTN: Residential Electricity Consumption Follow-Up Survey, 55 Thompson Road South, Milton, Ontario, L9T 6P7 with postage courtesy of the University of Waterloo. We have included $5 with this package, as a token of our appreciation for your previous and continued participation in this study.

…/2

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. Should you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519-888-4567 ext. 36005, or ssykes@admmail.uwaterloo.ca.

Thank you again for your invaluable participation in this study.

Sincerely,

Donald R. Thorne
President/CEO

H. Control Follow-up Survey

Milton Residential Electricity Consumption Follow-Up Survey
This survey was developed by researchers at the University of Waterloo to gain a better understanding of the needs of residential electricity consumers.

This survey should be completed by the household member responsible for setting the home's level of electricity usage. It should be the same person who completed this study's initial survey. **By checking the following box you are confirming that you are the member within your household that best fits this description.** (check here) ☐

Were you the person who completed the initial survey? Yes ☐ No ☐

Please provide your Milton Hydro account number ________________________

STRUCTURAL- This section is intended to gain an understanding of how your home uses electricity.

A1. Have you changed from using a gas to an electric appliance since October 2007?
Yes ☐ No ☐ What Appliance #1: ______________ In What Month: ____________

What Appliance #2: ______________ In What Month: ____________

A2. Have you changed from using an electric to a gas appliance since October 2007?
Yes ☐ No ☐ What Appliance #1: ______________ In What Month: ____________

What Appliance #2: ______________ In What Month: ____________

A3. Other than the appliances listed in A1 and A2, have you purchased or discarded any other equipment/appliance that may have altered your electricity consumption since October 2007? Yes ☐ No ☐ If yes, please indicate if it was (purchased ☐ or discarded ☐), what it was, and approximately when it was purchased or discarded.

____
____
____

A4. Since August 2006**,** has your home had any additions or renovations that may have altered your home's electricity consumption? Yes ☐ No ☐ If yes, please indicate what it was and approximately when it occurred.

____

____

A5. What is the resource that you primarily use to heat your home? (check only one)
Electricity ☐ Gas ☐ Wood ☐ Other ☐ ______________________

BEHAVIOURAL - This section is intended to gain an understanding of how you and the occupants within your house use electricity.

B1. At what temperature do you normally set your thermostat during the winter and summer? (If you DO NOT have an air conditioner, check N/A and leave summer blank. If you do not adjust the temperature, please leave the "Adjusted Temp" column blank)

		Regular Temp (e.g when active in home)	**Adjusted Temp** (e.g night time/ no one home)
☐ N/A- We do	Winter	___°C	___°C
not have A/C	Summer	___°C	___°C

B2. Which of the following statements best describes your household's usage of lights? (check only one)

Lights are always left on	☐
Lights are sometimes left on	☐
Lights are only on when someone is in the room	☐
Lights are only on when they need to be (no daylight present)	☐

B3. For each timeframe please select the most appropriate response to the following statement, "Compared to October 2007, the number of hours that are spent at my home using the listed appliance has (been)…" (D=Decreased, U=Unchanged, I=Increased) (circle one answer per timeframe, SKIP appliance if you do not have/use one)

Appliances	**Timeframe**				
	Mon.-Fri. 7am-11am	Mon.-Fri. 11am-5pm	Mon.-Fri. 5pm-10pm	Mon.-Fri. 10pm-7am	Weekend
Personal Computer	D U I	D U I	D U I	D U I	D U I
Washing Machine	D U I	D U I	D U I	D U I	D U I
Clothes Dryer	D U I	D U I	D U I	D U I	D U I
Dishwasher	D U I	D U I	D U I	D U I	D U I
Oven/Range	D U I	D U I	D U I	D U I	D U I
Conventional T.V	D U I	D U I	D U I	D U I	D U I
Plasma/LCD T.V	D U I	D U I	D U I	D U I	D U I
Hot Tub	D U I	D U I	D U I	D U I	D U I
Whirlpool Bathtub	D U I	D U I	D U I	D U I	D U I

B4. Have you completed any of the following home conservation upgrades since October 2007, or do you intend to in the near future?

Initiative	**Since October 2007**	**Within the next two years**	**No, too expensive**	**No, not necessary**
Purchase ENERGY STAR appliance	☐	☐	☐	☐
Upgrade heating or air conditioning	☐	☐	☐	☐
Upgrade attic/roof/ceiling insulation	☐	☐	☐	☐
Upgrade windows/doors	☐	☐	☐	☐
Have a home energy audit	☐	☐	☐	☐

B5. What is your assessment of your effort to reduce electricity use at home? (check only one)

Doing all I can possibly do ☐
Doing most of what I can do, but can do a little more ☐
Doing something, but could do more ☐
Doing very little ☐

ATTITUDINAL –This section is intended to gain an understanding of your attitude about electricity consumption.

C1. How would you rank your awareness of your household's electricity consumption now compared to October 2007? (check only one)
A lot more ☐ More ☐ Same ☐ Less ☐ A lot less ☐ Unsure ☐

C2. Please indicate the degree to which you agree with the following, "As a responsible citizen I am morally obligated to reduce my electricity consumption." (check only one)
Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Unsure ☐

C3. Do you feel that electricity conservation is important? Yes ☐ No ☐
If no, could you please elaborate as to why you feel electricity conservation is not important?____

____

C4. Please indicate what best describes your opinion of Ontario's current electricity prices. (check only one)
Much too high ☐ High ☐ Appropriate ☐ Low ☐ Much too low ☐

C5. Please indicate your household's level of commitment to reducing its 'on-peak' electricity consumption. (check only one)

Very Committed	☐	Committed	☐	Somewhat Committed	☐
Minimally Committed	☐	Not Committed	☐	Unsure	☐

KNOWLEDGE/FAMILIARITY- This section is intended to gain an understanding of your household's awareness of electricity consumption.

D1. How would you rate your understanding of your potential to conserve electricity? (check only one)
Very high ☐ High ☐ Average ☐ Low ☐ Very low ☐

D2. Do you pay attention to your electricity consumption indicated on your electricity bill? (check only one) Always ☐ Sometimes ☐ Never ☐

D3. Do you talk about electricity use with your children between the ages of 4-18? (check only one) Yes ☐ No ☐ Don't have children that age ☐

D4. Since October 2007 have you seen or heard any media advertisements promoting conservation? Yes ☐ No ☐

GENERAL DEMOGRAPHIC- This section is intended to gain an understanding of how particular demographic information relates to how electricity is consumed within the home. As a reminder all information will be kept confidential.

E1. Have the number of occupants living in your home changed since October 2007?
Yes ☐ No ☐, If yes, by how many (please note an increase or decrease) __________

E2. Was your family away from home between August 2007 and January 2008? (including cottage)

Yes ☐ No ☐	August ☐	Total days: __	September ☐	Total days: __
	October ☐	Total days: __	November ☐	Total days: __
	December ☐	Total days: __	January ☐	Total days: __

E3. Which of the following answers best describes your current total household income compared to your income in October 2007: (check only one)
Decreased ☐ Remained constant ☐ Increased ☐

If there is any additional information that you feel would be helpful to this study please indicate below:

____
____
____
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____

Thank you for your time, your input is an integral part of this study.

For administrative purposes, we would greatly appreciate it if you could initial the following statement:
"I have completed this survey; in appreciation for doing so, I received a five-dollar bill."
_____ ← (initial here)

Appendix II

A. Sample Baseline Survey Results

SECTION A- Structural

A1. Please specify your house type.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single detached	40	58.0	59.7	59.7
	Semi-detached	12	17.4	17.9	77.6
	Townhouse	15	21.7	22.4	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

A2. In what year was your house constructed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2001-2003	6	8.7	8.7	8.7
	After 2004	63	91.3	91.3	100.0
	Total	69	100.0	100.0	

A3. What is the approximate size of your home in square feet?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1000-1499	4	5.8	5.9	5.9
	1500-1999	37	53.6	54.4	60.3
	2000-2499	16	23.2	23.5	83.8
	2500-2999	5	7.2	7.4	91.2
	3000-3999	5	7.2	7.4	98.5
	Unsure	1	1.4	1.5	100.0

		Frequency	Percent	Valid Percent	Cumulative Percent
	Total	68	98.6	100.0	
Missing		1	1.4		
Total		69	100.0		

A4. Are any devices in your home set on a programmable timer?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	42	60.9	63.6	63.6
	Yes	24	34.8	36.4	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

In an open-ended question, those who answered 'yes', were invited to report what programmable devices. Devices reported were; *coffee maker, thermostat, television, lamps.*

A5. How do you usually set the temperature on your thermostat?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Program Schedule	43	62.3	63.2	63.2
	Manually Set	15	21.7	22.1	85.3
	Program Seasonally	10	14.5	14.7	100.0
	Total	68	98.6	100.0	
Missing		1	1.4		
Total		69	100.0		

A6. Please indicate if electricity is the predominant power source for the following appliances/equipment in your home?

Heater Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	26.1	28.1	28.1
	No	46	66.7	71.9	100.0
	Total	64	92.8	100.0	
Missing		5	7.2		
Total		69	100.0		

Clothes Dryer Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	57	82.6	86.4	86.4
	No	9	13.0	13.6	100.0
	Total	66	95.7	100.0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Missing		3	4.3		
Total		69	100.0		

Oven Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	68.1	71.2	71.2
	No	19	27.5	28.8	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

Water Heater Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	21.7	22.7	22.7
	No	48	69.6	72.7	95.5
	Don't know	3	4.3	4.5	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

A7. Please provide the following information about your appliances. LEAVE BLANK if you do not use or have appliance. Please check the box listed under ENERGY STAR if you have the ENERGY STAR version of this appliance. * ES=Energy Star, **Respondents asked to leave blank if they do not have an appliance, therefore missing will most often mean the home does not have this appliance.

Age of Fridge/ENERGY STAR Fridge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	5.0	5.0
	2 or less	14	20.3	35.0	40.0
	2-9	11	15.9	27.5	67.5
	10-19	2	2.9	5.0	72.5
	2 or less ES	5	7.2	12.5	85.0
	2-9 ES	6	8.7	15.0	100.0
	Total	40	58.0	100.0	
Missing		29	42.0		
Total		69	100.0		

Age of Fridge/Freezer Combo/ ENERGY STAR Fridge/Freezer Combo

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	5	7.2	9.6	9.6
	Less than 2	7	10.1	13.5	23.1
	2-9	15	21.7	28.8	51.9
	Less than 2 ES	7	10.1	13.5	65.4
	2-9 ES	18	26.1	34.6	100.0
	Total	52	75.4	100.0	
Missing		17	24.6		
Total		69	100.0		

Age of Washing Machine/ ENERGY STAR Washing Machine

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	3.0	3.0
	Less than 2	18	26.1	26.9	29.9
	2-9	17	24.6	25.4	55.2
	10-19	1	1.4	1.5	56.7
	Less than 2 ES	12	17.4	17.9	74.6
	2-9 ES	17	24.6	25.4	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

Age of Clothes Dryer/ ENERGY STAR Clothes Dryer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	3.0	3.0
	Less than 2	19	27.5	28.8	31.8
	2-9	17	24.6	25.8	57.6
	10-19	2	2.9	3.0	60.6
	Less than 2 ES	10	14.5	15.2	75.8
	2-9 ES	16	23.2	24.2	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

Age of Oven/ ENERGY STAR Oven

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	3.0	3.0
	Less than 2	21	30.4	31.3	34.3
	2-9	23	33.3	34.3	68.7
	Less than 2 ES	8	11.6	11.9	80.6

		Frequency	Percent	Valid Percent	Cumulative Percent
	2-9 ES	13	18.8	19.4	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

Age of Dishwasher/ENERGY STAR Dishwasher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	3.0	3.0
	Less than 2	21	30.4	31.3	34.3
	2-9	19	27.5	28.4	62.7
	Less than 2 ES	10	14.5	14.9	77.6
	2-9 ES	15	21.7	22.4	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

Age of Microwave/ENERGY STAR Microwave

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	3	4.3	4.5	4.5
	Less than 2	21	30.4	31.8	36.4
	2-9	31	44.9	47.0	83.3
	10-19	2	2.9	3.0	86.4
	Less than 2 ES	5	7.2	7.6	93.9
	2-9 ES	4	5.8	6.1	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

Age of Freezer/ENERGY STAR Freezer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	5.4	5.4
	Less than 2	9	13.0	24.3	29.7
	2-9	12	17.4	32.4	62.2
	10-19	5	7.2	13.5	75.7
	Less than 2 ES	5	7.2	13.5	89.2

		Frequency	Percent	Valid Percent	Cumulative Percent
	2-9 ES	4	5.8	10.8	100.0
	Total	37	53.6	100.0	
Missing		32	46.4		
Total		69	100.0		

Age of Hot Water Heater/ ENERGY STAR Hot Water Heater

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	3.1	3.1
	Less than 2	23	33.3	35.9	39.1
	2-9	28	40.6	43.8	82.8
	Unsure ES	1	1.4	1.6	84.4
	Less than 2 ES	5	7.2	7.8	92.2
	2-9 ES	5	7.2	7.8	100.0
	Total	64	92.8	100.0	
Missing		5	7.2		
Total		69	100.0		

Age of Water Cooler/ ENERGY STAR Water Cooler

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	11.8	11.8
	Less than 2	5	7.2	29.4	41.2
	2-9	9	13.0	52.9	94.1
	10-19	1	1.4	5.9	100.0
	Total	17	24.6	100.0	
Missing		52	75.4		
Total		69	100.0		

Age of Dehumidifier/ENERGY STAR Dehumidifier

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	7.4	7.4
	Less than 2	11	15.9	40.7	48.1
	2-9	7	10.1	25.9	74.1
	10-19	3	4.3	11.1	85.2
	Less than 2 ES	3	4.3	11.1	96.3

	2-9 ES	1	1.4	3.7	100.0
	Total	27	39.1	100.0	
Missing		42	60.9		
Total		69	100.0		

Age of Mini Fridge/ENERGY STAR Mini Fridge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	3	4.3	17.6	17.6
	Less than 2	4	5.8	23.5	41.2
	2-9	5	7.2	29.4	70.6
	10-19	3	4.3	17.6	88.2
	2-9 ES	2	2.9	11.8	100.0
	Total	17	24.6	100.0	
Missing		52	75.4		
Total		69	100.0		

Age of Pool

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	66.7	66.7
	Less than 2	1	1.4	33.3	100.0
	Total	3	4.3	100.0	
Missing		66	95.7		
Total		69	100.0		

Age of Hot tub

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	33.3	33.3
	Less than 2	4	5.8	66.7	100.0
	Total	6	8.7	100.0	
Missing		63	91.3		
Total		69	100.0		

Age of Whirlpool/ENERGY STAR Whirlpool

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	13.3	13.3
	Less than 2	7	10.1	46.7	60.0
	2-9	5	7.2	33.3	93.3
	2-9 ES	1	1.4	6.7	100.0
	Total	15	21.7	100.0	
Missing		54	78.3		
Total		69	100.0		

Age of Central Air Conditioning/ENERGY STAR Central Air Conditioning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	2.9	2.9
	Less than 2	21	30.4	30.4	33.3
	2-9	31	44.9	44.9	78.3
	Less than 2 ES	9	13.0	13.0	91.3
	2-9 ES	6	8.7	8.7	100.0
	Total	69	100.0	100.0	

Age of Window Air Conditioner

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	66.7	66.7
	Less than 2	1	1.4	33.3	100.0
	Total	3	4.3	100.0	
Missing		66	95.7		
Total		69	100.0		

Age of Furnace/ENERGY STAR Furnace

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	2	2.9	2.9	2.9
	Less than 2	21	30.4	30.4	33.3
	2-9	32	46.4	46.4	79.7
	Less than 2 ES	7	10.1	10.1	89.9
	2-9 ES	7	10.1	10.1	100.0
	Total	69	100.0	100.0	

A8. Have you changed from using a gas to an electric appliance in the past year?

Change Gas to Electric

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	69	100.0	100.0	100.0

A9. Have you changed from using an electric to a gas appliance in the past year?

Change Electric to Gas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	4.3	4.3	4.3
	No	66	95.7	95.7	100.0
	Total	69	100.0	100.0	

A10. Other than the appliances listed in A8 and A9, have you purchased any other equipment/appliance that may have altered your electricity consumption in the past year?

Major Appliance/Electronic Purchases

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	15.9	15.9	15.9
	No	58	84.1	84.1	100.0
	Total	69	100.0	100.0	

In an open-ended question, those who answered 'yes', were invited to report what equipment/appliances. The following equipment/appliances were reported; *Plasma television, dehumidifier, ENERGY STAR appliances.*

SECTION B- Behavioural

B1. At what temperature do you normally set your thermostat during the winter and summer?

Winter Thermostat when at Home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	12.0	1	1.4	1.5	1.5
	18.0	2	2.9	3.0	4.5
	19.0	2	2.9	3.0	7.5
	20.0	5	7.2	7.5	14.9
	21.0	13	18.8	19.4	34.3
	21.5	1	1.4	1.5	35.8
	22.0	14	20.3	20.9	56.7
	23.0	12	17.4	17.9	74.6
	24.0	8	11.6	11.9	86.6
	25.0	3	4.3	4.5	91.0
	26.0	2	2.9	3.0	94.0
	27.0	3	4.3	4.5	98.5
	28.0	1	1.4	1.5	100.0

		Frequency	Percent	Valid Percent	Cumulative Percent
	Total	67	97.1	100.0	
Missing	System	2	2.9		
Total		69	100.0		

Winter Thermostat when Sleeping/Away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14.0	1	1.4	1.7	1.7
	15.0	1	1.4	1.7	3.3
	16.0	3	4.3	5.0	8.3
	17.0	4	5.8	6.7	15.0
	18.0	13	18.8	21.7	36.7
	19.0	9	13.0	15.0	51.7
	20.0	7	10.1	11.7	63.3
	21.0	7	10.1	11.7	75.0
	22.0	6	8.7	10.0	85.0
	23.0	3	4.3	5.0	90.0
	24.0	3	4.3	5.0	95.0
	25.0	1	1.4	1.7	96.7
	26.0	1	1.4	1.7	98.3
	27.0	1	1.4	1.7	100.0
	Total	60	87.0	100.0	
Missing	System	9	13.0		
Total		69	100.0		

Summer Thermostat when at Home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15.0	1	1.4	1.5	1.5
	18.0	1	1.4	1.5	3.0
	20.0	1	1.4	1.5	4.5
	21.0	5	7.2	7.5	11.9
	21.5	1	1.4	1.5	13.4
	22.0	10	14.5	14.9	28.4
	23.0	18	26.1	26.9	55.2

		Frequency	Percent	Valid Percent	Cumulative Percent
	24.0	16	23.2	23.9	79.1
	25.0	6	8.7	9.0	88.1
	26.0	7	10.1	10.4	98.5
	32.0	1	1.4	1.5	100.0
	Total	67	97.1	100.0	
Missing	System	2	2.9		
Total		69	100.0		

Summer Thermostat when Sleeping/Away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15.0	1	1.4	1.7	1.7
	19.0	2	2.9	3.4	5.2
	20.0	1	1.4	1.7	6.9
	21.0	3	4.3	5.2	12.1
	22.0	2	2.9	3.4	15.5
	23.0	4	5.8	6.9	22.4
	23.5	1	1.4	1.7	24.1
	24.0	8	11.6	13.8	37.9
	25.0	14	20.3	24.1	62.1
	26.0	10	14.5	17.2	79.3
	27.0	5	7.2	8.6	87.9
	28.0	5	7.2	8.6	96.6
	30.0	2	2.9	3.4	100.0
	Total	58	84.1	100.0	
Missing	System	11	15.9		
Total		69	100.0		

B2. How often do you normally use hot water when doing a load of laundry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	13	18.8	18.8	18.8
	Sometimes	38	55.1	55.1	73.9
	Never	18	26.1	26.1	100.0
	Total	69	100.0	100.0	

B3. Which of the following statements best describe your household's usage of lights?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sometimes on	18	26.1	26.5	26.5

	Only on when someone is in the room	24	34.8	35.3	61.8
	Only on when necessary	26	37.7	38.2	100.0
	Total	68	98.6	100.0	
Missing	System	1	1.4		
Total		69	100.0		

B4. Please indicate the total number of hours that are spent at your home from **Monday to Friday** using the listed appliances and during what timeframe the appliance is used/left on?

Computer

		Total weekday PC use 7am-11am	Total weekday PC use 11am-5pm	Total weekday PC use 5pm-10pm	Total weekday PC use 10pm-7am
N	Valid	65	65	65	65
	Missing	4	4	4	4
Mean		4.424615	7.623077	9.430769	4
Median		2	2.5	5	9.176923077
Mode		0	0	5	2
Range		52.41782	123.969	95.40529	0
Minimum		0	0	0	241.4408654
Maximum		65	65	65	0

Washing Machine

		Total weekday Washing Machine use 7am-11am	Total weekday Washing Machine use 11am-5pm	Total weekday Washing Machine use 5pm-10pm	Total weekday Washing Machine use 10pm-7am
N	Valid	46	46	46	46
	Missing	23	23	23	23
Mean		0.184782609	0.51087	1.021739	1.315217
Median		0	0	0	1
Mode		0	0	0	0
Range		0.348429952	1.272101	2.243961	2.281763
Minimum		0	0	0	0
Maximum		3	4	6	5

Clothes Dryer

		Total weekday Clothes Dryer use 7am-11am	Total weekday Clothes Dryer use 11am-5pm	Total weekday Clothes Dryer use 5pm-10pm	Total weekday Clothes Dryer use 10pm-7am
N	Valid	43	43	43	43
	Missing	26	26	26	26
Mean		0.232558	0.523256	1.209302	1.337209
Median		0	0	0	1
Mode		0	0	0	0
Range		0.420819	1.249446	4.598007	2.722868
Minimum		0	0	0	0
Maximum		3	4	8	6

LCD/Plasma TV

		Total weekday LCD/Plasma use 7am-11am	Total weekday LCD/Plasma use 11am-5pm	Total weekday LCD/Plasma use 5pm-10pm	Total weekday LCD/ Plasma use 10pm-7am
N	Valid	34	34	34	34
	Missing	35	35	35	35
Mean		0.955882353	1.117647	5.5	2.205882
Median		0	0	3	1.5
Mode		0	0	2	0
Range		2.520721925	5.803922	48.56061	6.653298
Minimum		0	0	0	0
Maximum		8	10	25	10

Conventional TV

		Total weekday Conventional TV use 7am-11am	Total weekday Conventional TV use 11am-5pm	Total weekday Conventional TV use 5pm-10pm	Total weekday Conventional TV use 10pm-7am
N	Valid	43	43	43	43
	Missing	26	26	26	26
Mean		1.44186	3.813953	8.5	1.953488
Median		0	0	5	1
Mode		0	0	10	0
Range		10.95487	59.53599	68.20238	8.093023
Minimum		0	0	0	0
Maximum		20	30	25	10

Dishwasher

		Total weekday Dishwasher use 7am-11am	Total weekday Dishwasher use 11am-5pm	Total weekday Dishwasher use 5pm-10pm	Total weekday Dishwasher use 10pm-7am
N	Valid	54	54	54	53
	Missing	15	15	15	16
Mean		0.074074	0.111111	0.762963	1.943396
Median		0	0	0	1
Mode		0	0	0	0
Range		0.107617	0.213836	3.958602	6.814042
Minimum		0	0	0	0
Maximum		2	2	10	10

Oven

		Total weekday Oven use 7am-11am	Total weekday Oven use 11am-5pm	Total weekday Oven use 5pm-10pm	Total weekday Oven use 10pm-7am
N	Valid	58	58	58	59
	Missing	11	11	11	10
Mean		0.35	0.965517	2.462069	0.135593
Median		0	0	1	0
Mode		0	0	1	0
Range		0.745351	7.54265	5.513273	0.464056
Minimum		0	0	0	0
Maximum		5	15	10	5

Hot Tub

		Total weekday Hot Tub use 7am-11am	Total weekday Hot Tub use 11am-5pm	Total weekday Hot Tub use 5pm-10pm	Total weekday Hot Tub use 10pm-7am
N	Valid	2	2	2	2
	Missing	67	67	67	67
Mean		0	0	1.5	0
Median		0	0	1.5	0
Mode		0	0	1	0
Range		0	0	0.5	0
Minimum		0	0	1	0
Maximum		0	0	2	0

a Multiple modes exist. The smallest value is shown

Whirlpool

		Total weekday Whirlpool use 7am-11am	Total weekday Whirlpool use 11am-5pm	Total weekday Whirlpool use 5pm-10pm	Total weekday Whirlpool use 10pm-7am
N	Valid	5	5	5	5
	Missing	64	64	64	64
Mean				1.6	
Median				2	
Mode				2	
Range				0.3	
Minimum				1	
Maximum				2	

Pool Heater

		Total weekday pool heater use 7am-11am	Total weekday pool heater use 11am-5pm	Total weekday pool heater use 5pm-10pm	Total weekday pool heater use 10pm-7am
N	Valid	0	0	0	0
	Missing	69	69	69	69

B5. Please indicate the total number of hours that are spent at home during the **weekend** using the listed appliances and during what timeframe the appliance is used/left on?

Computer

		Total weekend PC use 7am-11am	Total weekend PC use 11am-5pm	Total weekend PC use 5pm-10pm	Total weekend PC use 10pm-7am
N	Valid	58	58	58	58
	Missing	11	11	11	11
Mean		3.172413	5.517241	5.155172	5.232759
Median		2	4.5	5	2
Mode		0	6	5	0
Range		16.6013309 1	28.11373	18.65971	61.37031
Minimum		0	0	0	0
Maximum		25	25	25	45

Washing Machine

		Total weekend Washing Machine use 7am-11am	Total weekend Washing Machine use 11am-5pm	Total weekend Washing Machine use 5pm-10pm	Total weekend Washing Machine use 10pm-7am
N	Valid	56	56	56	56
	Missing	13	13	13	13
Mean		0.678571	1.633929	0.633929	0.196429
Median		0	1.75	0	0
Mode		0	0	0	0

Range		0.985714	2.813555	1.486282	0.342532
Minimum		0	0	0	0
Maximum		4	7	6	3

Clothes Dryer

		Total weekend Clothes Dryer use 7am-11am	Total weekend Clothes Dryer use 11am-5pm	Total weekend Clothes Dryer use 5pm-10pm	Total weekend Clothes Dryer use 10pm-7am
N	Valid	54	53	52	53
	Missing	15	16	17	16
Mean		0.777778	1.613208	0.682692	0.245283
Median		0	2	0	0
Mode		0	0	0	0
Range		1.459119	2.583091	1.215969	0.380987
Minimum		0	0	0	0
Maximum		6	7	5	3

LCD/Plasma TV

		Total weekend LCD/Plasma TV use 7am-11am	Total weekend LCD/Plasma TV use 11am-5pm	Total weekend LCD/Plasma TV use 5pm-10pm	Total weekend LCD/ Plasma TV use 10pm-7am
N	Valid	30	30	30	30
	Missing	39	39	39	39
Mean		1.75	2.6	3.383333	1.633333
Median		2	2	2.25	1
Mode		0	0	2	0
Range		2.840517	5.351724	8.13247	4.58505
Minimum		0	0	0	0
Maximum		6	8	12	10

Conventional TV

		Total weekend Conventional TV use 7am-11am	Total weekend Conventional TV use 11am-5pm	Total weekend Conventional TV use 5pm-10pm	Total weekend Conventional TV use 10pm-7am
N	Valid	38	37	40	38
	Missing	31	32	29	31
Mean		1.631579	2.405405	3.6	1.868421
Median		1	1	3.5	1.5
Mode		0	0	2	0
Range		3.860597	11.96997	8.553846	4.387624
Minimum		0	0	0	0
Maximum		8	15	15	8

Dishwasher

		Total weekend Dishwasher use 7am-11am	Total weekend Dishwasher use 11am-5pm	Total weekend Dishwasher use 5pm-10pm	Total weekend Dishwasher use 10pm-7am
N	Valid	46	46	46	46
	Missing	23	23	23	23
Mean		0.065217	0.369565	0.728261	0.717391
Median		0	0	0	0
Mode		0	0	0	0
Range		0.062319	0.682609	0.930072	1.14058
Minimum		0	0	0	0
Maximum		1	4	4	4

Oven

		Total weekend Oven use 7am-11am	Total weekend Oven use 11am-5pm	Total weekend Oven use 5pm-10pm	Total weekend Oven use 10pm-7am
N	Valid	47	47	47	47
	Missing	22	22	22	22
Mean		0.506383	0.659574	1.212766	0.106383
Median		0	0	1	0
Mode		0	0	1	0
Range		0.636698	0.925069	0.638529	0.271045
Minimum		0	0	0	0
Maximum		4	4	4	3

Hot Tub

		Total weekend Hot Tub use 7am-11am	Total weekend Hot Tub use 11am-5pm	Total weekend Hot Tub use 5pm-10pm	Total weekend Hot Tub use 10pm-7am
N	Valid	2	2	2	2
	Missing	67	67	67	67
Mean		0	0	1	0
Median		0	0	1	0
Mode		0	0	1	0
Range		0	0	0	0
Minimum		0	0	1	0
Maximum		0	0	1	0

Whirlpool

		Total weekend Whirlpool use 7am-11am	Total weekend Whirlpool use 11am-5pm	Total weekend Whirlpool use 5pm-10pm	Total weekend Whirlpool use 10pm-7am
N	Valid	2	3	3	3
	Missing	67	66	66	66
Mean		0	0	0.333333	0.666667
Median		0	0	0	1
Mode		0	0	0	1
Range		0	0	0.333333	0.333333
Minimum		0	0	0	0
Maximum		0	0	1	1

Pool Heater

		Total weekday pool heater use 7am-11am	Total weekday pool heater use 11am-5pm	Total weekday pool heater use 5pm-10pm	Total weekday pool heater use 10pm-7am
N	Valid	0	0	0	0
	Missing	69	69	69	69

B6. Do you intend on doing any of the listed home conservation upgrades during this coming study period, within two years following the study, or not at all?

Purchase Energy Star Appliance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	During course of study	1	1.4	1.6	1.6
	Two years following study	6	8.7	9.8	11.5
	No, Not necessary	40	58.0	65.6	77.0
	No, too expensive	14	20.3	23.0	100.0
	Total	61	88.4	100.0	
Missing		8	11.6		
Total		69	100.0		

Upgrade Heating and Air System

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	During course of study	1	1.4	1.7	1.7
	Two years following study	2	2.9	3.4	5.1
	No, Not necessary	40	58.0	67.8	72.9
	No, too expensive	16	23.2	27.1	100.0
	Total	59	85.5	100.0	
Missing		10	14.5		
Total		69	100.0		

Upgrade Insulation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	During course of study	1	1.4	1.7	1.7
	Two years following study	3	4.3	5.2	6.9
	No, Not necessary	42	60.9	72.4	79.3
	No, too expensive	12	17.4	20.7	100.0
	Total	58	84.1	100.0	
Missing		11	15.9		
Total		69	100.0		

Have Home Energy Audit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	During course of study	2	2.9	3.2	3.2
	Two years following study	10	14.5	16.1	19.4
	No, Not necessary	38	55.1	61.3	80.6
	No, too expensive	12	17.4	19.4	100.0
	Total	62	89.9	100.0	
Missing		7	10.1		
Total		69	100.0		

B7. What is your assessment of your effort to reduce electricity use at home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Doing all I can	24	34.8	37.5	37.5
	Doing most of what I can, but could do more	26	37.7	40.6	78.1
	doing some, could do more	14	20.3	21.9	100.0
	Total	64	92.8	100.0	
Missing		5	7.2		
Total		69	100.0		

SECTION C- Attitudinal

C1. What is it about the Direct Energy Smart Home Energy Conservation kit or this study that made you want to participate?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Convenience	12	17.4	19.4	19.4
	Save money	13	18.8	21.0	40.3
	Environmental benefits	10	14.5	16.1	56.5
	New technology	9	13.0	14.5	71.0
	Free	4	5.8	6.5	77.4
	Increase Knowledge	7	10.1	11.3	88.7

		Frequency	Percent	Valid Percent	Cumulative Percent
	Address Electricity Issues	7	10.1	11.3	100.0
	Total	62	89.9	100.0	
Missing		7	10.1		
Total		69	100.0		

C2.How would you rank your awareness of your household electricity consumption now compared to this time a year ago?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot more	16	23.2	24.2	24.2
	More	31	44.9	47.0	71.2
	Same	17	24.6	25.8	97.0
	Less	1	1.4	1.5	98.5
	Unsure	1	1.4	1.5	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

C3. Please indicate the degree to which you agree with the following, "As a responsible citizen I am morally obligated to reduce my electricity consumption."

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	27	39.1	40.9	40.9
	Agree	37	53.6	56.1	97.0
	Disagree	1	1.4	1.5	98.5
	Unsure	1	1.4	1.5	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

C4. Do you feel that electricity conservation is important?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	66	95.7	97.1	97.1
	No	2	2.9	2.9	100.0
	Total	68	98.6	100.0	
Missing		1	1.4		
Total		69	100.0		

C5. Generally, do you feel that your family and friends share your outlook on electricity conservation?

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	No, they are more in favour of conservation	2	2.9	3.1	3.1
	No, they are less in favour of conservation	15	21.7	23.1	26.2
	Yes	48	69.6	73.8	100.0
	Total	65	94.2	100.0	
Missing		4	5.8		
Total		69	100.0		

C6. Please indicate what best describes your opinion of Ontario's current electricity prices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Much too high	15	21.7	22.7	22.7
	High	38	55.1	57.6	80.3
	Appropriate	12	17.4	18.2	98.5
	Low	1	1.4	1.5	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

SECTION D- Knowledge

D1. How would you rate your understanding of your potential to conserve electricity?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high	13	18.8	19.4	19.4
	High	30	43.5	44.8	64.2
	Average	22	31.9	32.8	97.0
	Low	1	1.4	1.5	98.5
	Very Low	1	1.4	1.5	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

D3. Do you pay attention to your electricity consumption indicated on your electricity bill?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	46	66.7	69.7	69.7
	Sometimes	18	26.1	27.3	97.0
	Never	2	2.9	3.0	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

D4. Do you talk about electricity use with your children between the ages of 4-18?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	34.8	34.8	34.8
	No	8	11.6	11.6	46.4
	Don't have children that age	37	53.6	53.6	100.0
	Total	69	100.0	100.0	

D5. Which of the following conservation programs have you heard of?

Programs	Have heard of	Have not heard of
Every Kilowatt Counts	☐	☐
Summer Savings (10/10 program)	☐	☐
Beat the Meter	☐	☐
Peaksavers	☐	☐

Scores based on following conservation above quiz.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-1	1	1.4	1.5	1.5
	0	9	13.0	13.2	14.7
	1	16	23.2	23.5	38.2
	2	21	30.4	30.9	69.1
	3	17	24.6	25.0	94.1
	4	4	5.8	5.9	100.0
	Total	68	98.6	100.0	
Missing	System	1	1.4		
Total		69	100.0		

*Those that responded correctly were given one point, incorrect responses to existing programs were given zero points, incorrect responses to non-existing programs were deducted two points.

D6. How would you rate the media's influence in informing you about electricity conservation?

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Very high	7	10.1	10.4	10.4
	High	19	27.5	28.4	38.8
	Average	29	42.0	43.3	82.1
	Low	8	11.6	11.9	94.0
	Very low	4	5.8	6.0	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

D7. In the last year have you seen or heard any media advertisements promoting conservation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	59	85.5	88.1	88.1
	No	8	11.6	11.9	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

D8. How would you rate your technological competence?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High	31	44.9	47.0	47.0
	High	22	31.9	33.3	80.3
	Average	11	15.9	16.7	97.0
	Low	1	1.4	1.5	98.5
	Very low	1	1.4	1.5	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

SECTION E- Demographic

E1. Your Gender:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	51	73.9	75.0	75.0
	Female	17	24.6	25.0	100.0
	Total	68	98.6	100.0	
Missing	0	1	1.4		
Total		69	100.0		

E2. Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25-29	11	15.9	16.2	16.2
	30-34	23	33.3	33.8	50.0
	35-39	14	20.3	20.6	70.6
	40-44	9	13.0	13.2	83.8
	45-49	3	4.3	4.4	88.2
	50-54	1	1.4	1.5	89.7
	55-59	2	2.9	2.9	92.6
	60-64	3	4.3	4.4	97.1
	65-69	1	1.4	1.5	98.5
	70-75	1	1.4	1.5	100.0
	Total	68	98.6	100.0	
Missing	System	1	1.4		
Total		69	100.0		

E3. Please indicate the highest level of education that you have completed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Some grade or high school	1	1.4	1.5	1.5
	High school	10	14.5	14.7	16.2
	College or Tech diploma	18	26.1	26.5	42.6
	University degree	27	39.1	39.7	82.4
	Graduate Degree	12	17.4	17.6	100.0
	Total	68	98.6	100.0	
Missing		1	1.4		
Total		69	100.0		

E4. What is your household's approximate annual income (before taxes)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	$20,001-$40,000	1	1.4	1.6	1.6
	$40,001-60,000	3	4.3	4.7	6.3
	$80,001-$100,000	12	17.4	18.8	25.0
	$100,001-$150,000	26	37.7	40.6	65.6
	More than $150,000	22	31.9	34.4	100.0
	Total	64	92.8	100.0	
Missing		5	7.2		
Total		69	100.0		

E5. Please indicate what best describes your current employment status?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Employed	60	87.0	88.2	88.2
	Unemployed	3	4.3	4.4	92.6
	Retired	2	2.9	2.9	95.6
	Student	1	1.4	1.5	97.1
	Other	2	2.9	2.9	100.0
	Total	68	98.6	100.0	
Missing		1	1.4		
Total		69	100.0		

E6. Please indicate the number of occupants living in your house for the majority of time during the following years 2006: 2007:

Number of Occupants in 2006

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	2.9	3.0	3.0
	2	26	37.7	38.8	41.8
	3	16	23.2	23.9	65.7
	4	15	21.7	22.4	88.1
	5	7	10.1	10.4	98.5
	6	1	1.4	1.5	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

Number of Occupants in 2007

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	4.3	4.5	4.5
	2	19	27.5	28.4	32.8
	3	21	30.4	31.3	64.2
	4	17	24.6	25.4	89.6
	5	6	8.7	9.0	98.5
	7	1	1.4	1.5	100.0
	Total	67	97.1	100.0	
Missing	System	2	2.9		
Total		69	100.0		

E6b. Change in the number of occupants.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-2	1	1.4	1.5	1.5
	-1	3	4.3	4.5	6.0
	0	53	76.8	79.1	85.1
	1	9	13.0	13.4	98.5
	2	1	1.4	1.5	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

E7. Please indicate the amount of free time you have in a week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	4	5.8	6.0	6.0
	Some	32	46.4	47.8	53.7
	Not a lot	28	40.6	41.8	95.5
	None	3	4.3	4.5	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

E8. As of August 1, 2007 have you lived in your current home for more than one year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	63	91.3	95.5	95.5
	No	3	4.3	4.5	100.0
	Total	66	95.7	100.0	
Missing		3	4.3		
Total		69	100.0		

E9. Did you go away on vacation anytime between August and December of 2006?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	33	47.8	48.5	48.5
	No	35	50.7	51.5	100.0
	Total	68	98.6	100.0	
Missing		1	1.4		

Total		69	100.0		

Went on Vacation in August

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	28.9	28.9	28.9
	No	49	71.1	71.1	100.0
Total		69	100.0		

Went on Vacation in September

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	20.2	20.2	20.2
	No	55	79.8	79.8	100.0
Total		69	100.0		

Went on Vacation in October

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	13.4	13.4	13.4
	No	60	86.6	86.6	100.0
Total		69	100.0		

Went on Vacation in November

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	8.6	8.6	8.6
	No	63	91.4	91.4	100.0
Total		69	100.0		

Went on Vacation in December

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	8.6	8.6	8.6
	No	63	91.4	91.4	100.0
Total		69	100.0		

E10. Which of the following statements best describes your current total household income compared to your income during the summer of 2006:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Decreased	11	15.9	16.7	16.7
	Remain Constant	24	34.8	36.4	53.0
	Increased	31	44.9	47.0	100.0
	Total	66	95.7	100.0	

Missing		3	4.3		
Total		69	100.0		

B. Control Baseline Survey Results

SECTION A- Structural

A1. Please specify your house type.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single detached	19	82.6	82.6	82.6
	Semi-detached	4	17.4	17.4	100.0
	Total	23	100.0	100.0	

A2. In what year was your house constructed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2001-2003	4	17.4	17.4	17.4
	After 2004	19	82.6	82.6	100.0
	Total	23	100.0	100.0	

A3. What is the approximate size of your home in square feet?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1000-1499	3	13.0	13.0	13.0
	1500-1999	6	26.1	26.1	39.1
	2000-2499	6	26.1	26.1	65.2

2500-2999	2	8.7	8.7	73.9
3000-3999	6	26.1	26.1	100.0
Total	23	100.0	100.0	

A4. Are any devices in your home set on a programmable timer?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	15	65.2	68.2	68.2
	Yes	7	30.4	31.8	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

In an open-ended question, those who answered 'yes', were invited to report what programmable devices. Devices reported were; *coffee maker, thermostat, television, lamps.*

A5. How do you usually set the temperature on your thermostat?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Program Schedule	12	52.2	57.1	57.1
	Manually Set	4	17.4	19.0	76.2
	Program Seasonally	5	21.7	23.8	100.0
	Total	21	91.3	100.0	
Missing		2	8.7		
Total		23	100.0		

A6. Please indicate if electricity is the predominant power source for the following appliances/equipment in your home?

Heater Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	17.4	18.2	18.2
	No	17	73.9	77.3	95.5
	Don't know	1	4.3	4.5	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

Clothes Dryer Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	91.3	95.5	95.5

	No	1	4.3	4.5	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

Oven Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	78.3	81.8	81.8
	No	4	21.7	18.2	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

Water Heater Power Source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	39.1	40.9	40.9
	No	13	52.2	59.1	100.00
	Total	23	95.7	100.0	
Missing	System	1	4.3		
Total		23	100.0		

A7. Please provide the following information about your appliances. LEAVE BLANK if you do not use or have appliance. Please check the box listed under ENERGY STAR if you have the ENERGY STAR version of this appliance. * ES=Energy Star, **Respondents asked to leave blank if they do not have an appliance, therefore missing will most often mean the home does not have this appliance.

Age of Fridge/ENERGY STAR Fridge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	8	34.8	47.1	47.1
	2-9 ES	9	39.1	52.9	100.0
	Total	17	73.9	100.0	
Missing		6	26.1		
Total		23	100.0		

Age of Fridge/Freezer Combo/ ENERGY STAR Fridge/Freezer Combo

		Frequency	Percent	Valid Percent	Cumulative Percent

Valid	2-9	9	39.1	56.3	56.3
	2-9 ES	7	30.4	43.8	100.0
	Total	16	69.6	100.0	
Missing		7	30.4		
Total		23	100.0		

Age of Washing Machine/ ENERGY STAR Washing Machine

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2	1	4.3	4.5	4.5
	2-9	9	39.1	40.9	45.5
	Less than 2 ES	1	4.3	4.5	50.0
	2-9 ES	11	47.8	50.0	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

Age of Clothes Dryer/ ENERGY STAR Clothes Dryer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	8	34.8	38.1	38.1
	Less than 2 ES	2	8.7	9.5	47.6
	2-9 ES	11	47.8	52.4	100.0
	Total	21	91.3	100.0	
Missing		2	8.7		
Total		23	100.0		

Age of Oven/ ENERGY STAR Oven

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	1	4.3	4.8	4.8
	2-9	10	43.5	47.6	52.4
	Less than 2 ES	1	4.3	4.8	57.1
	2-9 ES	9	39.1	42.9	100.0
	Total	21	91.3	100.0	
Missing		2	8.7		
Total		23	100.0		

Age of Dishwasher/ENERGY STAR Dishwasher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	9	39.1	40.9	40.9
	2-9 ES	13	56.5	59.1	100.0
	Total	22	95.7	100.0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Missing		1	4.3		
Total		23	100.0		

Age of Microwave/ENERGY STAR Microwave

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	1	4.3	5.0	5.0
	2-9	16	69.6	80.0	85.0
	2-9 ES	3	13.0	15.0	100.0
	Total	20	87.0	100.0	
Missing		3	13.0		
Total		23	100.0		

Age of Freezer/ENERGY STAR Freezer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2	1	4.3	6.7	6.7
	2-9	10	43.5	66.7	73.3
	10-19	2	8.7	13.3	86.7
	2-9 ES	2	8.7	13.3	100.0
	Total	15	65.2	100.0	
Missing		8	34.8		
Total		23	100.0		

Age of Hot Water Heater/ ENERGY STAR Hot Water Heater

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	1	4.3	5.0	5.0
	2-9	16	69.6	80.0	85.0
	2-9 ES	3	13.0	15.0	100.0
	Total	20	87.0	100.0	
Missing		3	13.0		
Total		23	100.0		

Age of Water Cooler/ ENERGY STAR Water Cooler

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	2	8.7	100.0	100.0
Missing		21	91.3		
Total		23	100.0		

Age of Dehumidifier/ENERGY STAR Dehumidifier

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	5	21.7	83.3	83.3
	2-9 ES	1	4.3	16.7	100.0
	Total	6	26.1	100.0	
Missing		17	73.9		
Total		23	100.0		

Age of Mini Fridge/ENERGY STAR Mini Fridge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2	1	4.3	25.0	25.0
	2-9	2	8.7	50.0	75.0
	10-19	1	4.3	25.0	100.0
	Total	4	17.4	100.0	
Missing		19	82.6		
Total		23	100.0		

Age of Pool

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2	1	4.3	100.0	100.0
Missing		22	95.7		
Total		23	100.0		

Age of Whirlpool/ENERGY STAR Whirlpool

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	2	8.7	100.0	100.0
Missing		21	91.3		
Total		23	100.0		

Age of Central Air Conditioning/ENERGY STAR Central Air Conditioning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-9	17	73.9	77.3	77.3
	2-9 ES	5	21.7	22.7	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

Age of Window Air Conditioner

	Frequency	Percent
Missing	23	100.0

Age of Furnace/ENERGY STAR Furnace

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	1	4.3	4.5	4.5
	2-9	14	60.9	63.6	68.2
	2-9 ES	7	30.4	31.8	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

A8. Have you changed from using a gas to an electric appliance in the past year?

Change Gas to Electric

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	22	95.7	100.0	100.0
Missing	System	1	4.3		
Total		23	100.0		

A9. Have you changed from using an electric to a gas appliance in the past year?

Change Electric to Gas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	22	95.7	100.0	100.0
Missing	System	1	4.3		
Total		23	100.0		

A10. Other than the appliances listed in A8 and A9, have you purchased any other equipment/appliance that may have altered your electricity consumption in the past year?

Major Appliance/Electronic Purchases

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	13.0	13.6	13.6
	No	19	82.6	86.4	100.0
	Total	22	95.7	100.0	
Missing	System	1	4.3		
Total		23	100.0		

In an open-ended question, those who answered ‘yes’, were invited to report what equipment/appliances. The following equipment/appliances were reported; *Plasma television, dehumidifier, ENERGY STAR appliances.*

SECTION B- Behavioural

B1. At what temperature do you normally set your thermostat during the winter and summer?

Winter Thermostat when at Home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18.0	1	4.3	4.8	4.8
	19.0	1	4.3	4.8	9.5
	20.0	5	21.7	23.8	33.3
	21.0	4	17.4	19.0	52.4
	22.0	5	21.7	23.8	76.2
	23.0	4	17.4	19.0	95.2
	25.0	1	4.3	4.8	100.0
	Total	21	91.3	100.0	
Missing		2	8.7		
Total		23	100.0		

Winter Thermostat when Sleeping/Away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16.0	1	4.3	8.3	8.3
	17.0	1	4.3	8.3	16.7
	18.0	4	17.4	33.3	50.0
	20.0	2	8.7	16.7	66.7
	21.0	4	17.4	33.3	100.0
	Total	12	52.2	100.0	
Missing	System	11	47.8		
Total		23	100.0		

Summer Thermostat when at Home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18.0	1	4.3	4.8	4.8
	19.0	1	4.3	4.8	9.5
	20.0	1	4.3	4.8	14.3
	21.0	4	17.4	19.0	33.3
	22.0	1	4.3	4.8	38.1
	23.0	7	30.4	33.3	71.4
	24.0	5	21.7	23.8	95.2
	25.0	1	4.3	4.8	100.0
	Total	21	91.3	100.0	
Missing		2	8.7		
Total		23	100.0		

Summer Thermostat when Sleeping/Away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	17.0	1	4.3	8.3	8.3
	18.0	1	4.3	8.3	16.7
	20.0	1	4.3	8.3	25.0
	21.0	1	4.3	8.3	33.3
	23.0	1	4.3	8.3	41.7
	24.0	2	8.7	16.7	58.3
	25.0	3	13.0	25.0	83.3
	27.0	1	4.3	8.3	91.7
	28.0	1	4.3	8.3	100.0
	Total	12	52.2	100.0	
Missing		11	47.8		
Total		23	100.0		

B2. How often do you normally use hot water when doing a load of laundry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	3	13.0	13.6	13.6
	Sometimes	11	47.8	50.0	63.6
	Never	8	34.8	36.4	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

B3. Which of the following statements best describe your household's usage of lights?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always on	1	4.3	4.5	4.5
	Sometimes on	7	30.4	31.8	36.4
	Only on when someone is in the room	7	30.4	31.8	68.2
	Only on when necessary	7	30.4	31.8	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

B4. Please indicate the total number of hours that are spent at your home from **Monday to Friday** using the listed appliances and during what timeframe the appliance is used/left on?

Computer

		Total weekday PC use 7am-11am	Total weekday PC use 11am-5pm	Total weekday PC use 5pm-10pm	Total weekday PC use 10pm-7am
N	Valid	7	9	16	5
	Missing	16	14	7	18
Mean		6.571428571	12.77778	11.3125	8.6
Median		5	10	10	9
Mode		5	4	4	4
Range		15	28	22	11
Minimum		0	2	3	4
Maximum		15	30	25	15

Washing Machine

		Total weekday Washing Machine use 7am-11am	Total weekday Washing Machine use 11am-5pm	Total weekday Washing Machine use 5pm-10pm	Total weekday Washing Machine use 10pm-7am
N	Valid	2	0	8	1
	Missing	21	23	15	22
Mean		5.5		2.75	4
Median		5.5		2	4
Mode		1		1	4
Range		9		5	0
Minimum		1		1	4
Maximum		10		6	4

Clothes Dryer

		Total weekday Clothes Dryer use 7am-11am	Total weekday Clothes Dryer use 11am-5pm	Total weekday Clothes Dryer use 5pm-10pm	Total weekday Clothes Dryer use 10pm-7am
N	Valid	1	1	7	2
	Missing	22	22	16	21
Mean		1	5	2.571429	2.5
Median		1	5	2	2.5
Mode		1	5	2	1
Range		0	0	5	3
Minimum		1	5	1	1
Maximum		1	5	6	4

LCD/Plasma TV

		Total weekday LCD/Plasma use 7am-11am	Total weekday LCD/Plasma use 11am-5pm	Total weekday LCD/Plasma use 5pm-10pm	Total weekday LCD/ Plasma use 10pm-7am
N	Valid	4	5	8	2
	Missing	19	18	15	21
Mean		5.75	7.2	14.875	6.5
Median		5	6	10	6.5
Mode		5	3	10	3
Range		3	9	21	7
Minimum		5	3	4	3
Maximum		8	12	25	10

Conventional TV

		Total weekday Conventional TV use 7am-11am	Total weekday Conventional TV use 11am-5pm	Total weekday Conventional TV use 5pm-10pm	Total weekday Conventional TV use 10pm-7am
N	Valid	4	3	14	4
	Missing	19	20	9	19
Mean		7.375	8.333333	9.571429	3.5
Median		3.75	10	6.5	4
Mode		2	10	5	5
Range		18	5	24	4
Minimum		2	5	1	1
Maximum		20	10	25	5

Dishwasher

		Total weekday Dishwasher use 7am-11am	Total weekday Dishwasher use 11am-5pm	Total weekday Dishwasher use 5pm-10pm	Total weekday Dishwasher use 10pm-7am
N	Valid	2	0	6	6
	Missing	21	23	17	17
Mean		3		3.666667	4.5
Median		3		4	3.5
Mode		1		5	3
Range		4		4	8
Minimum		1		1	2
Maximum		5		5	10

Oven

		Total weekday Oven use 7am-11am	Total weekday Oven use 11am-5pm	Total weekday Oven use 5pm-10pm	Total weekday Oven use 10pm-7am
N	Valid	2	4	13	0
	Missing	21	19	10	23
Mean		3.5	5.25	3.923077	
Median		3.5	5	5	
Mode		2	5	5	
Range		3	1	7	
Minimum		2	5	1	
Maximum		5	6	8	

Hot Tub

		Total weekday Hot Tub use 7am-11am	Total weekday Hot Tub use 11am-5pm	Total weekday Hot Tub use 5pm-10pm	Total weekday Hot Tub use 10pm-7am
N	Valid	0	0	1	0
	Missing	23	23	22	23
Mean				5	
Median				5	
Mode				5	
Range				0	
Minimum				5	
Maximum				5	

a Multiple modes exist. The smallest value is shown

Whirlpool

		Total weekday Whirlpool use 7am-11am	Total weekday Whirlpool use 11am-5pm	Total weekday Whirlpool use 5pm-10pm	Total weekday Whirlpool use 10pm-7am
N	Valid	0	0	2	0
	Missing	23	23	21	23
Mean		0	0	2	0
Median		0	0	2	0
Mode		0	0	1	0
Range		0	0	2	0
Minimum		0	0	1	0
Maximum		0	0	3	0

Pool Heater

		Total weekday pool heater use 7am-11am	Total weekday pool heater use 11am-5pm	Total weekday pool heater use 5pm-10pm	Total weekday pool heater use 10pm-7am
N	Valid	0	0	0	0
	Missing	23	23	23	23

B5. Please indicate the total number of hours that are spent at home during the **weekend** using the listed appliances and during what timeframe the appliance is used/left on?

Computer

		Total weekend PC use 7am-11am	Total weekend PC use 11am-5pm	Total weekend PC use 5pm-10pm	Total weekend PC use 10pm-7am
N	Valid	5	12	13	4
	Missing	18	11	10	19
Mean		5.2	5.416667	4.076923	4.5
Median		4	4	4	4
Mode		4	4	2	4
Range		8	11	9	2
Minimum		2	1	1	4
Maximum		10	12	10	6

Washing Machine

		Total weekend Washing Machine use 7am-11am	Total weekend Washing Machine use 11am-5pm	Total weekend Washing Machine use 5pm-10pm	Total weekend Washing Machine use 10pm-7am
N	Valid	9	11	7	0
	Missing	14	12	16	23
Mean		2.666667	2.363636	2.285714	0
Median		2	2	2	0
Mode		2	2	2	0

Range		9	3	3	0
Minimum		1	1	1	0
Maximum		10	4	4	0

Clothes Dryer

		Total weekend Clothes Dryer use 7am-11am	Total weekend Clothes Dryer use 11am-5pm	Total weekend Clothes Dryer use 5pm-10pm	Total weekend Clothes Dryer use 10pm-7am
N	Valid	6	13	8	0
	Missing	17	10	15	23
Mean		1.666667	2.961538	2.25	0
Median		1.5	2	2	0
Mode		1	2	1	0
Range		2	8.5	3	0
Minimum		1	2	1	0
Maximum		3	10.5	4	0

LCD/Plasma TV

		Total weekend LCD/Plasma TV use 7am-11am	Total weekend LCD/Plasma TV use 11am-5pm	Total weekend LCD/Plasma TV use 5pm-10pm	Total weekend LCD/ Plasma TV use 10pm-7am
N	Valid	3	1	5	3
	Missing	20	22	18	20
Mean		3.333333	4	6	4.666667
Median		4	4	5	6
Mode		4	4	5	6
Range		2	0	6	4
Minimum		2	4	4	2
Maximum		4	4	10	6

Conventional TV

		Total weekend Conventional TV use 7am-11am	Total weekend Conventional TV use 11am-5pm	Total weekend Conventional TV use 5pm-10pm	Total weekend Conventional TV use 10pm-7am
N	Valid	5	4	11	2
	Missing	18	19	12	21
Mean		2.2	4.25	5.363636	1.5
Median		2	4	5	1.5
Mode		2	4	2	1
Range		3	3	9	1

Minimum		1	3	1	1
Maximum		4	6	10	2

Dishwasher

		Total weekend Dishwasher use 7am-11am	Total weekend Dishwasher use 11am-5pm	Total weekend Dishwasher use 5pm-10pm	Total weekend Dishwasher use 10pm-7am
N	Valid	2	1	7	2
	Missing	21	22	16	21
Mean		1.5	2	2.142857	1.5
Median		1.5	2	2	1.5
Mode		1	2	2	1
Range		1	0	2	1
Minimum		1	2	1	1
Maximum		2	2	3	2

Oven

		Total weekend Oven use 7am-11am	Total weekend Oven use 11am-5pm	Total weekend Oven use 5pm-10pm	Total weekend Oven use 10pm-7am
N	Valid	2	3	13	0
	Missing	21	20	10	23
Mean		1.5	2	2.846154	
Median		1.5	2	2	
Mode		1	2	2	
Range		1	0	9	
Minimum		1	2	1	
Maximum		2	2	10	

Hot Tub

		Total weekend Hot Tub use 7am-11am	Total weekend Hot Tub use 11am-5pm	Total weekend Hot Tub use 5pm-10pm	Total weekend Hot Tub use 10pm-7am
N	Valid	0	0	1	0
	Missing	23	23	22	23
Mean				2	
Median				2	
Mode				2	
Range				0	
Minimum				2	

Maximum			2	

Whirlpool

		Total weekend Whirlpool use 7am-11am	Total weekend Whirlpool use 11am-5pm	Total weekend Whirlpool use 5pm-10pm	Total weekend Whirlpool use 10pm-7am
N	Valid	0	0	0	0
	Missing	23	23	23	23

Pool Heater

		Total weekday pool heater use 7am-11am	Total weekday pool heater use 11am-5pm	Total weekday pool heater use 5pm-10pm	Total weekday pool heater use 10pm-7am
N	Valid	0	0	0	0
	Missing	23	23	23	23

B6. Do you intend on doing any of the listed home conservation upgrades during this coming study period, within two years following the study, or not at all?

Purchase Energy Star Appliance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	During course of study	1	1.4	5.0	5.0
	Two years following study	3	4.3	15.0	20.0
	No, too expensive	2	2.9	10.0	30.0
	No, Not necessary	14	20.3	70.0	100.0
	Total	20	29.0	100.0	
Missing		49	71.0		
Total		69	100.0		

Upgrade Heating and Air System

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Two years following study	2	8.7	10.0	10.0
	No, too expensive	1	4.3	5.0	15.0
	No, Not necessary	17	73.9	85.0	100.0
	Total	20	87.0	100.0	
Missing		3	13.0		
Total		23	100.0		

Upgrade Insulation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Two years following study	1	4.3	5.0	5.0
	No, too expensive	2	8.7	10.0	15.0
	No, Not necessary	17	73.9	85.0	100.0
	Total	20	87.0	100.0	
Missing		3	13.0		
Total		23	100.0		

Have Home Energy Audit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Two years following study	2	8.7	10.0	10.0
	No, too expensive	4	17.4	20.0	30.0
	No, Not necessary	14	60.9	70.0	100.0
	Total	20	87.0	100.0	
Missing		3	13.0		
Total		23	100.0		

B7. What is your assessment of your effort to reduce electricity use at home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Doing all I can	5	21.7	22.7	22.7
	Doing most of what I can, but could do more	14	60.9	63.6	86.4
	Doing some, could do more	2	8.7	9.1	95.5
	Doing little	1	4.3	4.5	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

SECTION C- Attitudinal

C1. How would you rank your awareness of your household electricity consumption now compared to this time a year ago?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot more	4	17.4	17.4	17.4
	More	12	52.2	52.2	69.6
	Same	4	17.4	17.4	87.0

	lot less	1	4.3	4.3	91.3
	Unsure	2	8.7	8.7	100.0
	Total	23	100.0	100.0	

C2. Please indicate the degree to which you agree with the following, "As a responsible citizen I am morally obligated to reduce my electricity consumption."

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	7	30.4	30.4	30.4
	Agree	15	65.2	65.2	95.7
	Disagree	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

C3. Do you feel that electricity conservation is important?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	22	95.7	95.7	95.7
	no	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

C4. Generally, do you feel that your family and friends share your outlook on electricity conservation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No, they are more in favour of conservation	4	17.4	17.4	17.4
	No, they are less in favour of conservation	3	13.0	13.0	30.4
	Yes	16	69.6	69.6	100.0
	Total	23	100.0	100.0	

C5. Please indicate what best describes your opinion of Ontario's current electricity prices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Much too high	7	30.4	30.4	30.4
	High	13	56.5	56.5	87.0
	Appropriate	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

SECTION D- Knowledge

D1. How would you rate your understanding of your potential to conserve electricity?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high	2	8.7	8.7	8.7
	High	17	73.9	73.9	82.6
	Average	2	8.7	8.7	91.3
	Low	1	4.3	4.3	95.7
	Very Low	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

D2. What information can be provided to assist you in conserving electricity?
This was an open-ended question resulting in the following responses;

monetary feedback, comparative feedback, individual appliance electricity consumption feedback, methods to improve conservation, anything, nothing.

D3. Do you pay attention to your electricity consumption indicated on your electricity bill?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	14	60.9	60.9	60.9
	Sometimes	6	26.1	26.1	87.0
	Never	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

D4. Do you talk about electricity use with your children between the ages of 4-18?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	39.1	39.1	39.1
	No	4	17.4	17.4	56.5
	Don't have children that age	10	43.5	43.5	100.0
	Total	23	100.0	100.0	

D5. Which of the following conservation programs have you heard of?

Programs	Have heard of	Have not heard of
Every Kilowatt Counts	☐	☐
Summer Savings (10/10 program)	☐	☐
Beat the Meter	☐	☐

Peaksavers ☐ ☐

Scores based on following conservation above quiz.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	4.3	4.3	4.3
	1	8	34.8	34.8	39.1
	2	8	34.8	34.8	73.9
	3	5	21.7	21.7	95.7
	4	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

*Those that responded correctly were given one point, incorrect responses to existing programs were given zero points, incorrect responses to non-existing programs were deducted two points.

D6. How would you rate the media's influence in informing you about electricity conservation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high	1	4.3	4.3	4.3
	High	5	21.7	21.7	26.1
	Average	9	39.1	39.1	65.2
	Low	8	34.8	34.8	100.0
	Total	23	100.0	100.0	

D7. In the last year have you seen or heard any media advertisements promoting conservation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	91.3	91.3	91.3
	No	2	8.7	8.7	100.0
	Total	23	100.0	100.0	

D8. How would you rate your technological competence?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High	1	4.3	4.3	4.3
	High	11	47.8	47.8	52.2
	Average	10	43.5	43.5	95.7
	Low	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

SECTION E- Demographic

E1. Your Gender:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	12	52.2	52.2	52.2
	Female	11	47.8	47.8	100.0
	Total	23	100.0	100.0	

E2. Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25-29	2	8.7	8.7	8.7
	30-34	4	17.4	17.4	26.1
	35-39	4	17.4	17.4	43.5
	40-44	7	30.4	30.4	73.9
	45-49	3	13.0	13.0	87.0
	50-54	1	4.3	4.3	91.3
	60-64	1	4.3	4.3	95.7
	70-75	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

E3. Please indicate the highest level of education that you have completed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High school	3	13.0	13.0	13.0
	College or Tech diploma	13	56.5	56.5	69.6
	University degree	4	17.4	17.4	87.0
	Graduate Degree	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

E4. What is your household's approximate annual income (before taxes)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	$40,001-60,000	1	4.3	4.3	4.3
	$80,001-$100,000	2	8.7	8.7	13.0
	$100,001-$150,000	8	34.8	34.8	47.8
	More than $150,000	10	52.1	52.1	100.0
	Total	23	100.0	100.0	

E5. Please indicate what best describes your current employment status?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Employed	18	78.3	78.3	78.3
	Unemployed	2	8.7	8.7	87.0
	Retired	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

E6. Please indicate the number of occupants living in your house for the majority of time during the following years 2006: 2007:

Number of Occupants in 2006

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.3	4.5	4.5
	2	6	26.1	27.3	31.8
	3	5	21.7	22.7	54.5
	4	6	26.1	27.3	81.8
	5	3	13.0	13.6	95.5
	6	1	4.3	4.5	100.0
	Total	22	95.7	100.0	
Missing	System	1	4.3		
Total		23	100.0		

Number of Occupants in 2007

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.3	4.5	4.5
	2	5	21.7	22.7	27.3
	3	6	26.1	27.3	54.5
	4	6	26.1	27.3	81.8
	5	3	13.0	13.6	95.5
	6	1	4.3	4.5	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		
Total		23	100.0		

E6b. Change in the number of occupants.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-1	1	4.3	4.5	4.5
	0	19	82.6	86.4	90.9
	1	2	8.7	9.1	100.0
	Total	22	95.7	100.0	
Missing		1	4.3		

Total		23	100.0		

E7. Please indicate the amount of free time you have in a week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	4	17.4	17.4	17.4
	Some	6	26.1	26.1	43.5
	Not a lot	13	56.5	56.5	100.0
	Total	23	100.0	100.0	

E8. As of August 1, 2007 have you lived in your current home for more than one year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	22	95.6	95.6	95.6
	No	1	4.4	4.4	100.0
	Total	23	100.0	100.0	

E9. Did you go away on vacation anytime between August and December of 2006?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	56.5	56.5	56.5
	No	10	43.5	43.5	100.0
	Total	23	100.0	100.0	

Went on Vacation in August

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	21.7	21.7	21.7
	No	18	78.3	78.3	78.3
Total		23	100.0		

Went on Vacation in September

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	17.4	17.4	17.4
	No	19	82.6	82.6	100.0
Total		23	100.0		

Went on Vacation in October

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	13.0	13.0	13.0
	No	20	87.0	87.0	100.0
Total		23	100.0		

Went on Vacation in November

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	8.7	8.7	8.7
	No	21	91.3	91.3	100.0
Total		23	100.0		

Went on Vacation in December

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	8.7	8.7	8.7
	No	21	91.3	91.3	100.0
Total		23	100.0		

E10. Which of the following statements best describes your current total household income compared to your income during the summer of 2006:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Decreased	4	17.4	17.4	17.4
	Remain Constant	12	52.2	52.2	69.6
	Increased	7	30.4	30.4	100.0
	Total	23	100.0	100.0	

C. Sample and Control Follow-up Survey Results and Comparisons

This table displays changes that have occurred throughout the course of the study and compares these changes between sample and control group. Changes were determined by comparing the responses of the baseline survey with the follow-up survey. The frequency of response for the sample group was 24 and 18 for the control group.

Question	Response	Sample Baseline	Sample Follow-up	Control Baseline	Control Follow-up
Changed gas to electric appliance during study	Yes	N/A	0	N/A	0
	No	N/A	100	N/A	100
Changed electric to gas appliance during study	Yes	N/A	0	N/A	0
	No	N/A	100	N/A	100
Purchased or discarded major equipment and appliances during study	Yes	N/A	12.5	N/A	5.6
	No	N/A	87.5	N/A	94.4
Renovations during course of study	Yes	N/A	12.5	N/A	5.6
	No	N/A	87.5	N/A	94.4
Resource used to heat home	Gas	N/A	100	N/A	83.3
	Electricity	N/A	0	N/A	16.7
Lighting Usage	Always left on	4.2	0	5.9	0
	Sometimes left on	29.2	50	29.4	22.2
	Only on when someone is in room	37.5	37.5	23.5	16.7
	Only on when necessary	29.2	12.5	41.2	61.1
Purchase Energy Star Appliance	During the study	0	0	0	0
	Two years following the study	0	8.7	11.8	0
	No, not necessary	52.2	82.6	82.4	93.3

	No, too expensive	28.8	8.7	5.9	6.7
Upgrade Heating and Air Conditioning System	During the study	0	0	0	0
	Two years following the study	9.1	4.2	5.9	6.7
	No, not necessary	54.5	83.3	88.2	86.7
	No, too expensive	36.4	12.5	5.9	6.7
Upgrade Insulation	During the study	0	4.2	0	0
	Two years following the study	0	8.3	5.9	0
	No, not necessary	72.7	66.7	82.4	86.7
	No, too expensive	27.3	20.8	11.8	13.3
Have Home Energy Audit	During the study	0	4.2	0	0
	Two years following the study	18.2	20.8	5.9	6.7
	No, not necessary	59.1	62.5	82.4	86.7
	No, too expensive	22.7	12.5	11.8	6.7
Effort to reduce at home electricity use	Doing all I can	27.3	29.2	22.2	6
	Doing most of what I can, but could do more	40.9	45.8	61.1	35.3
	Doing some, but could do more	22.7	25	11.1	41.2
	Doing very little	8.3	0	5.6	23.5
Belief in being morally obligated to reduce electricity consumption	Strongly Agree	39.1	29.2	38.9	38.9
	Agree	47.8	58.3	61.1	61.1
	Disagree	4.3	8.3	0	0
	Strongly Disagree	4.3	0	0	0
	Unsure	4.3	4.3	1	0

Is conservation important	Yes	90.9	100	94.4	94.4
	No	9.1	0	5.6	5.6
Opinion of Ontario's electricity prices	Much too high	22.7	29.2	27.8	33.3
	High	45.5	41.7	66.7	55.6
	Appropriate	27.3	25	5.6	11.1
	Low	4.5	4.2	0	0
	Much too low	0	0	0	0
Commitment to reduce peak electricity consumption	Very committed	N/A	29.2	N/A	27.8
	Committed	N/A	58.3	N/A	55.6
	Somewhat committed	N/A	12.5	N/A	16.7
	Minimal commitment	N/A	0	N/A	0
	Not committed	N/A	0	N/A	0
Understanding of potential to conserve	Very high	4.5	12.5	5.6	11.1
	High	59.1	50	77.8	55.6
	Average	36.4	37.5	5.6	33.3
	Low	0	0	5.6	0
	Very low	0	0	5.6	0
Attention paid to electricity bill	Always	60.9	62.5	60.9	44.4
	Sometimes	30.4	37.5	30.4	44.4
	Never	8.7	0	8.7	11.1
Talking about electricity use with children	Yes	33.3	37.5	38.9	50
	No	8.3	4.2	22.2	5.6
	Do not have children	58.3	58.3	38.9	44.4
Knowledge of conservation advertisements	Yes	N/A	83.3	N/A	77.8
	No	N/A	16.7	N/A	22.2
Change in the number of household occupants	Yes	N/A	16.7	N/A	22.2

	No	N/A	83.3	N/A	77.8
Away from home during study	Yes	N/A	45.8	N/A	55.6
	No	N/A	54.2	N/A	44.4
Number of days away in August	1-7 days	N/A	3	N/A	2
	8-14 days	N/A	1	N/A	0
	15+ days	N/A	1	N/A	0
Number of days away in September	1-7 days	N/A	1	N/A	2
	8-14 days	N/A	1	N/A	0
	15+ days	N/A	1	N/A	0
Number of days away in October	1-7 days	N/A	1	N/A	1
	8-14 days	N/A	1	N/A	0
	15+ days	N/A	1	N/A	0
Number of days away in November	1-7 days	N/A	1	N/A	2
	8-14 days	N/A	1	N/A	0
	15+ days	N/A	1	N/A	0
Number of days away in December	1-7 days	N/A	1	N/A	4
	8-14 days	N/A	4	N/A	0
	15+ days	N/A	1	N/A	0
Number of days away in January	1-7 days	N/A	1	N/A	1
	8-14 days	N/A	1	N/A	0
	15+ days	N/A	0	N/A	0
Income during study	Increased	N/A	8.3	N/A	13.7
	Remained Constant	N/A	62.5	N/A	55.6
	Decreased	N/A	29.2	N/A	27.8

Appendix III

A. Sample Group's Feedback

Baseline Survey

A4. **'Are any devices in your home set on a programmable timer?'**
In an open-ended question, those who answered 'yes', were invited to identify the programmable devices that are set on a timer. Devices reported were: *lamps, fish tank lights, outdoor lights, video recorder, washing machine, computer & dishwasher.*

A10. **'Have you purchased any other equipment/appliance that may have altered your electricity consumption in the past year?'**
In an open-ended question, those who answered 'yes' were invited to report what equipment/appliances they had purchased. The following equipment/appliances were reported: *computer, LCD television, Plasma television, coffee maker, ENERGY STAR Washing Machine, solar attic vent, inflectors on windows, espresso machine, central air conditioning, dehumidifier, fridge.*

D2. **'What information can be provided to assist you in conserving electricity?'**
This was an open-ended question resulting in the following responses:
real time feedback, monetary feedback, comparative feedback, individual appliance electricity consumption feedback, methods to improve conservation, additional stickering on appliances, rebates on efficient appliances, greater access to programmable tools, ramifications for not conserving, do it yourself home modifications, time-of use, standby energy use, insulating the home, acquiring conservation technology, electricity generation source (form, location), prompting conservation behaviour, ENERGY STAR appliances, detailed graphs, unsure, anything, nothing.

Follow-up Survey

A3. **'Have you purchased or discarded any other equipment/appliance that may have altered your electricity consumption since the installation of the Direct Energy Smart Home Energy System?'**
In an open-ended question, those who answered 'yes' were invited to report what equipment/appliances. The following equipment/appliances were reported: *solar roof vent, R20 insulation in attic, electric fans, air conditioner, space heater.*

A4. **'Since installation, has your home had any additions or renovations that may have altered your home's electricity consumption?'**
In an open-ended question, those who answered 'yes', were invited to report what equipment/appliances. The following renovations were reported: *solar roof vent, R20 insulation in attic, basement carpeting.*

‘We would like to hear any of your experiences and opinions with regards to the Direct Energy Smart Home Energy System, please elaborate below.’ (Note: Each ‘new hyphen’ represents a different respondent.)

- Finally got the bugs worked out of the system and am now able to change the lights and temperature via mode settings where I was not able to do this since at least October and had to do temperature and light changes manually. Even though this is a test run, would like to see better controls in the computer portal. ie. 15 minute or 1/2 hour increments, two different controls 1 for temperature, 2nd for lighting. Need better manual that explains all the features of the portal settings. Finally, need to give your direct energy help technicians a system to play with so that they know what they are talking about! IE Hands on experience. Cudos to Bell representative Patrick who finally was able to fix my system with Direct Energy people on site January 25, 2008.
- The web interface was not nearly as useful as we originally through it would be.
    - 1) Automated lighting We through the automated lighting would be easy to use. We have been using it successfully for our Christmas lights. What is difficult however is programming it to turn on and off lights while we are away on holiday since... - the vacation setting overrides everything else, but does not allow lights to turn on and off during the vacation period (maybe I just didn't figure out how to properly set this up - there wasn't much of a manual provided) - if we want to turn down the temperature while we are away, but still keep our usual lighting program we have to go and change the temperature in every single mode - it's not geared towards turning on and off individual lights - there is no randomness in the turn on/off times for the given light sets (this feature is found on many lighting timers) - it would have been much more useful to have something akin to an Outlook style calendar which would show the turn on/off times of individual lights/devices in the system
    - 2) Limited number of lighting options No 3-way switches could be automated. Unfortunately most of the main light switches in houses are 3-way (ie. hallways, main living areas, kitchen, etc...)
    - 3) Out of date electricity usage data The electricity usage is always at least 2 days out of date (sometimes up to a week out of date). If it had been a couple of hours or even one day old it would have been much more useful in allowing us to determine what causes spikes in our electricity usage. Even better would be to have real-time electricity use (if possible). This would allow a home owner to be able to do their own electricity audit (ie. how much electricity does each appliance use when on/off)
    - 4) Firewalled I do most of my computer use at work which is behind a firewall. The web interface does not work behind company firewalls. Our company does not allow opening of the corporate firewall for personal use.
- The web portal is always malfunctioning. It's not a very reliable system.
- I got a hard time with some programming feature. Call me for more info.
- The thermostat needs more focus and attention. compared to the thermostat i had before this one is much less programmable (even in the online). if you are creating an online option then you have to do better with the flexibility (we need 7

days programmable as we do with standard off the shelf). This is the biggest draw back. Also better troubleshooting document when things fail (how to reset and do troubleshooting on our own). This can be frustrating when you get time out on the sets.

- Many problems connecting to appliances...lights are always timing out. Thermostat changes take time to take effect. It could be due to poor connectivity. A good program, learn a lot about the patterns of energy consumption in my household.
- I love the graphing capabilities of the system. I look forward to seeing the web cam enabled. However, I feel that the programmable lighting system would be more useful if we had more light switches available. I understand these components are very costly but 4 are not enough... especially considering they would not install 2 way light switches which many of my commonly used home lights are.
- I think that a device to monitor the kilowatt usage on a particular device would assist in diagnosing which devices should be used less often as they use more energy... bar fridge, lamps, etc... if there are choices in using these items but I know how much energy they consume I would make usage changes.
- Data is not current enough...I would like to know how my electricity usage is today....not last week...an option on the graph or web site to choose none coal power for our home.

Independent 'Blog'

Hawthorne Village, the location of many of the study's homes, hosts forums about topics of interest to its residents. One forum was started about the Direct Energy Smart Home Energy Conservation Kit. It can be found at http://www.hawthornevillager.com/phpbb/viewtopic.php?t=7354&postdays=0&postorder=asc&highlight=direct+energy&start=165

B. Control Group's Feedback

Baseline Survey

A4. **'Are any devices in your home set on a programmable timer?'**
In an open-ended question, those who answered 'yes', were invited to identify the programmable devices that are set on a timer. Devices reported were: *dishwasher.*

A10. **'Other than the appliances listed in A8 and A9, have you purchased any other equipment/appliance that may have altered your electricity consumption in the past year?'**
In an open-ended question, those who answered 'yes', were invited to report what equipment/appliances. The following equipment/appliances were reported: *freezer.*

D2. **'What information can be provided to assist you in conserving electricity?'**
This was an open-ended question resulting in the following responses:
Standby power, home energy audits, consumption feedback, use, energy efficient appliances, comparative feedback, individual appliance electricity consumption feedback, schools education children about electricity conservation, literature, real time feedback, nothing.

Follow-up Survey

A3.**' Have you purchased or discarded any other equipment/appliance that may have altered your electricity consumption since the installation of the Direct Energy Smart Home Energy System?'**
In an open-ended question, those who answered 'yes', were invited to report what equipment/appliances. The following equipment/appliances were reported: *Flow through humidifier attached to the furnace, freezer.*

Appendix IV

A. Average Monthly Consumption

		Sample		Control	
		Baseline	Study	Baseline	Study
August	Total	997.6629	1074.663	1016.679	1047.876
n=7	Off	506.8737	548.8561	509.8793	505.6837
	Mid	294.5796	333.3163	301.7014	285.2597
	On	196.2103	192.4891	205.0984	256.9323
September	Total	583.4319	680.7314	486.6145	593.12
n=21	Off	333.1825	398.3417	277.4025	337.6188
	Mid	162.1868	182.0951	135.6738	158.9039
	On	88.06157	100.2958	73.53824	96.59729
October	Total	617.6354	655.8287	598.3845	619.1553
n=70	Off	344.5269	361.4775	343.0429	338.4467
	Mid	181.8977	194.2456	170.7963	183.6332
	On	91.20639	100.5191	84.54543	97.07539
November	Total	638.4746	665.4059	579.3048	628.4613
n=108	Off	334.538	347.7807	304.1378	320.8199
	Mid	153.4477	160.8614	141.1481	157.2354
	On	150.4911	153.7511	133.9956	150.2496
December	Total	750.9223	764.9423	708.1462	749.8727
n=108	Off	446.89	465.2024	422.821	446.8214
	Mid	156.4788	153.6019	148.4266	157.3129
	On	147.5544	146.258	136.8846	145.5062
January	Total	723.4251	724.3706	670.7308	709.2844
n=108	Off	386.8552	398.6919	354.9119	385.7397
	Mid	171.0216	164.4859	163.5329	173.2397
	On	165.5492	161.2887	152.2828	159.5308

B. Both Groups' Monthly Consumption Percentage Change

		Sample			Control		
		Group*	Individual**	Combo***	Group	Individual	Combo
August	Total	7.72%	8.53%	8.13%	3.07%	4.81%	3.94%
n=7	Off	8.28%	7.96%	8.12%	-0.82%	-1.18%	-1.00%
	Mid	13.15%	14.88%	14.01%	-5.45%	-3.43%	-4.44%
	On	-1.90%	1.39%	-0.25%	25.27%	32.76%	29.02%
September	Total	16.68%	19.00%	17.84%	21.89%	22.84%	22.36%
n=21	Off	19.56%	22.13%	20.84%	21.71%	23.25%	22.48%
	Mid	12.27%	14.53%	13.40%	17.12%	19.08%	18.10%
	On	13.89%	26.83%	20.36%	31.36%	35.89%	33.62%
October	Total	6.18%	8.53%	7.35%	3.47%	15.82%	9.65%
n=70	Off	4.96%	8.75%	6.86%	-1.34%	10.46%	4.56%
	Mid	7.07%	10.90%	8.99%	7.52%	22.60%	15.06%
	On	10.21%	22.63%	16.42%	14.82%	35.50%	25.16%
November	Total	4.22%	8.31%	6.27%	8.49%	16.63%	12.56%
n=108	Off	3.96%	8.14%	6.05%	4.60%	11.75%	8.18%
	Mid	4.83%	12.05%	8.44%	11.11%	24.19%	17.65%
	On	2.17%	7.64%	4.90%	12.13%	23.29%	17.71%
December	Total	1.87%	6.67%	4.27%	5.89%	8.12%	7.01%
n=108	Off	4.10%	10.66%	7.38%	5.48%	7.75%	6.62%
	Mid	-1.84%	2.17%	0.16%	2.66%	6.54%	4.60%
	On	-0.88%	3.17%	1.14%	6.30%	9.99%	8.14%
January	Total	0.13%	3.17%	1.65%	5.75%	8.72%	7.24%
n=108	Off	3.06%	6.84%	4.95%	5.69%	9.14%	7.41%
	Mid	-3.82%	0.19%	-1.81%	5.85%	11.54%	8.70%
	On	-2.57%	0.85%	-0.86%	4.76%	9.39%	7.07%

*Group= Calculation using the variance of the entire groups total

**Individual= Calculations using the variance of each individual

***Combo=Group and Individual mean

C. Year-Over-Year Consumption Shifts

		Sample Year-Over-Year Shift	Control Year-Over-Year Shift	Relative Shift
August	Off	0.52%	-3.78%	4.30%
	Mid	5.04%	-8.26%	13.31%
	On	-8.93%	21.54%	-30.47%
September	Off	2.47%	-0.15%	2.62%
	Mid	-3.77%	-3.91%	0.14%
	On	-2.39%	7.77%	-10.16%
October	Off	-1.30%	-4.65%	3.35%
	Mid	0.68%	3.91%	-3.23%
	On	3.63%	10.97%	-7.34%
November	Off	0.20%	-3.80%	4.00%
	Mid	1.05%	12.35%	-11.31%
	On	-1.52%	3.32%	-4.84%
December	Off	2.19%	0.65%	1.46%
	Mid	-3.64%	-2.03%	-1.95%
	On	-2.70%	0.14%	-2.24%
January	Off	2.93%	0.19%	2.23%
	Mid	-3.95%	0.33%	-3.02%
	On	-2.70%	-0.91%	-1.98%

D. Time-of-use Pricing Groups Consumption Comparisons

		Group*	Individual**	Combo***	Group	Individual	Combo	Group	Individual	Combo	Group	Individual	Combo
November	Total	4.26%	6.09%	5.18%	6.70%	12.34%	9.52%	4.17%	10.53%	7.35%	10.68%	20.86%	15.77%
	On	-0.32%	2.77%	1.22%	7.99%	15.15%	11.57%	4.96%	12.52%	8.74%	17.17%	31.53%	24.35%
December	Total	1.88%	5.16%	3.52%	5.42%	5.28%	5.35%	1.86%	8.19%	5.02%	6.28%	10.47%	8.38%
	On	-1.07%	0.93%	-0.07%	3.99%	4.53%	4.26%	-0.67%	5.41%	2.37%	8.59%	14.80%	11.70%
January	Total	-0.04%	1.92%	0.94%	4.38%	7.45%	5.91%	0.33%	4.42%	2.38%	7.53%	9.97%	8.75%
	On	-2.42%	-0.10%	-1.26%	0.04%	5.31%	2.68%	-2.75%	1.81%	-0.47%	10.05%	13.09%	11.57%

*Group= Calculation using the variance of the entire groups total

**Individual= Calculations using the variance of each individual

*** Combo= Group and Individual mean

E. Average Consumption of Sample Respondents and Sub-group

Summary of Survey Respondent Sample's Consumption	
November 2006-January 2007 (Baseline months) total consumption	150272.36
November 2007- January 2008 (Sample months) total consumption	154771.96
Change in total consumption between periods	4499.60
Respondent's average total consumption for baseline months	2177.86
Respondent's average total consumption for study months	2243.07
Average percentage change in total consumption	2.99%
November 2006-January 2007 (baseline months) total on-peak consumption	33062.98
November 2007- January 2008 (sample months) total on-peak consumption	33075.99
Change in on-peak consumption between periods	13.01
Respondent's average on-peak consumption for baseline months	479.17
Respondent's average on-peak consumption for study months	479.36
Average percentage change in on-peak consumption	0.02%

Sub-groups Consumption

Question	Response	Baseline Months [4]Total Consumption	Study Months[5] Total Consumption	% Change	On-peak 2006	On-peak 2007	% Change
Structural							
Housing Type	Single Detached N=40	2343.71	2315.98	-1.18%	512.62	497.52	-2.95%
	Semi-Detached N=11	2004.01	2244.41	13.09%	456.01	470.24	3.40%
	Townhouse N=16	1910.35	2070.57	8.39%	416.83	443.07	6.30%
Housing Size	1500-1999 N=37	1951.00	2099.88	7.63%	434.78	447.04	2.82%
	2000-2499 N=16	2249.95	2294.77	1.99%	482.18	488.89	1.39%
	2500-2999 N=5	3151.31	3221.82	2.24%	709.04	750.18	5.80%
	3000-3999 N=5	2896.66	2367.51	-18.27%	642.79	506.59	-21.19%
Setting the thermostat	Program schedule	1986.90	2124.73	-6.94%	441.92	458.79	-3.82%
	Manually set	2774.24	2583.31	6.88%	604.04	542.73	10.15%
	Set seasonally	2413.58	2526.38	-4.67%	521.56	534.61	-2.50%
Purchased new appliance	Yes	1898.52	2024.59	7.39%	419.08	445.02	7.11%
	No	2230.84	2284.51	2.41%	490.57	485.87	3.86%
Power Source	Electric Heat N=18	2179.35	2201.10	1.00%	475.55	456.39	-4.03%
	Non-Electric Heat N=49	2129.52	2250.27	5.67%	468.64	483.51	3.17%
	Electric Dryer N=57	2222.10	2262.02	1.80%	488.19	482.53	-1.16%
	Non-Electric Dryers N=10	2051.59	2279.54	11.11%	454.36	485.74	6.91%
	Electric Oven N=47	2202.95	2235.58	1.48%	481.25	479.16	-0.43%
	Non-Electric Oven N=19	2175.32	2303.12	5.88%	486.54	487.01	0.10%
	Electric Water Heater N=14	2284.57	2303.33	0.82%	510.77	483.59	-5.32%
	Non-Electric Water Heater N=48	2163.28	2243.14	4.62%	475.75	483.73	1.68%
Behavioural							
Thermostat setting-winter	Less than 22 N=24	2244.44	2295.50	2.28%	499.22	497.83	-0.28%
	22-23 N= 26	2171.95	2273.14	4.66%	471.71	471.03	-0.14%
	Greater than 23 N=17	1971.80	2118.17	7.42%	434.39	459.63	5.81%
Thermostat	Less than 23 N=19	2014.99	2028.98	0.69%	462.08	444.17	-3.88%

[4] Baseline Months= November 2006- January 2007

[5] Study Months= November 2007- January 2008

setting-summer	23-24 N=34	2277.49	2354.59	3.39%	495.14	498.84	0.75%
	More than 24 N=14	2009.87	2256.86	12.29%	429.71	472.04	9.85%
Lights Usage	Sometimes on	2471.70	2503.77	1.30%	528.55	529.44	3.11%
	Someone in room	1946.34	2146.38	10.28%	437.39	474.57	11.18%
	Only when necessary	2179.14	2154.91	-1.11%	481.76	451.11	-6.36%
Purchase EnergyStar Appliances	Within next two years N=7	2308.09	2316.90	0.38%	485.27	479.93	-1.10%
	No, not necessary N=41	2191.30	2288.97	4.46%	484.83	494.66	2.03%
	No, too expensive N=14	2120.72	2038.66	-3.87%	474.50	441.21	-7.02%
Energy Audit	Within next two years N=12	2385.77	2614.99	9.61%	490.96	540.33	10.05%
	No, not necessary N=38	2165.92	2256.64	4.19%	481.71	485.31	0.75%
	No, too expensive N=11	2299.08	2232.43	-2.90%	515.49	483.38	-6.23%
Effort to Reduce Home Electricity Use	Doing all I can N=24	2347.74	2361.02	0.57%	509.39	501.44	-1.56%
	Doing most of what I can do, but could do more N=26	2204.93	2202.69	-0.10%	493.77	485.32	-1.71%
	Doing some, could do more N=1	1974.44	2156.17	9.20%	428.76	448.45	4.59%
Attitudinal							
Conservation Awareness	A lot more	2408.27	2425.55	0.72%	514.69	495.87	-3.66%
	More	2366.11	2538.08	3.55%	536.78	557.24	3.81%
	Same	1945.93	2070.23	6.39%	432.67	449.44	3.88%
Share Outlook	Yes N=48	2156.23	2206.93	2.35%	465.80	465.32	-0.10%
	No N=17	2117.71	2224.58	5.05%	491.11	497.63	1.33%
Participation	Convenience N=12	2299.67	2361.94	2.71%	508.05	495.20	-2.30%
	Save Money N=13	2042.63	1941.66	-4.94%	465.62	436.27	-6.30%
	Environmental Benefits N=10	2207.49	2378.71	7.76%	477.95	513.63	7.47%
	New Technology N=9	2204.09	2432.89	10.38%	476.22	514.46	8.03%
	Free N=4	1940.38	2302.34	18.65%	420.35	469.54	11.70%
	Increase Knowledge N=7	1962.76	1836.85	-6.41%	452.19	389.87	-13.78%
	Address Electricity Issues N=7	2613.65	2887.83	10.49%	540.18	591.95	9.58%

Ontario's Electricity Prices	Much too high N=15	2046.64	2051.18	0.22%	449.26	435.80	-2.99%
	High N=38	2150.79	2275.43	5.80%	469.87	483.54	2.91%
	Appropriate N=12	2259.59	2206.11	-2.37%	513.23	485.05	-5.49%
	Low N=1	5417.88	5284.10	-2.47%	1119.0	1202.6	7.47%
Knowledge							
Potential to Conserve	Very High N=13	2077.03	1963.75	-5.45%	475.42	413.63	-12.33%
	High N=30	2282.69	2351.26	3.00%	496.56	497.38	0.17%
	Average N=22	2193.59	2345.14	6.91%	479.79	509.74	6.24%
	Low N=1	2671.04	2658.33	-0.48%	597.79	602.09	0.72%
	Very Low N=1	739.56	997.64	34.90%	128.33	181.39	41.35%
Pay Attention to Electricity Bill	Always N=46	2223.40	2281.56	2.62%	495.50	489.13	-1.28%
	Sometimes N=18	2189.64	2239.70	2.29%	466.43	470.36	0.84%
	Never N=2	2361.11	2525.94	6.98%	520.90	574.25	10.24%
Talk about electricity with children	Yes N=23	2195.27	2202.17	0.31%	490.24	469.97	-4.13%
	No N=7	3130.13	2915.54	-6.86%	640.24	622.79	-2.72%
	Do not have children (4-18 yrs) N=36	2020.25	2169.11	7.37%	448.69	462.91	3.17%
Scores on Conservation Quiz	-1 N=1	2417.27	2591.34	7.20%	545.77	579.76	6.23%
	0 N=9	2077.62	2095.91	0.88%	470.51	450.59	-4.23%
	1 N=16	2209.61	2193.86	-0.71%	478.21	458.74	-4.07%
	2 N=21	1922.51	2080.81	8.23%	422.16	431.07	2.11%
	3 N=17	2610.66	2586.65	-0.92%	571.82	562.96	-1.55%
	4 N=4	1539.66	1835.35	23.84%	341.55	422.01	32.82%
Level of Media Influence	Very High N=7	1598.71	1517.94	-5.05%	353.36	340.59	-3.61%
	High N=19	2232.70	2392.29	7.15%	494.15	506.66	2.53%
	Average N=29	2161.30	2290.05	5.96%	474.71	497.23	4.74%
	Low N=8	2234.26	2184.91	-2.21%	482.62	449.44	-6.88%
	Very Low N=4	3084.18	2818.99	-8.60%	682.48	574.93	-15.76%
Technologica l Competence	Very High N=31	1988.04	2113.59	6.31%	445.20	447.89	0.60%
	High N=22	2445.72	2509.62	2.61%	531.66	539.73	1.52%
	Average N=11	1964.17	2066.34	5.20%	420.34	432.06	2.79%
	Low N=1	2890.27	3204.22	10.86%	678.69	790.27	16.44%
	Very low N=1	5348.86	3134.53	-41.40%	1162.13	688.68	-40.74%
Demographic							
Gender	Female N=17	2337.28	2298.35	-1.67%	506.76	494.02	-2.51%
	Male N=51	2133.77	2239.13	4.94%	471.35	477.01	1.27%
Age	25-29 yrs N=10	2117.37	2261.14	6.79%	451.12	460.71	2.12%
	30-34 yrs N=23	2086.89	2301.62	10.29%	452.14	487.39	7.79%
	35-39 yrs N=14	2175.44	2116.73	2.30%	488.62	464.65	0.39%
	40-44 yrs N=8	2610.90	2347.90	-10.07%	575.27	501.95	-12.75%
	45-49 yrs N=3	1801.70	2120.74	17.71%	407.17	478.41	17.50%

	50-59 yrs N=3	1600.58	1584.57	-1.00%	349.49	326.22	-6.66%
	60+ yrs N=5	2963.97	2973.31	0.32%	668.66	653.49	-2.27%
Education Level	Some Grade or High School N=1	2473.04	2362.40	-4.47%	651.30	563.79	-13.44%
	High School N=10	2689.86	2587.84	-3.79%	606.59	544.91	-10.17%
	College N=18	2192.12	2256.00	2.91%	467.72	468.03	0.07%
	University N=27	2068.12	2130.95	6.61%	441.11	458.59	3.96%
	Graduate Degrees N=12	1990.57	2062.67	3.62%	430.53	454.01	5.46%
Household Incomes	$20,001- $40,000 N=1	1711.67	1354.42	-20.87%	427.40	342.92	-19.77%
	$40,001- $60,000 N=3	1588.96	1497.43	-5.76%	365.25	323.92	-11.31%
	$80,001- $100,000 N=12	2020.83	2206.99	9.21%	445.96	490.76	10.04%
	$100,001- $150,000 N=18	2185.72	2277.54	4.21%	454.10	445.01	-2.00%
	Greater than $150,001 N=20	2231.71	2343.21	5.02%	459.03	472.69	2.97%
Number of Occupants in Home	One N=3	1593.80	1534.77	-3.70%	338.03	360.79	6.73%
	Two N=19	1883.24	2033.43	7.98%	431.07	443.65	2.92%
	Three N=21	2247.28	2365.05	5.24%	490.29	497.28	1.43%
	Four N=17	2675.23	2603.41	-2.68%	573.05	566.21	-1.19%
	Five N=6	1860.55	1869.54	0.48%	425.05	363.96	-14.37%
	Seven N=1	2226.49	2928.20	31.52%	436.52	540.47	23.81%
Self-Assessment of Free time	A lot N=5	2201.52	2173.96	-1.25%	458.06	438.66	-4.23%
	Some N=32	2788.91	2813.81	0.89%	615.58	612.23	-0.54%
	Not a lot N=28	2182.13	2302.37	5.51%	484.48	484.97	0.10%
Change in income	Remained Constant N=24	2210.45	2219.10	0.39%	491.41	479.96	-2.33%
	Increased N=31	2251.55	2333.72	3.65%	493.87	493.37	-0.10%
	Decreased N=11	1987.20	2202.20	10.82%	427.76	475.44	11.15%

Appendix V

A. Repeated Measure of ANOVA Results

Variables	Significance
August Total	.594
August Total TOU Group	.629
August On-peak	.126
August On-peak TOU Group	.730
September Total	.732
September Total TOU Group	.392
September On-peak	.461
September On-peak	.257
October Total	.867
October Total TOU Group	.200
October On-peak	.354
October On-peak TOU Group	.742
November Total	.349
November Total TOU Group	.371
November On-peak	.075
November On-peak TOU Group	.425
December Total	.994
December Total TOU Group	.839
December On-peak	.234
December On-peak TOU Group	.601
January Total	.585
January Total TOU Group	.743
January On-peak	.833
January On-peak TOU Group	.151

B. Chi Square Test Results

Total Consumption Conserver and Consumers

Variables	**Pearson r-value**
Housing Type	.284
Housing Age	.352
Housing Size	.589
Use of Programmable Devices	.492
Thermostat Use	.044
Heat Power Source	.111
Dryer Power Sources	.479
Oven Power Source	.633
Water heater Power Source	.514
Change Gas to Electric	N/A
Change Electric to Gas	.520
Appliance Purchase	.204
Laundry	.413
Light usage	.649
Energy Star	.407
HVAC	.236
Insulation	.619
Energy Audit	.523
Effort	.475
Awareness	.595
Participation	.407
Moral Obligations	.362
Conservation Importance	.145
Outlooks	.586
Electricity Prices	.425
Understanding	.236
Attention	.892
Talking with Children	.604
Program Awareness	.284
Influence of Media	.508
Heard Advertisements	.567
Technological Competence	.321
Gender	.234
Age	.166
Level of Education	.791
Income	.374
Employment Status	.852
Occupants 2007	.898
Income	.829

On-peak Consumption Conserver and Consumers

Variables	Pearson r-value
Housing Type	.879
Housing Age	.087
Housing Size	.233
Use of Programmable Devices	.924
Thermostat Use	.110
Heat Power Source	.006
Dryer Power Sources	.757
Oven Power Source	.460
Water heater Power Source	.099
Change Gas to Electric	N/A
Change Electric to Gas	.555
Appliance Purchase	.742
Laundry	.436
Light usage	.774
Energy Star	.677
HVAC	.751
Insulation	.184
Energy Audit	.492
Effort	.826
Awareness	.435
Participation	.815
Moral Obligations	.497
Conservation Importance	.157
Outlooks	.832
Electricity Prices	.382
Understanding	.485
Attention	.816
Talking with Children	.077
Program Awareness	.878
Influence of Media	.217
Heard Advertisements	.507
Technological Competence	.560
Gender	.725
Age	.179
Level of Education	.245
Income	.815
Employment Status	.442
Occupants 2007	.403
Income	.225