Assessing socio-economic determinants of energy-saving behavior in Waterloo Region

by

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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.

I understand that my thesis may be made electronically available to the public.

Abstract

The residential sector is responsible for significant amounts of energy consumption; leading to several important social, economic, and environmental issues. The expected future population growth will require additional residential units to be built, and thus, more energy is expected to be consumed. Different sources of energy are consumed by households for many purposes, and the amount of consumed energy by the different household activities varies widely. Therefore, households are considered as an important target group that can help reduce the levels of energy consumption and mitigate several sustainability concerns through energy-saving behavior.

The energy-saving behavior is regarded as a sub-set of larger and more general environment-friendly or pro-environmental behaviors and it can be categorized into two broad categories: energy conservation behaviors and energy efficiency behaviors. In this study, which aims at providing a better understanding of households' energy conservation and efficiency behaviors and identifying the various determinates or characteristics that predict people who are likely to engage in such behaviors, the relationships between the number of reported energy saving behaviors by 401 respondents and several psychological, situational, and socio-demographic determinants were examined. The findings of the study underscore the complexity associated with examining and understanding households' energy-related behaviors and the various determinants that are able to influence such behaviors.

According to the findings of this thesis, except for the moderate relationship that was identified between the independent variable (home ownership) and the number of reported energy efficiency behaviors, the relationships between all the examined independent variables and the number of reported energy conservation and efficiency behaviors were found either weak or statistically insignificant.

More specifically, the independent variables (knowledge, cost-benefit appraisal, information, dwelling type, year home was built, income, number of people in the home, and the relationship status of the participants) were found to have statistically significant, but weak relationships with both the number of reported energy conservation and efficiency behaviors. However, other determinants like (gender, age, employment, having children at home, and the city/township that the study participants reside in) were found to have no statistically significant relationship with both the number of reported energy conservation and efficiency behaviors. Moreover, independent variables like (attitude of the study participants, subjective norms, and the level of education) were found to have statistically significant weak relationship with the number of reported energy conservation behaviors, but not with the number of reported energy efficiency behaviors.

Given the complexity and heterogeneity of human behavior that can be affected by a number of interacting intrinsic and extrinsic variables, this study recommends that future research should examine additional determinants that were not addressed in this work. It is also recommended and advisable to measure the actual energy conservation and efficiency behaviors of households whenever possible, as this will help provide better and more accurate understanding of households' energy related behaviors. This means that more effective interventions can be designed and implemented in order to achieve the desired sustainable behavior patterns and lower the levels of energy consumption in the residential sector.

Acknowledgements

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Sincere gratitude and appreciation is forwarded to my family for care, moral support and understanding during my research work. I owe my deepest gratitude to my parents. Words cannot express how grateful I am to my mother, father, sisters, and brother for their support and encouragements, making this journey easier.

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Chapter 1: Introduction

1.1. Introduction of the Issues

Households are regarded as an important target group that can help reduce energy consumption and mitigate several environment and sustainability concerns. Therefore, social scientists and policy makers have paid particular policy and research attention to household energy consumption, conservation, and efficiency behaviors, as well as the various determinants that may influence these behaviors for a number of decades.

During the 1970s, energy conservation and efficiency topics received special attention in the aftermath of the energy crises and the raising concerns about the possible depletion of fossil fuels, as well as the increasing prices of oil and gas. Currently, the interest in such topics is motivated by the growing concerns associated with major environmental and sustainability problems like climate change, which is fundamentally an energy issue and being driven by the increasing concentrations of greenhouse gases (GHG) in the atmosphere (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Azlina, Abdullah, Kamaludin, & Radam, 2015).

Undeniably, energy is a fundamental element of human society and has always played a key role in the development and urbanization of communities. However, with the incessant population growth, the technological booming, as well as the development of societies which strive for the best and highest quality of life; energy problems are inevitable. The rapidly growing demand for energy in all sectors of the economy - including the residential sector - has already raised several social, economic, and environmental concerns. These concerns include, but are not limited to energy costs and the security of energy supply systems, the exhaustion of energy resources, the need for additional investments in

energy infrastructure, and the heavy environmental impacts like the greenhouse emissions and climate change.

Indeed, the residential sector is responsible for one-fifth of global energy consumption, and that is mainly due to the heating and cooling loads, and the high electricity demand for lighting and running appliances (Brounen, Kok, & Quigley, 2013). In the OCED countries, household energy consumption ranges between 15% and 20% of total energy consumption (Abrahamse et al., 2005).

Despite a series of implemented policies and initiatives (e.g., intervention strategies, energy efficiency and conservation programs and campaigns, low energy consuming appliances, home energy audits, providing incentives and rebates for home renovations and energy saving products) that aim at controlling the increase in the residential energy consumption and the associated GHG emissions, household energy consumption continues to grow. For instance, according to Natural Resources Canada, in 2013 the total household energy consumption accounted for 17 percent of all energy used in Canada, and the energy consumption of the residential sector in 2013 increased 6.5 percent compared to that in 1990.

Along with the expected future population growth, additional residential units are expected to be built, and thus, more energy is expected to be consumed. According to Hu, Yan, Guo, Cui, & Dong (2017), as more appliances and electronics become more widespread and as the demand for higher quality of life and more comfort increase, household average energy consumption will continue to grow. This necessitates a detailed understanding of the sector's energy consumption, as well as the various determinants that are associated with occupants' energy-related decisions and behaviors.

It should be noted that, while innovative energy saving technology can be introduced and utilized to help lower the household energy consumption, the responsibility still rests on the occupants of the residential units and the users to optimize the usage of the technology (Lee & Tanusia, 2016). So, not

only technological innovations will help reduce the amount of energy consumed in the residential sector, changes in occupants' behavior are expected to have positive impacts as well.

Occupants' behavior is a major determinant of the energy usage in residential buildings. That's why the energy conservation and efficiency behaviors in the residential sector have been recognized for their importance in reducing the overall energy consumption, and mitigating energy-related social, economic, and environmental impacts. According to Gram-Hanssen and Petersen (2004), energy consumption in the residential sector could be significantly reduced if people paid more attention to selecting more energy efficient models when purchasing appliances and technologies or by avoiding the unnecessary use of electricity.

1.2. Household Energy Saving Behaviors

Energy saving behavior can be regarded as a sub-set of larger and more general environmental-friendly or pro-environmental behaviors, that are defined by Steg and Vlek (2009) as behaviors that harm the environment as little as possible or even benefit the environment. Energy saving behaviors can be categorized into two broad categories: energy conservation and energy efficiency behaviors (Barr, Gilg, & Ford, 2005).

Energy conservation refers to actions based on curtailment and is usually known as habitual behavior (Stern, 1992), since it focuses on reducing energy consumption in everyday life, such as switching off lights when not in the room and running appliances at off-peak hours. So, it requires minimal or no structural adjustments or thinking about it (Barr et al., 2005).

Energy efficiency refers to actions based on the adoption of energy efficient technologies and is usually known as investment behavior (Nair, Gustavsson, & Mahapatra, 2010). This type of behavior is associated with purchasing decisions and may require structural adjustments. Examples of this type of

behavior include installing insulation in walls and attic, or the purchase and installation of energy efficient light controls.

It should be noted however that, although both terms (energy conservation and energy efficiency) are used in the energy behavior research (Abrahamse et al., 2005; Barr et al., 2005; Nair et al., 2010) and are going to be used in this work as well, some writers argue that since energy efficiency is based on the adoption of specific technologies that lower the overall energy usage without changing the relevant behavior, the term "energy efficiency" should not be used when referring to energy saving behaviors (Oikonomou, Becchis, Steg, & Russolillo, 2009).

1.3. Factors Influence Household Energy Consumption and Saving Behavior

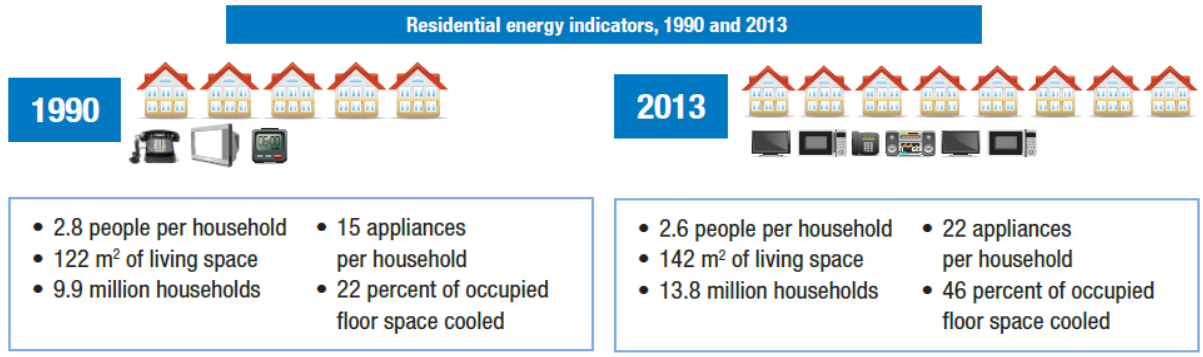
Peoples' behavior is challenging to influence, due to its complex nature, heterogeneity, and ability to be affected by several intrinsic and extrinsic variables. One can think of these variables as individual (socio-demographic and psychological) and situational (contextual and structural) factors (Frederiks, Stenner, & Hobman, 2015). So, human behavior is both complicated and difficult to change as it can be influenced by several internal and external factors. Socio-demographic factors include income, level of education, age, gender, household characteristics, and employment status. Examples of the psychological factors that may influence household energy consumption, efficiency and conservation behaviors include personal values, beliefs, norms, attitudes, perceived behavioral control, knowledge, perceived responsibility, and awareness of consequences. The situational (contextual and structural) factors include information, available technology, laws, regulations and policies, dwelling characteristics, and many others. More details about the influence of these factors on household energy consumption and decisions to engage in energy conservation and/ or efficiency behaviors will be presented in chapter 2 of this thesis.

1.4. The Energy Use and Greenhouse Gas Emissions of the Canadian Residential Sector

According to Natural Resources Canada's 2016 publication *Energy Efficiency Trends in Canada, 1990 to 2013*, in 2013 Canadians spent $28 billion on household energy needs and the residential sector accounted for 17 percent of the total energy used in the country. Additionally, the residential sector was responsible for 14 percent of all secondary energy use-related greenhouse gases emitted in Canada that year. Specifically, the consumption of 1,517.5 PJ in the residential sector resulted in emitting 66.2 Mt of GHGs in 2013.

The 40 percent increase in the number of households over the 1990–2013 period, combined with the increased number of dwellings and the average living space, as well as the higher penetration rate and the greater use of the various and varied types of appliances and equipment resulted in 6.5 percent increase in the residential energy use in 2013 compared to that in 1990. Please see figure (1)

Figure 1 - Energy Efficiency Trends in Canada, 1990 to 2013 (oee.nrcan.gc.ca/statistics/publications)



A breakdown of Canada's residential energy use in 2013 shows that space heating consumed almost two thirds (63.3 percent) of all energy, followed by water heating and appliances which accounted for 19.4 percent and 12.4 percent respectively, then lighting with 3.6 percent and space cooling with 1.3 percent (NRCan, 2016).

The above figures confirm the role of households as an important target group for reducing energy consumption, and thus eliminating or mitigating many social, economic, and environmental issues that are associated with household energy consumption.

However, major upgrades in the building codes and improvements in the building envelope (insulation, windows, etc.), as well as upgrades and improvements in the efficiency of new furnaces, appliances, and lighting contributed to the 45 percent improved energy efficiency in the in the residential sector over the 1990–2013 period. The residential energy use would have increased 51 percent without energy efficiency improvements (NRCan, 2016).

1.5. The Energy Use and Greenhouse Gas Emissions of the Residential Sector in the Region of Waterloo

Waterloo Regio is a midsized community located in southern Ontario, Canada. It consists of three main cities (Kitchener, Waterloo, and Cambridge) and four townships (Wellesley, Wilmot, Woolwich, and North Dumfries). With a total population of 535,155 people in 2016 (representing 1.5% of the total 35,151,728 population in Canada) and a projected population that will reach 742,000 in 2031, this makes Waterloo Region one of the fastest growing regions in Ontario (Region of Waterloo Demographics, 2018; Statistics Canada, 2016). The estimated number of households in 2017 is 209,240 representing a one-year growth rate of 1.58%, or 3,250 more households than that in 2015 (Population and Household Estimates for Waterloo Region, 2017)

By the end of 2014, the residential sector accounted for 26% of the total energy used in Waterloo Region (Community Energy Investment Strategy for Waterloo Region, 2018). Additionally, out of the 3.6 million tonnes of the Greenhouse gases emitted in 2010 by all sectors of the economy, the residential sector accounted for 22% (782,459 tonnes CO2e) of the total emissions. In that year, the residential sector was responsible 50% and 30% of the community's natural gas and electricity use respectively

(ClimateActionWR, 2013). Moreover, comparing 2010 to 2015 an increase in the electricity and natural gas consumption was observed in the residential sector. However, during the same period, around 10% decrease in emissions was reported. This decrease in the emissions is mainly due to the provincial phase-out of the coal fired electricity generation plants (Brown et al., n.d.).

The above confirms the importance of pursuing energy saving programs and encouraging households to engage in energy conservation and efficiency behaviors to reduce the overall energy consumption and greenhouse gas emissions.

1.6. Objectives and Research Question

The objectives of this study include providing better understanding of the energy conservation and efficiency behaviors in the residential sector, as well as the various factors or variables influencing households' energy related-behaviors. The study also aims to help develop a better understanding of how to increase peoples' decisions to reduce energy consumption, and to do that we need to understand their relationship with energy.

Research question:

What are the determinates or characteristics that help predict people who are likely to engage in energy conservation and efficiency behaviors in the residential sector?

1.7. Structure of the Thesis

This thesis consists of 6 chapters. After this introduction chapter, Chapter 2 presents a review of literature including a review of some of the related theories, energy saving behaviors, determinates influencing household energy consumption and saving behaviors, and various interventions and strategies for promoting household energy saving behaviors. Chapter 3 presents the methods selected to achieve the research objectives and a justification of the research instrument used, as well as the

source of data used in this work. Additionally, the limitations of this work are recognized in chapter 3. In Chapter 4 the results of the statistically analyzed data are presented and then discussed in Chapter 5. The thesis concludes in Chapter 6 with recommendations and suggestions for future work.

Chapter 2: Literature Review

2.1. Introduction and Chapter Outline

In this chapter, findings from the literature review are presented. This review has included articles relating to household energy usage and saving behaviors, determinants or variables that are able to influence such behaviors, as well as challenges and difficulties relating to home energy management. The review has also included articles relating to interventions and strategies for promoting household energy-saving behaviors. Additionally, a theoretical perspective providing an overview of some of the influential theories and widely used frameworks to explain variations in pro-environmental behaviors and behavior change is presented in this chapter.

The purpose of this literature review is to provide a background covering previous research and identifying the current state of knowledge about various determinates that may influence household energy conservation and efficiency behaviors. This review will also shed light on various interventions and strategies that may help in promoting household energy-saving behaviors.

The reviewed literature includes articles from both the academic and grey literatures. These articles were retrieved primarily using Google Scholar and the Web of Science. Most of the collected journal articles are peer reviewed.

Following this introduction, this chapter contains five more sections that present the literature on the challenges and difficulties relating to home energy management, theoretical perspective that addresses a range of environmentally relevant behaviors and behavior change, distinction between energy conservation and efficiency behaviors, determinants of residential energy consumption and saving behaviors, and various interventions and strategies that are usually applied for promoting household energy-saving behaviors.

2.2. Challenges and difficulties relating to home energy management

Energy in the residential sector is used for many purposes and the amount of energy consumed by different household activities varies widely. Vringer and Blok (1995) explain that households' energy requirements include direct and indirect energy uses. While the direct energy consumption refers to the use of electricity, natural gas, and other fossil fuels. The indirect energy refers to the energy used in the production, transportation and disposal of goods and services (Vringer and Blok, 1995; Steg, 2008). The latter i.e. the indirect household energy consumption will not be the main focus of this work.

A number of articles identified several challenges that usually make it difficult to understand and control residential energy usage. Azlina et al. (2015) point to the difficulty of controlling households' energy consumption because they are run by individuals who are generally not forced to take particular actions or measures through regulatory means compared to other major energy consuming sectors such as the industrial and transportation sectors. Additionally, Swan and Ugursal (2009) consider the residential sector an undefined energy sink because of the following:

- It includes a wide variety of structure sizes, various geometries, and different thermal envelope materials.
- The widely varying occupant behavior that can significantly impact energy consumption.
- Various issues (e.g. privacy) which can affect the process of collecting or distributing energy data related to individual households.
- Cost associated with the detailed sub-metering of household end-uses.

In addition to the above Van Raaij and Verhallen (1983a) give a number of reasons to explain why some households do not consider behaving in an energy conscious way. The following is a list of those reasons:

- the availability of energy is not their problem or concern since it is the responsibility of the government to supply energy.
- factors attached to their social environment.
- some households underestimate the effectiveness of their energy conservation behaviors.
- the lack of adequate knowledge and feedback about the energy cost of many households' behaviors.
- unwillingness to give up comfort.

2.3. Theoretical Perspective

Several social-psychological models have been applied in the literature to explain variations in pro-environmental behaviors. That is, investigating and understanding the complex, wide-ranging, and dynamic variables influencing environmentally significant decision-making processes and actions has led to the utilization of several models of pro-environmental behaviors.

Ajzen's Theory of Planned Behavior (TPB) is one of the most influential and widely used frameworks to explain a range of environmentally relevant behaviors and behavior change. This theory, which started as the Theory of Reasoned Action (TRA) Ajzen & Fishbein, 1980, stresses the important role of intention in predicting peoples' willingness to engage in a particular behavior. Steg and Vlek (2009) mention a number of studies where the TPB has proven to be successful in explaining a variety of environmental behaviors. The cited studies include "travel mode choice (Bamberg & Schmidt, 2003; Harland, Staats, & Wilke, 1999; Heath & Gifford, 2002; Verplanken, Aarts, Van Knippenberg, & Moonen, 1998), household recycling (Kaiser & Gutscher, 2003), waste composting (Mannetti, Pierro, & Livi, 2004; Taylor & Todd,1995), the purchasing of energy-saving light bulbs, use of unbleached paper, water use, meat

consumption (Harland et al., 1999), and general pro-environmental behaviour (Kaiser et al., 1999)" (Steg & Vlek, 2009, p. 311).

The TPB - figure (2) is built out of a number of constructs. The first one is the attitude towards a certain act or behavior. That is, an individual's belief regarding a certain act or behavior makes it a positive or negative contribution to that person's life. The second construct is called subjective norms. This construct focuses on everything around the individual. The third construct is called perceived behavioral control. What this construct actually expresses is a person's belief on how easy or hard it is to display a certain behavior or act in a certain way.

According to (Abrahamse & Steg, 2011), variables that are assumed to determine intentions include attitudes, subjective norms, and perceived behavioral control, whereas socio-demographic variables influence intention and behavior indirectly since the former - psychological variables - are assumed by the TPB to mediate the relationship between socio-demographic variables and behavior. The authors continue to define each of these variables as below:

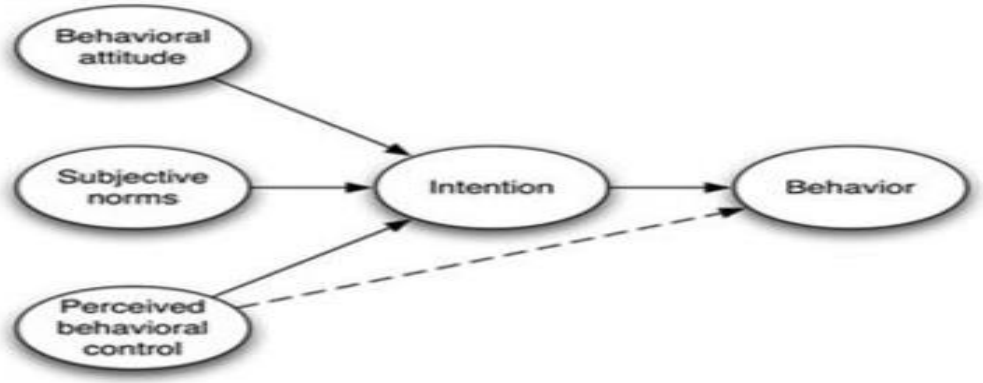
- Attitudes: "refer to the degree to which a person has a favorable or unfavorable evaluation of a given behavior".
- Subjective norms "refer to individual perceptions of the extent to which important others would endorse a given behavior and individual motivations to comply with this social pressure".
- Perceived behavioral control "refers to the perceived ease or difficulty of engaging in a behavior".

In view of the above, what the model actually predicts is that a positive attitude towards an act or behavior, favorable social norms, and a high level of perceived behavioral control are the best predictors for forming a behavioral intention and in turn lead to a displayed behavior or an act. So, if any of these variables is considered or seen unfavorable, then a person is much less likely to display that act or

behavior. Accordingly, the likelihood to display a certain behavior decreases if two or even three of those constructs is regarded as unfavorable.

Based on a reviewed empirical literature on the four constructs of the TPB, Pals and Singer(2015), argue that the TPB model is strong enough, reasonable, and a suitable framework for studying households' environmental attitudes and behaviors. According to Steg and colleagues (Abrahamse & Steg, 2011; Steg & Vlek, 2009) the TPB appears to be successful in explaining high cost environmental behaviors such as car use or energy use.

Figure 2 - The Theory of Planned Behavior (TPB)



Another important model that extends Schwartz' norm activation model (1977) is the value-belief-norm (VBN) theory (Stern, 2000) which was specifically developed to explain environmental behavior (Abrahamse & Steg, 2011). The theory received extensive attention and has been cited by many researchers (e.g., Abrahamse & Steg, 2011; Lopes, Antunes, & Martins, 2012; Steg & Vlek, 2009). Like the TPB, the VBN theory - figure (3) has proven to be successful in explaining various types of environmental behaviors in several studies. Abrahamse and Steg (2011) refer to a number of those studies that addressed behaviors like the acceptability of policy measures, intentions to reduce car use, and recycling.

According to (Abrahamse & Steg, 2011; Lopes et al., 2012), the theory proposes a causality relation between several variables starting with the basic and general values, that are considered as guiding principles of individuals' lives (Rokeach, 1973) cited by (Abrahamse & Steg, 2011). Abrahamse and Steg (2011) also point out that these values relate to the level of concern that a person holds towards the environment as reflected in the new environmental paradigm. Citing Schwartz (1992,1994), (Abrahamse & Steg, 2011; Fornara, Pattitoni, Mura, & Strazzera, 2016) indicate that these values can be categorized and viewed in two dimensions: self-transcendence (concern for others) vs. self-enhancement (concern for self), and openness to change (variation) vs. conservation (tradition). While the self-transcendence values are shown to be connected to altruistic and biospheric values as well as a variety of pro-environmental intentions and/ or behaviors, the self-enhancement values are shown to be connected to egoistic view and in a negative way to environmentally-related behaviors.

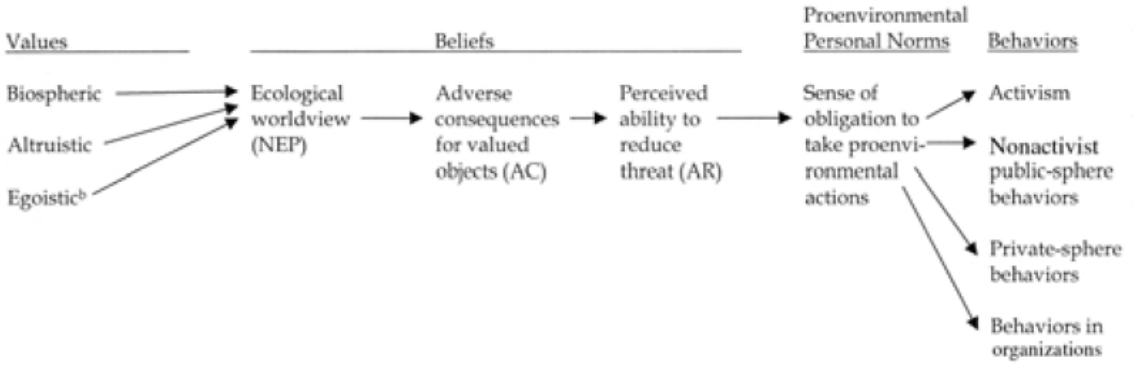
In line with the VBN theory (Abrahamse & Steg, 2011; Fornara et al., 2016) continue to explain that individuals perform a certain pro-environmental act or behavior because they feel morally obligated (Personal Norms) to do so when they believe and become aware that their behaviors have negative environmental consequences (Awareness of Consequences, AC), and thus assume responsibility (Ascription of Responsibility, AR) for those environmental problems.

Referring to the VBN theory Stern says "The theory links value theory, norm activation theory, and the New Environmental Paradigm (NEP) perspective through a causal chain of five variables leading to behavior: personal values (especially altruistic values), NEP, AC, and AR beliefs about general conditions in the biophysical environment, and personal norms for pro-environmental action" (Stern, 2000, p. 412).

Abrahamse and Steg (2011), notes that the socio-demographic variables in the VBN theory are assumed to act as opportunities and constraints for behavior, and as is the case of the TPB the psychological variables are assumed to mediate the relationship between socio-demographic variables and behavior.

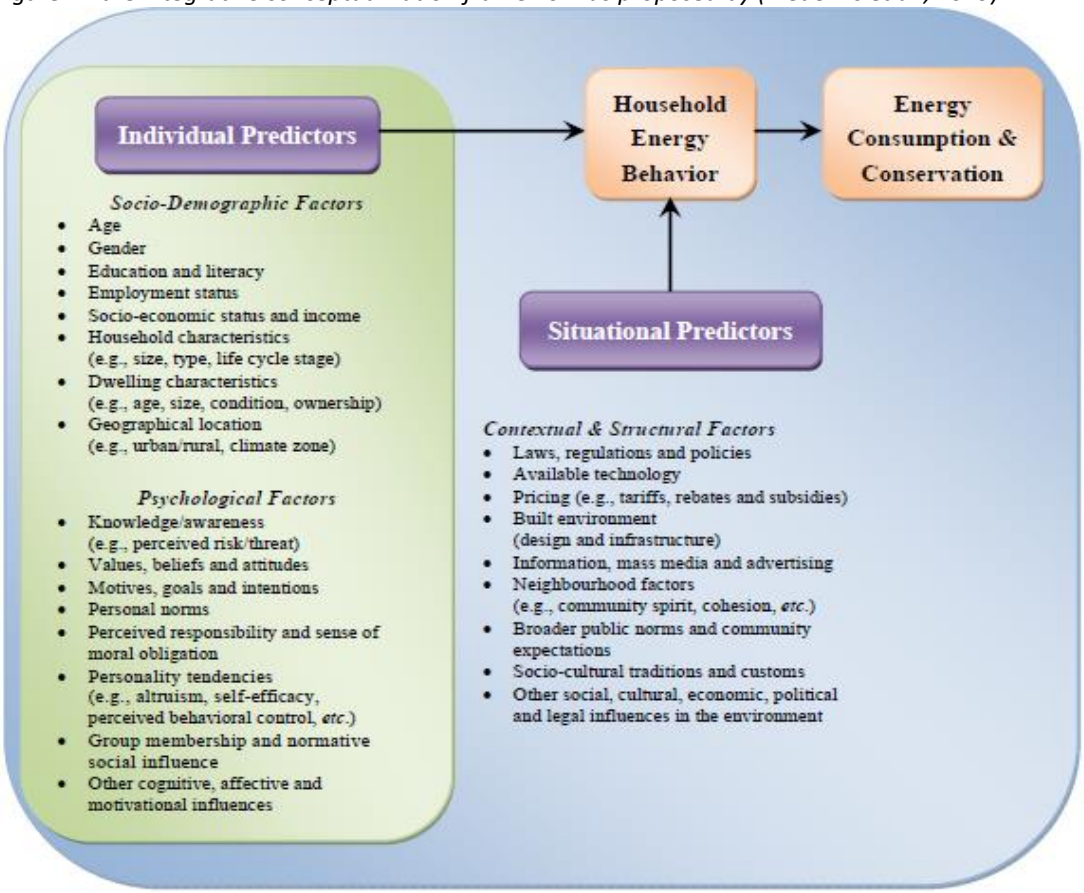
Additionally, according to (Abrahamse & Steg, 2011; Steg & Vlek, 2009) the VBN theory appears to be successful in explaining low cost environmental behaviors.

Figure 3 - The Value-Belief-Norm theory (VBN)



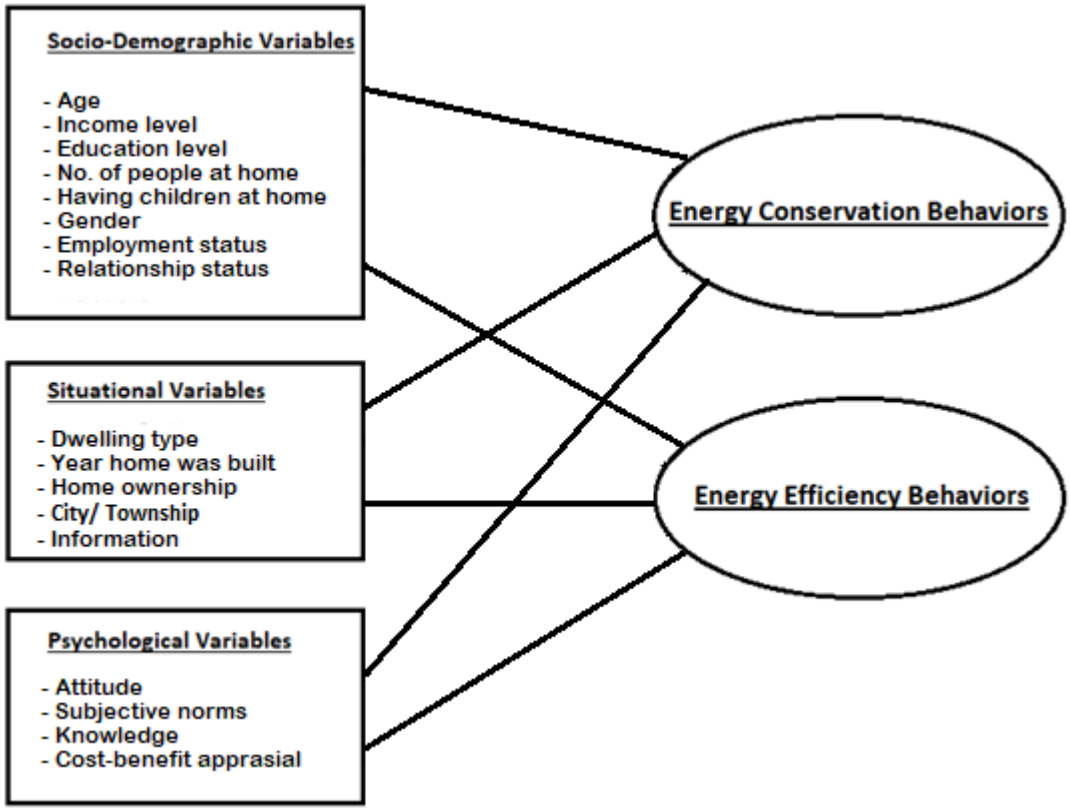
While there are many examples of the conjoint use of the TPB and VBN in the literature as the reference framework for addressing different pro-environmental behaviors (e.g., Bamberg, Hunecke, & Blöbaum, 2007; López-Mosquera & Sánchez, 2012), Frederiks et al. (2015) point out that researchers have increasingly favored the use of integrative conceptualization as an overreaching framework for understanding energy consumption and saving behaviors. The writers argue that such integrative conceptualization allows for a better consideration and understanding of the multiple interacting factors (e.g. individual and situational) that influence the energy-related behaviors and practices of households. Figure (4) show the integrative conceptualization of various factors that may impact household energy related behaviors as proposed by (Frederiks et al., 2015).

Figure 4 - the integrative conceptualization framework as proposed by (Frederiks et al., 2015).



Considering the type of the survey questions used in this thesis (see Chapter 3 for more details), an integrative conceptualization/ approach will be considered for this work as it is believed that household energy consumption, conservation and efficiency behaviors represent a complex process with a range of determinants or variables that together influence household energy related behaviors. It should be noted however that, only a subset of the determinants or variables identified in the literature will be covered in this work. Including the independent and dependent variables examined in this work, Figure (5) shows the suggested model which will be used as an integrative conceptual framework in this thesis.

Figure 5 - The integrative conceptual framework used in this thesis.



2.4. Distinction between energy conservation and energy efficiency

It is important to discuss and distinguish the difference between two fundamental categories of energy saving behaviors. These behaviors are mainly referred to in the literature as energy efficiency and energy conservation behaviors. However, it is observed that a variety of other labels and terms are also used in the literature to refer to these two types of behaviors. Therefore, these terms (energy conservation and energy efficiency) are often overlapped and a confusion is created in some of the energy and behavior literature, as well as the policy making contexts (Lopes et al., 2012; Oikonomou et al., 2009).

The following terms or labels are used by different scholars to refer to actions taken or implemented on daily basis to reduce energy usage; 'Habitual actions' (Barr et al., 2005), 'non-investment measure' (Nair et al., 2010), 'adjustments' (Dillman, Rosa, & Dillman, 1983), 'usage-related' (Van Raaij & Verhallen, 1983a), 'curtailment' (Black, Stern, & Elworth, 1985). These terms are used to discuss behaviors that require either no or minimal structural adjustments (Barr et al., 2005), i.e. such behaviors involve repetitive and continuous efforts to achieve the maximum energy savings (Abrahamse et al., 2005; Black et al., 1985).

According to Black et al. (1985), such behaviors rarely cost money, but they usually involve a loss of amenities, discomfort, or inconvenience. Stern and Gardner (1981) also explain that these behaviors require people to modify the way they use energy systems which are already in place, so they (people), may see themselves as making do with less since they decrease their use of existing energy systems. That is curtailing the benefits derived from energy use. In this thesis, this type of energy behavior will be referred to as energy conservation actions or behaviors. Examples of such behaviors include lowering thermostat settings and switching off lights in unoccupied rooms.

One can describe such behaviors as actions that we usually do without thinking or behaviors that people are likely to make in their everyday routine of life and require little or no conscious thought (Barr et al., 2005).

The second type of household energy saving behaviors will be referred to in this work as energy efficiency behaviors or improvements. Again, a number of different terms and labels are used in the literature to describe this type of behaviors or actions. While (Barr et al., 2005) described such behaviors as 'purchasing activities. (Nair et al., 2010) used the term 'investment measure'. Additionally, the terms 'technology choices', 'purchase related behaviors', and 'energy efficiency choices' are used by (Stern, 1992), (Van Raaij & Verhallen, 1983a), and (Black et al., 1985) respectively. Such behaviors and actions

do involve financial and technical resources that can vary greatly. Examples of efficiency behaviors include: purchasing energy saving appliances, insulating and weatherizing a house, using energy-efficient light bulbs.

Although such behaviors involve one-time decisions (Black et al., 1985), they often include long term structural alterations as well as internal changes in a home (Barr et al., 2005). It should be noted here that efficiency behaviors have greater potential to save energy than conservation behaviors (Gardner & Stern, 2002) cited by (Abrahamse et al., 2005). However; that does not mean that energy conservation actions do not save energy and should be ignored. In fact, some energy conservation activities (e.g., lowering thermostat setting) can result in large energy savings, and may even contribute to changing users' consciousness about energy use (Stern & Gardner, 1981). Additionally, it is important to shed light on a challenge that is usually associated with efficiency behaviors and the use of energy efficient appliances: the rebound effect, which occurs when people use appliances more often because they are energy efficient, thus partially reducing the energy efficiency gains (Herring & Sorrell, 2009). For example, when incandescent light bulbs are replaced with energy-saving light bulbs in a home, occupants may leave the lights on for longer time because they think less harm results from more efficient light bulbs.

In short, a clear distinction between energy conservation and energy efficiency behaviors is that the former entails repetitive efforts to reduce energy usage such as lowering thermostat settings, so it basically implies a change in consumers' behavior (Abrahamse et al., 2005; Oikonomou et al., 2009). While the latter involves the purchase or adoption of specific energy efficient technologies that can reduce the overall energy consumption without changing the relevant behavior "one-shot behavior" (Abrahamse et al., 2005, p. 2).

2.5. Determinates of Residential Energy Consumption and Saving Behaviors

A review of the literature on household energy use, efficiency, and conservation behaviors show a general consensus on a number of variables that are important in explaining variability in energy consumption within the residential sector. In fact, these variables play a key role in determining and shaping household energy-related behavior. Therefore, it is crucially important to shed the light on these variables and try to understand the relationship between them, as well as the relative importance that each variable has in driving household energy consumption and saving behaviors. This is also important because it helps in determining and deciding on the most effective and suitable intervention strategies that usually aim to alter households' energy-related patterns and reduce energy consumption (and the associated carbon footprint) in the residential sector.

The key variables underlying patterns of household energy usage range from situational factors through to more individual-specific characteristics.

In study by Costanzo, Archer, Aronson, & Pettigrew (1986), the writers proposed a social-psychological model and suggested methods of improving the effectiveness of energy conservation programs. The proposed model consists of two interacting sets of factors: psychological and positional/situational factors.

In another study by Abrahamse et al. (2005) several macro-level factors that can influence household energy consumption were proposed. These factors are referred to as TEDIC factors and are summarized below:

- Technological developments (e.g. energy-intensive appliances),
- Economic growth (e.g. increase of household incomes),
- Demographic factors (e.g. population growth),

- Institutional factors (e.g. governmental policies), and
- Cultural developments (e.g. emancipation, increasing mobility of women)

Abrahamse et al. (2005) continue to say that the TEDIC factors shape individual (micro-level) factors including motivational factors (e.g. preferences, attitudes), abilities and opportunities. Therefore, according to the writers, it is necessary to consider both the macro and micro-level factors in order to change households' consumption patterns.

In their paper, Frederiks et al. (2015) gathered factors that influence household energy-related behaviors into three broad interrelated groups. The groups include several socio-demographic variables (e.g., income, gender, age, etc.), psychological variables (e.g., intentions, attitude, social norms, values, knowledge, etc.), and a range of external contextual and situational factors (e.g., laws and regulations, available technology, etc.).

It should be noted that, although there is a general agreement on the factors and variables that may influence household energy-related behaviors, findings from empirical studies (e.g., Abrahamse & Steg, 2011; Curtis, Simpson-Housley, & Drever, 1984; Fornara et al., 2016) provide a clear evidence that the impact of those variables is inconsistent. This inconsistency makes researchers very cautious in drawing generalizable conclusions.

2.5.1. Socio-Demographic Variables

In this section, a number of socio-demographic factors that contribute to differences in the patterns of household energy usage will be reviewed. Many writers (e.g., Abrahamse & Steg, 2009; Abrahamse et al., 2005; Frederiks et al., 2015) assume that socio-demographic variables act as opportunities and constraints that are important in determining and explaining the amount, type, duration, and frequency of energy use at a particular home. The socio-demographic factors include: age, gender, level of

education, household size, and income level. The effects of these variables, as identified in the literature, will be discussed below.

I. Age

Generally, a review of the literature revealed inconsistency in the significance of age in explaining or predicting household energy-related behaviors (usually studies consider the age of the household head). Some research shows a positive association between the age and energy consumption i.e. the older the households, the more energy is consumed (e.g., Abrahamse & Steg, 2011). This can be linked to the negative association, that is usually identified, between the age and the number of energy improvements that older people are willing to adopt. This type of association is attributed to factors like the low expectation about the return on investment (Nair et al., 2010; Walsh, 1989), the lower levels of awareness and information about various energy saving measures (Lindén, Carlsson-Kanyama, & Eriksson, 2006), the low or no concern about the energy situation (Black et al., 1985), lower income levels (Poortinga, Steg, Vlek, & Wiersma, 2003), the poor conditions of the home they live in, and the need for more cooling or heating to be comfortable; though the need for greater thermal comfort may encourage the investment in energy efficiency measures like improving home envelope conditions (Nair et al., 2010).

However, a study by Barr et al. (2005) shows that those in higher age groups with a mean age of 55 years were more likely to be energy savers because they were more likely to undertake both energy efficiency and conservation measures than younger age groups (Barr et al., 2005; Nair et al., 2010). This is in line with findings from previous studies by (Painter, Semenik, & Belk, 1983; Ritchie, McDougall, & Claxton, 1981) who found that ‘‘energy savers’’ are older.

Mills and Schleich (2010) reports “Younger household cohorts are more likely to adopt energy-efficient technologies and energy conservation practices and place primary importance on energy savings for

environmental reasons, while households with a high share of elderly members place more importance on financial savings".

Other academics believe that there is no correlation between individual's age and household electricity consumption, therefore it is necessary to consider other variables like the household income (Gatersleben, Steg, & Vlek, 2002).

Given the reviewed literature and considering the inconsistent empirical support of the type of the relationship (that tends to be very weak or statistically insignificant) between age and the engagement in pro-environmental behaviors, it is reasonable to expect that the findings of this work will show a statistically significant weak relationship between the age of the study participants and the number of reported energy saving behaviors.

II. Income Level

Income seems to be one of the most important determinants influencing household energy conservation and efficiency behaviors. The majority of the reviewed studies show a positive correlation between income and household energy consumption (e.g., Abrahamse & Steg, 2009, 2011; Brounen, Kok, & Quigley, 2012). This is mainly because higher income households usually live in larger houses and use more appliances than lower income households. At the same time however, higher income households may be more willing and able to reduce their energy consumption as they are more able to invest in one-off energy efficient technologies (Frederiks et al., 2015; Sardianou, 2007).

One can also argue that lower-income households may consume large amounts of energy simply because they are unable to lower their energy consumption. This is because they usually live in energy inefficient homes and cannot afford to retrofit their homes or adopt energy efficient technologies or appliances. Noting that energy efficiency measures tend to have greater potential to save energy compared to curtailments, Black et al. (1985) argue that energy conservation measures may be the only

option for lower income households to reduce their energy consumption. The writers add that, this usually involves more sacrifice of amenities than the responses of higher income consumers.

Other studies by (Dúll & Janky, 2011; Nair et al., 2010) show a weak or insignificant relationship between income level and household energy consumption patterns.

Despite the inconsistent findings in the literature and the various arguments made by many scholars, it can be concluded that most of the reviewed studies show a statistically significant and positive relationship between the income level and the engagement in pro-environmental behaviors. Therefore, it can be assumed that a positive relationship may also be identified in this study between the income level of the study participants and the number of reported energy-saving behaviors.

III. Education

Although a review of the literature shows that the impact of education on household energy saving behaviors varies across studies, one can argue that there is generally a positive correlation between the attained level of education and household energy saving activities.

Pals and Singer (2015) indicate that better educated people usually show higher levels of concern about the energy situation, this suggests that the likelihood of performing actions to reduce household energy consumption is higher for better educated people than those who attained lower levels of education. Similarly, using data from 5000 households in 11 European countries, findings from a study by Mills and Schleich (2012) show that households with higher levels of education are more willing to save energy, implement energy conservation, and adopt energy efficient technologies for environmental reasons than those with lower levels of education and knowledge about household energy use. This agrees with the findings of other studies conducted by (Hirst and Goeltz, 1982; Brechling & Smith, 1994; Scott, 1997).

According to Mills and Schleich (2012), reasons for explaining this positive correlation include that education lowers the costs associated with information acquisition, and the low household discount rate that may be correlated with considering education as long-term investment. Pals and Singer (2015), who employed the TPB, also explain that education might increase intentions as well as likelihood of performing actual energy conservation behaviors either because it transmits norms and beliefs about conservation, or because it helps reducing barriers to energy conservation behaviors. That is, attaining higher levels of education might result in perceiving more control over the environment and consequently more control over energy conservation behaviors.

However, several other studies show no evidence of the impact of education on energy saving behaviors (e.g., Curtis et al., 1984; Ferguson, 1993; Ritchie et al., 1981).

As stated earlier, although findings vary across studies, but the majority of the reviewed articles suggest and show that identifying a positive relationship between the level of education and the level of engagement in pro-environmental behaviors like the energy-saving behaviors is usually the case.

IV. Household Size, Composition, and Gender

Differences in the household characteristics such as the age of the family members as well as the material status and the presence of children in the family, lead to differences in household needs, priorities, and activities. This contributes to variability in household energy requirements and usage levels. According to Schipper, Bartlett, Hawk, & Vine (1989), household characteristics influence residents' behavior and affects their lifestyle as well as activities usually performed by those occupants. Therefore, any changes in these characteristics can result in substantial changes in energy usage by the household.

Abrahamse and Steg (2009) claim that the household size and composition, affect the amount of energy consumption in a home due to the frequency of activities that are associated with energy usage such as

showering, dishwashing, clothes washing, etc. Similarly, Hu et al. (2017) note that more family members means higher energy consumption since more people living in a house generally implies more equipment usage, more cooking and domestic hot water usage. Larger families also require larger living space, and this leads to higher space heating and cooling loads, which combine as the largest element in the residential buildings energy consumption, especially in hot summer and cold winter zones.

In line with the above, the presence of children in a family, including their age and number affect decisions and behaviors related to energy usage. Schipper (1996) notes that throughout a family life cycle, energy usage in residential units increases with the birth of children and continues to rise slightly, then it peaks when the children are in their teens. The writer adds that families with young children use less energy than those with older children.

However, Mills and Schleich (2012) attribute the positive relationship between the number of children in a household and the adoption of energy efficient technologies and conservation behaviors to the parental concerns about the wellbeing of their children which can be affected by the environmental impacts that are usually associated with energy consumption.

With regards to the impact of gender on energy consumption and saving behaviors, there is generally inconsistency in the literature regarding the effect of this variable. Zelezny, Chua, & Aldrich (2000) note that, females regardless of their age show more concern for the environment and pro-environmental behaviors than males do. However, findings from other studies show that the effect tends to be rather small and/or statistically insignificant. For example, a study by Parker, Rowlands, & Scott (2005) shows that gender is an irrelevant variable that is of little value for electricity conservation.

In view of the reviewed research, it can be argued that a positive relationship can be expected between the family size and the number of adopted energy saving behaviors. One reason to explain that is,

having a larger family may create a feeling that more energy is consumed, so the engagement in more energy saving activities may become a desirable thing to do.

However, with regards to the family composition and gender, most of the reviewed studies show a very weak or insignificant relationship between those variables and the engagement in pro-environmental behaviors.

V. Employment Status, Occupation, and Technical Expertise

The effect of employment status of household occupants - particularly the head of the household - (e.g., full or part time employment, unemployed, or retired) on energy usage is addressed and examined by many researchers (e.g., Curtis et al., 1984; Frederiks et al., 2015; Olsen, 1983). It is generally believed that this variable can influence other variables like household income, which in turn impacts the financial capacity to adopt energy efficient technologies as well as the household's decision regarding other energy-saving strategies.

While Curtis et al. (1984) report that the employment status of home residents has no significant influence on the number of energy conservation actions taken by them, Olsen (1983) claims that persons with higher-status occupation show slightly more acceptance and ability to reduce energy consumption.

According to Frederiks et al. (2015), people in full-time employment can either be high or low energy consumers. The writers explain that on one hand, full time employment usually means better financial capability and more disposable income to spend on energy use and energy-intensive appliances. On the other hand, consumers in full-time employment usually have more money to adopt energy efficient technologies and energy-saving measures, as well as perform home renovations. The authors add that full-time employed consumers generally spend fewer hours per day at their homes compared to retired, part-time, or unemployed consumers; leading to lower energy demand and consumption.

Furthermore, some writers highlight that the presence of a technically skilled household member with good knowledge and understanding of new home technologies, repairs, and installations "handyperson" is positively related to performing energy-saving behaviors (Darley, 1978; Frederiks et al., 2015; Nair et al., 2010). However, it should be noted that as per Mayer (1996) do-it-yourself consumers may be less inclined to adopt energy-saving equipment and appliances, as they may perceive that their installation and maintenance can be complicated and may require special skills and tools which they do not have in order to complete the job.

Given the findings from the literature and considering other factors that are usually associated with the employment status, one can argue that there is a general consensus in the literature that the relationship between the occupation or occupation status and the engagement in energy saving behaviors is insignificant. Therefore, similar finding can be expected in this study

2.5.2. Situational Variables

I. Dwelling Characteristics (Size, Type, and Age)

The impact of dwelling size, type (e.g., detached house, semi-detached house, apartment) and age appear to have a strong influence on household energy consumption. Variation in household energy consumption can be linked to differences in the characteristics of residential units such as the number of rooms, building envelope conditions including the degree of insulation and the utilization of double or triple glazed windows, the building or home design and orientation, the utilization of energy-efficient heating and cooling systems, etc. According to Van Raaij and Verhallen (1983a), these and many other home characteristics may also influence the behavior of occupants, and consequently the energy use. For example, living in large dwellings may make the occupants feel that their household consumes considerable amounts of energy, and thus, energy savings and home improvements are more desirable or even necessary (Powers, Swan, & Lee, 1992).

A study on the energy use and conservation in residential units by Brounen et al. (2012) concludes that the amount of electricity consumed in detached and semi-detached homes is larger than that consumed in row houses or apartments. Similarly, Holloway and Bunker (2006) indicate that households lived in in multi-unit dwellings consumed 74 percent less electricity than those lived in detached houses, semi-detached dwellings, and townhouses.

Generally, the amount of energy consumed in a home is directly related to the size of the home or dwelling (Nielsen, 1993; stern, 1992). Similarly, according to Brandon and Lewis (1999) older homes are found to be less energy efficient. This is mainly attributed to the poor insulation and design conditions that are usually associated with old homes. However, Walsh (1989) argue that the larger and older the home, the more likely that households will perform energy improvements. Nair et al. (2010) also point out that homeowners living in older dwellings may be more inclined to adopt energy-efficient technologies than those living in newer dwellings, and that is usually due to the poor physical and aesthetic conditions of old residential units and the need for installing or upgrading envelope components.

To offset the high energy consumption that may be associated with older homes, renovations and upgrades are often promoted. This is usually encouraged by governmental initiatives, incentive and awareness programs, as well as the continual improvements in building technologies and codes that emphasize the importance of aspects like upgrading home envelope, the purchase and utilization of energy efficient heating; ventilation; and air conditioning systems (HVAC) and appliances. There is no doubt that such improvements and upgrades have contributed to lowering the overall energy consumption of newly constructed homes.

However, it should be noted that due to users' misunderstanding and overestimation of the potential benefits, upgrades and improvements like those mentioned can result in outcomes opposite to the

intended ones. Van Raaij and Verhallen (1983a) cite (Costanzo et al., 1986; Sardianou, 2007; Edelson & Olsen, 1980) who found that after improving home insulation, some residents increased the consumption of their heating fuel by 40 -50 percent because they assumed that they can keep their well-insulated homes as warm as they want.

In general, findings from most of the reviewed studies show that there appears to be a positive relationship between the amount of energy consumption and both the dwelling size and age. This can be attributed to the larger number of rooms and floor spaces, as well as to the poor physical and envelope conditions of old dwellings. However, such factors also seem to play an important role in encouraging the occupants of such dwellings to engage in more conservation and efficiency behaviors to offset the high energy consumption. Additionally, the literature shows a general agreement that occupants of detached dwellings (free standing homes and townhouses) tend to participate in more energy saving behaviors than those residing in multi-unit dwellings (apartments). Accordingly, similar findings are expected to be identified in this study.

VI. Home Ownership (Owned vs. Rented Dwelling)

The effect of home ownership on energy use and the type of energy-related behavior that residents would adopt is studied by many researchers (e.g., Costanzo et al., 1986; Sardianou, 2007). According to Black et al. (1985) home ownership can affect occupants' beliefs and norms about energy efficiency in two ways. Firstly, by directly influencing personal norms suggesting that homeowners simply feel responsible for improving the energy efficiency of their dwellings. Secondly, the writers assume that home ownership affects the perception of social norms for energy efficiency.

Dúll and Janky (2011) note that although homeowners usually take more pro-environmental actions to improve the energy performance of their dwellings compared to renters, they do not decrease their energy-consuming activities more than renters do.

A review of several studies by Sardianou (2007) shows that homeowners are more likely to invest in energy efficiency measures than renters do. Costanzo et al. (1986), Frederiks et al. (2015), and Sardianou (2007) argue that homeowners are usually wealthier with greater financial security, hold longer tenure, whereas renters are more transient, usually poorer and cannot afford investments that involve expensive technologies and major home upgrades. Even long-term renters with high income are unlikely to be motivated to invest and perform efficiency improvements on a dwelling owned by someone else (Costanzo et al., 1986). Additionally, Brandon and Lewis (1999) point out that residents of rented dwellings might not have the right, as tenants, or the incentive to invest in energy saving for their homes. In their literature review, Frederiks et al. (2015) found that some people who rented their homes consume less energy than those who owned their homes.

Overall, it can be argued that the reviewed research in general shows that homeowners tend to participate in larger number of energy-saving behaviors than renters do. So homeowners in this study are expected to be more likely to engage in energy-saving behaviors than renters.

2.5.3. Psychological Variables

In addition to the key role that the socio-demographic and situational variables play in the household energy usage and saving behaviors, several psychological variables that may also have influential effect were addressed by numerous studies (e.g., Abrahamse & Steg, 2009, 2011; Fornara et al., 2016; Ha & Janda, 2012; Pals & Singer, 2015; Van Raaij & Verhallen, 1983b). Psychological variables that are most commonly mentioned in the literature as determinants that can affect household energy consumption include, but not limited to: beliefs, values, and attitudes; intentions; personal and social norms; perceived behavioral control; and knowledge. These as well as many other psychological variables will be discussed in this section. Like the socio-demographic variables, findings from the reviewed literature show that the levels of impact that psychological variables have on household energy-related behavior vary and their influence is far from consistent. This adds to the complexity and challenge of understating

and determining the most powerful factors that influence household energy-related behavior. This also makes it very difficult to generalize findings and draw conclusions regarding the best predictors or determinates that are associated with household energy consumption and saving behaviors.

I. Intention

In addition to the impact of socio-demographic variables on households' intentions to reduce energy consumption, it is also important to examine psychological variables as they are generally connected to behavioral intentions too. While the TPB explains that having an intention is necessary for a behavioral change to take place, there is no clear consensus in the literature on the strength and direction of this relationship (Kollmuss & Agyeman, 2002) cited (Pals & Singer, 2015). It should be noted that, Sheeran(2002) who defines behavioral intentions as instructions that individuals give to themselves to behave in a certain way, also make a note that the TPB acknowledges that individuals may not always have sufficient control over performing the behavior to actually enact their intentions.

Additionally, Abrahamse and Steg say that "*behavioral intentions are an indication of the extent to which people are willing to perform the behavior in question*" (Abrahamse & Steg, 2011, p. 31). The authors then explain that intentions to reduce energy consumption are assumed to be determined by attitudes towards energy conservation, subjective norms, and perceived behavioral control. They assume that intentions to perform a certain behavior require conscious efforts as they usually involve planning and deliberation, and therefore behavioral intentions are seen to be strongly related to psychological variables. Kollmuss and Agyeman (2002) also point out that behavioral intentions are influenced by attitudes and social "normative" pressures. Thus "*the ultimate determinants of any behavior are the behavioral beliefs concerning its consequences and normative beliefs concerning the prescriptions of others*" (Ajzen & Fishbein, 1980, p. 239). Additionally, a meta-analysis of six studies by Hines, Hungerford, & Tomera (1987) revealed a strong relationship between having an intention to engage in a pro-environmental behavior and the actual performance of that behavior i.e. individuals with higher

pro-environmental intentions are more likely to be involved and actually participate in pro-environmental behaviors compared to those who do not have such intentions.

However, although many scholars show that intentions appear to be good predictors of actual behaviors, there is often a gap between individuals' intentions and their subsequent behaviors (Sheeran & Abraham, 2003). This discrepancy between intentions and behavior is referred to in many studies as "intentions-action-gap" or "intention-behavior-gap" (e.g., Frederiks et al., 2015; Sheeran, 2002). In a meta-analysis study of meta-analyses of the intention behavior relation, Sheeran (2002) find that intentions account for only 28% of the variance of future behavior. Frederiks et al. (2015) argue that having intentions to engage in energy-saving behaviors does not necessary mean that these intentions will automatically translate to behavior.

In view of the aforementioned and considering the TPB which assumes that decisions made by people are rational, planned decisions, and are motivated by self-interest (Abrahamse & Steg, 2011), some studies reported that, the best predictor to perform a behavior is the intention to perform it, which in turn can be determined by attitudes, subjective norms, and perceived behavioral control.

Overall, intention to perform a certain behavior did not always emerge in the literature as a significant predictor of that behavior. i.e., the findings from the literature are mixed. An explanation to such mixed findings is that the intention to perform a behavior is influenced by several other psychological, situational, and socio-demographic variables.

II. Attitude

Attitudes are seen as the positive or negative assessment that a person makes towards a specific situation, idea, activity, or even a person (Frederiks et al., 2015). On one hand, some studies show a positive relationship between holding a pro-environmental attitude towards a behavior and the actual performance of that behavior. For example, in a meta-analysis study by Hines et al. (1987) that included

an assessment of the relationship between behavior and attitudinal variables like individual's feelings, pro or con, favorable or unfavorable towards the environment in general and towards particular aspects like energy crisis, the findings of the study indicate that there is a positive relationship between attitude and behavior. That is people with more positive attitude toward the environment are more likely to engage in pro-environmental behavior than those with less positive attitudes. It is also worth noting that the writers mention the existence of several moderator variables that were detected in the attitude-behavior relationship. On the other hand, several studies (e.g., Abrahamse & Steg, 2009, 2011) show that attitude-behavior relationship is often inconsistent, weak, or even insignificant. That is having pro-environmental attitudes towards energy saving behaviors like the adoption of energy efficiency or conservation measures does not mean that such attitudes will inherently lead to actual energy reduction actions. This discrepancy is usually referred to as "attitude-action-gap" (Frederiks et al., 2015).

Generally, findings from the literature regarding the relationship between having an attitude towards a behavior and the performance of that behavior are mixed, as the attitude depends mainly on a person's assessment of that specific behavior which involves other factors as well.

III. Subjective Norms

Fornara and colleagues say that "attitude towards the behavior derives from the beliefs about that behavior (weighted by the evaluation of the outcomes), whilst the subjective norm stems from the normative beliefs (weighted by the motivation to comply)" (Fornara et al., 2016, p. 2). So, as another predictor of intention; subjective norms are defined as "the perceived social pressure to perform or to refrain from a behavior" (Abrahamse & Steg, 2009, p. 712). That is an individual's perception of the extent to which important others would support or condemn a certain behavior and the individual's motivation to abide by this social pressure. Therefore, one can assume that individuals act in line with the expectations of their family members, friends, as well as broader society. A study by Ha and Janda (2012) to predict consumer intentions to purchase energy-efficient products finds that the subjective

norm component has a weaker effect on intention compared to the attitude toward the energy-efficient product. Another study by Ek and Söderholm (2010) on household electricity saving behavior shows that social interactions are important determinants of electricity saving activities since other people's attitudes and behavior in electricity saving may trigger individuals to rethink their current situation and thus influence their willingness for electricity saving activities. The writers continue to say that "Beliefs about how other people behave might be interpreted as a (descriptive) social norm, and thus increase the perception that undertaking measures to reduce electricity consumption is a desirable activity" (Ek & Söderholm, 2010, p. 1584). Pals and Singer (2015) provide an explanation of the two distinctive types of subjective norms: injunctive norms and descriptive norms. The writers point out that the former refers to the perceptions of what "ought to be done", while the latter refers to the perceptions of what "others are doing".

It is clear that people usually follow other peoples' behaviors, conform to social norms, and/or behave according to behavioral expectations within a society that guides what is considered normal and/or desirable (Frederiks et al., 2015). Accordingly, a positive relationship between subjective norms and the engagement in energy-saving behaviors can be expected in this work.

IV. Perceived Behavioral Control (PBC)

A large body of literature shows that, the perceived behavioral control which is the third predictor of intention in the TPB, tends to be positively associated with pro-environmental behaviors such as energy efficiency and conservation behaviors (Frederiks et al., 2015). The perceived behavioral control refers to peoples' perception of the extent to which it is easy or difficult to engage in a certain behavior. So, it represents individuals' perception of their ability to perform or change their own behavior and/or control events that affect them. Some studies used different terminologies to assess the perceived behavioral control. Examples include; self-efficacy by (Lopes et al., 2012) who assume that it is usually

influenced by past experience, efficacy perceptions and locus of control (Hines et al., 1987; Kollmuss & Agyeman, 2002).

As noted in the literature, people with a strong internal locus of control – those who believe that their own decisions, actions, and activities make a difference and are efficacious – are more likely to engage in pro-environmental behavior than those with a more external locus of control(e.g., Frederiks et al., 2015; Kollmuss & Agyeman, 2002). People with external locus of control are those who feel and believe that their actions are insignificant, do not make a difference, and that change can only be brought about by powerful others. This is consistent with the findings of the meta-analysis study conducted by (Hines et al., 1987) who conclude that people with internal locus of control are more likely to engage in responsible pro-environmental behavior than those having more external locus of control.

In summary, the perceived behavior control variable in most of the reviewed studies appeared to have a have a statistically significant and positive relationship with the performance of pro-environmental behaviors.

V. Knowledge

Knowledge is another important psychological variable that can influence household energy behaviors. According to Hines et al. (1987) the possession of awareness and knowledge is a prerequisite for people to intentionally act on a particular environmental problem, which they must be cognizant of its existence as well. The authors add that peoples' knowledge should include the course of actions that are most effective in a given situation. Energy related knowledge reflects the levels of understanding and awareness of energy costs, energy-saving behavior, as well as the consequences associated with such behaviors (Frederiks et al., 2015; Van Raaij & Verhallen, 1983a).

Mills and Schleich (2012) cite Scott (1997) who point out that household knowledge about potential energy savings is linked to improved adoption of energy efficient technologies. Additionally, although

Mills and Schleich (2012) explain that higher levels of education usually lead to higher knowledge, but the writers also note that education can be more effective in developing actual behavioral changes than increasing the knowledge of energy saving opportunities. Similarly, Abrahamse et al. (2005) indicate that information can also lead to greater knowledge on energy-related problems, increased awareness of the possibilities to reduce these problems, as well as the energy-saving measures that household can adopt. However, this greater knowledge does not necessarily lead to behavioral changes or energy savings. This is referred to in many studies as "knowledge-action gap". Frederiks et al. (2015) argue that although greater knowledge and awareness of various environmental issues like high energy consumption tend to be directly related to pro-environmental behavior (e.g., energy saving), but the possession of greater knowledge and problem awareness does not necessarily and directly result in pro-environmental behavior as this relationship is likely to be weak and/or insignificant.

In conclusion, having higher level of knowledge does not seem to lead directly and constantly to performing pro-environmental behaviors such as energy-saving behaviors. This is usually referred to in the literature as "knowledge-action gap". Accordingly, the results of this work are not expected to find a statistically significant relationship between the study participants' knowledge and number of energy-saving behaviors they engage in.

VI. Values, Beliefs, Awareness of Consequences (AC), Aspiration of Responsibility (AR), and Personal Norms

Other important psychological variables that received considerable attention in the literature – especially in studies that employed the VBN theory – include values, beliefs, awareness of consequences, perceived/aspiration of responsibility , and personal norms.

Schwartz defines personal values as "*the criteria that people use to select and justify actions and to evaluate people (including the self) and events*" (Schwartz, 1992, p. 1). Other researchers point out that such values reflect a relatively enduring set of ideas, standards and beliefs that serve as the guiding

principles in peoples' lives (Abrahamse & Steg, 2011; Frederiks et al., 2015). As mentioned earlier in section 2.3. of this work, (Abrahamse & Steg, 2011; Fornara et al., 2016) who cite Schwartz (1992,1994) indicate that personal values can be categorized and viewed in two dimensions: self-transcendence (concern for others) vs. self-enhancement (concern for self), and openness to change (variation) vs. conservation (tradition). while the self-transcendence values appear to be connected to altruistic and biospheric values as well as a variety of pro-environmental intentions and/ or behaviors, the self-enhancement values appear to be connected to egoistic view and in a negative way to environmentally-related behaviors. As per Schultz and Zelezny (2003), people valuing self-transcendence life goals typically express greater care about environmental issues and tend to engage in more pro-environmental behaviors. In contrast, people who value self-enhancing life goals typically tend to express more egoistic concern about environmental issues and display less engagement in pro-environmental behaviors.

According to Fornara et al. (2016) and Frederiks et al. (2015), and in line with the VBN framework, individuals usually engage in pro-environmental behavior when they feel that their actions have negative consequences on the environment: Aspiration of Consequences (AC) which is assumed to be supported by general pro-environmental beliefs – (e.g., due to their excessive energy consumption). It is presumed that, this will make them accept the blame (self-blame) and feel personally responsible: perceived/ Aspiration of Responsibility (AR). The authors continue to explain that such feelings make those individuals feel a stronger obligation to mitigate or reduce the environmental damage, thus, activating personal norms (moral obligation to act), and increasing the willingness to behave in a pro-environmental way. As noted by Frederiks et al. (2015), feelings of self-satisfaction and pride may arise when a person behaves in a way that is consistent with their personal norms, whereas negative feelings of guilt and regret may be the result of acting or behaving in a way that is inconsistent with personal norms.

In a meta-analysis of six studies by Hines et al. (1987) to determine the relationship between personal responsibility and behavior, the authors conclude that people who feel some degree of personal responsibility toward the environment are more likely to engage in responsible environmental behavior than those who do not feel personally responsible. However, *"the strength of the relationship between perceived responsibility and the specific pro-environmental behavior of energy conservation may not always be consistent or reliable"* (Frederiks et al., 2015, p. 590).

Referring to the VBN theory and pointing out that general values are related to a person's environmental concern, Abrahamse and Steg provide a brief and good explanation of the role of those variables by saying that "*environmental concern is related to the extent to which individuals believe their own behavior has negative environmental consequences (i.e. awareness of consequences). People with a stronger concern for the environment will be more aware of the environmental impact of their actions. Next, the more people are aware of these consequences, the more likely it is that they will assume responsibility for environmental problems (i.e. ascription of responsibility). In turn, feelings of responsibility will lead to the activation of personal norms (moral obligation to act). Feelings of moral obligation are assumed to be positively related to willingness to act pro-environmentally and actual pro-environmental behaviors"* (Abrahamse & Steg, 2011, p. 32).

Overall, the literature suggests that values and beliefs toward a particular behavior do not reliably and always translate into that behavior. That is, mixed findings were identified in the literature with regards to having values and beliefs towards a particular behavior and the engagement in that behavior.

With respect to variables like the awareness of consequences, awareness of responsibility, and personal norms, the majority of the reviewed literature show that a positive association tends to be the case between such variables and the engagement in pro-environmental behaviors like the energy-saving behaviors.

VII. Cost-Benefit Appraisal

Additionally, people are often motivated by self-interest and usually try to consider alternatives that result in the highest benefits for the lowest cost; the perceived cost benefit ratio can be viewed as another important factor that may influence households' energy related decisions and behaviors. Frederiks and colleagues note that "*benefits and costs may include scarce or valued resources such as time, effort, money, social status/acceptance, convenience, comfort, and so forth*" Frederiks et al., 2015, p.591). The writers also add that pro-environmental behaviors such as household energy consumption and savings may be influenced by both economic and behavioral cost-benefit tradeoffs.

From a financial or economic point of view, including monetary expenses or potential savings, the likelihood that households will invest in one-off energy efficiency measures (e.g., insulation, energy-efficient appliances) may decrease if high financial costs are involved, especially when there is a very long return on investment period (Frederiks et al., 2015). Moreover, energy cost/price can influence households' decision on whether to adopt energy saving measures or not. It may even influence their choice of energy saving measure to be considered (Black et al., 1985). A study conducted by Nair et al. (2010) indicates that, those who perceive a high energy cost may consider the adoption of investment measures, especially if they believe that non-investment measures would not be sufficient to reduce the energy cost. However, uncertainty about the size of future cost savings or environmental benefits may affect the decision-making process (Ek & Söderholm, 2010). Moreover, past or previous experience in energy efficient measures might also affect households' confidence in adopting energy efficiency measures in the future (Costanzo et al., 1986).

Given the reviewed literature, it can be expected that the more financial savings the study participants expect themselves to make, the more likely they are to participate in energy saving behaviors.

2.6. Interventions and Strategies for Promoting Household Energy-Saving Behaviors

Michie and colleagues defined interventions as "as coordinated sets of activities designed to change specified behaviour patterns" (Michie, van Stralen, & West, 2011, p. 2). According to Abrahamse et al. (2005), within the realm of social and environmental psychology, interventions mainly focus on voluntary behavior change, rather than changing contextual factors, which can also influence households' behavioral decisions.

To a large extent, employing behavioral interventions aiming to encourage households to reduce their energy consumption are generally effective. However, various degrees of success are observed in the reviewed literature. Factors like the type and acceptability of employed intervention(s), the duration of the intervention, the targeted behavior as well as the causes of that behavior can influence the effectiveness and degree of success of those strategies.

As identified in the literature, there are two main types of strategies or interventions that can be employed to promote household energy efficiency and conservation behaviors: structural and psychological strategies/interventions (Abrahamse et al., 2005; Steg, 2008; Steg & Vlek, 2009).

2.6.1. Structural Interventions

Structural interventions aim to change the context in which behavioral decisions are made in order to make energy savings more attractive. That is by altering the conditions in which a behavior takes place (e.g. changes in infrastructure, pricing policies, better products and services, and legal measures) behavioral changes will occur, and consequently energy savings will be achieved (Steg, 2008). Steg (2008) point out that structural interventions can be categorized into three groups which include the following:

a) financial-economic measures (e.g., taxes). The point is to promote energy savings by means of financial-economic measures. The strategy aims to make excessive energy consumption and energy inefficient products and appliances more expensive compared to those using less energy.
b) physical or technical alternatives (e.g., technical innovations and changes to already existing infrastructure and equipment), and
c) legal regulations (e.g., the introduction of legislation by the government). For this strategy to be effective; there is a need for a properly working monitoring and enforcement systems.

According to Steg (2008), this type of strategies i.e. structural interventions, received less attention than the psychological strategies, and most of the studies that addressed structural strategies examine intentions to change behavior, not actual behavioral changes.

2.6.2. Psychological Interventions

The second type of interventions is the psychological interventions or strategies that aim to change already existing peoples' perception, knowledge, motivation, attitude, cognition and norms that are linked to energy use and saving behaviors (those are referred to as individual level variables) (Abrahamse et al., 2005; Steg, 2008). The assumption here is that changes to these variables will lead to behavioral changes, and consequently energy savings.

The reviewed literature revealed that researchers have a general agreement that psychological interventions are grouped into two categories: antecedent interventions and consequence interventions (Abrahamse et al., 2005; Steg, 2008). It should be noted here that, both antecedent and consequence interventions can be employed together to improve the effectiveness of the interventions i.e. these interventions can be paired or coupled together.

2.6.2.1. Antecedent Interventions

Such interventions focus on changing one or several behavioral determinants before a behavior takes place. Examples of antecedent interventions include commitment, goal setting, information, and modeling.

a) Commitment is a promise or a pledge that can be made verbally or in writing to change behavior, such as committing to reduce energy consumption. Commitment is usually linked to a specific target or goal, like reducing energy use by 10% (Abrahamse et al., 2005).

By a pledge to oneself, personal norms (moral obligation to conserve energy for example) can be activated. Moreover, a commitment that is made in public can activate social norms (expectations of others) (Abrahamse et al., 2005). In view of the above, it can be argued that commitment influence behavior through intrinsic rewards and social norms. However, a study by Katzev and Johnson (1984) shows that the effectiveness of commitment on energy conservation does not last long.

b) Goal setting involves assigning a specific goal to be achieved. For example, the goal can be viewed as a reference point to save 5% or 10% energy. The goal can either be self-set or assigned by others (Abrahamse et al., 2005).

To enhance the effectiveness of goal setting, it is usually combined with other interventions such as feedback. A study by Becker (1978) for example shows that significant households electricity reductions (15.1%) are achievable when the set goal “relatively difficult” (20%) is combined with feedback three times a week. However, the writer points out also that setting a relatively easy goal (e.g., 2%) appeared not to be effective at all, as it may have been perceived as not being worth the effort.

c) The third antecedent strategy that is commonly used to promote behaviors aiming to reduce energy consumption is information. The usually provided information can either be general

(about energy related problems) or specific information involving possible solutions such as energy saving measures that households can adopt (Abrahamse et al., 2005).

It is generally agreed that providing households with such information will result in improved knowledge and awareness about different energy problems and ways to reduce energy consumption. According to Nilsson et al. (2014), although providing information alone seems to result in improving the levels of households' knowledge and awareness, but it does not necessarily lead to actual changes in behavior or reduced energy consumption. However, the writers highlight that combining information with other interventions such as goal setting, and commitment has been found to produce environmentally responsible behavior.

Stern (1992) indicates that for this intervention/strategy to make a difference and be more effective, what matters is not only the amount of available information, but other things like the careful framing of energy information, the trust of the source of information, the psychological techniques used to attract the attention of the intended audience, and the way this information is delivered – all can influence and/or contribute to the level of success and effectiveness of this intervention.

The delivery of information to households about saving energy can be done in several ways. Abrahamse et al. (2005) present three ways that can be used to convey information to households: workshops, mass media campaign, and tailoring i.e. tailored information through home energy audits, and modeling.

I. Workshops: a study to measure the effectiveness of workshops was conducted by Geller (1981) shows that although information delivered through a workshop led to a higher individual concern and knowledge about the energy crisis, improved optimism that individuals can contribute to substantial reductions in energy consumption, as well as stronger intention to

adopt energy-saving measures, but no real difference was observed between attendees and non-attendees with regards to the number of actually adopted energy saving measures.

II. Mass media campaigns: the effect of mass media campaigns seem to be relatively similar to workshops. Mass media campaigns appear to contribute to improved knowledge and willingness to engage in pro-environmental behaviors. However, Staats, Wit, & Midden (1996) reported no significant increase in the actual adoption of energy saving measures when mass media campaigns were carried out .

III. Tailoring: tailored information is specific and highly personalized information. This is considered an advantage because only relevant information is delivered to participants, that is they do not receive an overload of information that does not usually apply to their household situation (Abrahamse et al., 2005). This is somehow consistent with Stern's point that "*information is more likely to change behavior when it is specific, vivid, and personalized*" (Stern, 1992, p. 1227).

An example of tailored information is home energy audits that involve a home visit by an auditor who recommends or suggests a range of energy saving options (e.g., efficiency and conservation behaviors) considering the current situation of the audited home.

Abrahamse et al. (2005) cite serval studies that investigated the effectiveness of home energy audits. In general, the studies show that the utilization of tailored energy advice leads to positive effects on household energy use (Winett, Love, & Kidd, 1982), as well as on the extent to which energy efficiency actions are taken (Gonzales, Aronson, & Costanzo, 1988). However, a study conducted by McDougall, Claxton, & Ritchie (1982) did not find any reductions in energy use as a result of tailoring.

d) Modeling: according to Abrahamse et al. (2005) modeling entails providing examples of recommended behavior, and these examples are expected to be followed by people when they are relevant, meaningful, understandable, and rewarding (in terms of positive results). Steg and

Vlek (2009) see that modeling can help strengthen social norms as providing people with information about the behavior of others (role models) appears to be successful in supporting pro-environmental behavior. The writers add that information on descriptive norms can also be provided in writing or via role models.

2.6.2.2. Consequence Interventions

Such interventions focus on changing one or several behavioral determinants after a behavior takes place. It is assumed that when positive or negative consequences are attached to a certain behavior, this will subsequently lead to an alteration of that behavior (Abrahamse et al., 2005). Examples of consequence interventions include feedback and rewards.

a) Feedback: like other strategies, feedback aims to promote energy saving behaviors. It involves providing consumers with information about the consequences of their past behavior – individuals are expected to learn about, and from their behavior when provided with such information. With regards to energy consumption, feedback information can be provided, for example, in terms of kWh and/or in terms of cost (monetary and/ or environmental) or compared to other energy users.

Considering their frequency, Abrahamse et al. (2005) and Nilsson et al. (2014) provide a distinction between several types of feedbacks. These include continuous feedback, daily, weekly and monthly feedback, and comparative feedback. Given the reviewed literature, it can be argued that the more frequent the feedback is provided, the more effective it is. Several studies (e.g., Hayes & Cone, 1981; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007) show that feedback is an effective strategy for reducing household energy consumption, however, exceptions exist (Abrahamse et al., 2005)..

A study conducted in North Carolina by Schultz et al. (2007) shows that 12% less electricity is consumed when continuous feedback is provided to households using devices that continuously displaying the

electricity consumed for heating, cooling, and other uses in twenty-five homes over a period of eleven months. In another study by Sexton, Johnson, & Konakayama (1987) where continuous feedback about the difference between monetary costs of electricity used in on- and off-peak periods (off-peak electricity prices are cheaper) is provided, the results indicate a significate shift in electricity use from on-peak to off-peak periods. However, no decrease in the total electricity consumption is observed.

(Hayes & Cone, 1981) who examined the effect of monthly feedback, which was received by households (in terms of kWh and money) over a four months intervention period. The study shows that consumers who received the monthly feedback consumed 4.7% less electricity, while the control group consumers increased their electricity consumption by 2.3%. According to the writers, the withdrawal of the feedback resulted in a return to higher levels of electricity consumption.

Additionally, individual performance feedback relative to performance of others can also help reduce household energy consumption. According to Abrahamse et al. (2005), providing comparative feedback can be very effective as it can trigger a feeling of competition, social comparison, or social pressure. The writers also point out that comparative feedback was part of the so-called Eco Team Program (ETP), which appears to be promising intervention. The Eco Teams represent small group of people like friends, neighbors, or family members who meet regularly (e.g. once a month) to exchange information about various energy saving measures and receive feedback about their own energy savings, as well as the savings of other Eco Teams (Abrahamse et al., 2005). A study conducted by Midden, Meter, & Weeing (1983) to test the effectiveness of various interventions indicates that the effectiveness of the comparative feedback is not better than that of individual feedback.

b) Rewards: there is a general consensus in the literature that rewards appear to have a positive impact in motivating households to reduce energy consumption. While recognizing households for their energy-related behaviors is considered as intrinsic, providing people with monetary or

financial rewards may serve as an extrinsic motivator to reduce energy consumption. Abrahamse et al. (2005) note that monetary rewards can either be contingent on the amount of energy saved, or a fixed amount (e.g. when a certain percentage is attained).

In one study by Schultz et al. (2007) where households are provided with recognition in the form of 'happy faces' ☺ (for those with energy consumption below average for the neighborhood) and 'sad faces' ☹ (for those with energy consumption above average for the neighborhood), the findings show that households that received these emoticons save more energy than those only received descriptive information about their energy consumption.

In summary, the literature review identified several socio-demographic, situational, and psychological variables that my influence households' energy consumption and saving behaviors. The identified variables are regarded by numerous researchers as being important determinants in explaining variability in households' energy-related behaviors. The reviewed literature shows that such variables may directly, indirectly, or in interaction influence how householders consume and save energy. Therefore, it is reasonable to say that, the level of impact and the relationship that each variable may have on such behaviors is far from consistent.

Given that literature revealed several models that have been applied by many researches to explain variations in pro-environmental behaviors, this thesis suggests and uses an integrative conceptual framework to study the relationship between a subset of psychological, situational, socio-demographic determinant and households' energy-saving behaviors.

The findings and conclusions of this thesis are expected to be very useful for energy practitioners, utility providers, and policymakers as they should provide quality information about the unique household profiles. So, better opportunities can be identified, and more effective interventions can be designed,

developed, and implemented to achieve the desired reductions in household energy consumption, and to encourage sustainable behavior pattern. Moreover, this work is expected to be useful for academic researchers as it should add to the growing body of literature exploring determinants influencing household energy consumption and saving behaviors.

Chapter 3: Methodology

3.1. Research Strategy

According to Naoum (2007), the research strategy is the way in which the research objectives can be achieved. There are two main types of research strategies, namely, qualitative research and quantitative research. Despite the differences between the two-research strategy, there is also much that units them (Bryman, Bell, & Teevan, 2012). The decision on which type of research strategy to follow depends on factors like the type and availability of data, as well as the purpose of the study itself. It should also be noted that numerous studies exist where a combination of qualitative and quantitative research is used.

In addition to Bryman (2012) who pointed out that the quantitative approach is the most common approach of social research, Fellow and Lin (2008) indicated that the quantitative approach provides snapshots and therefore are used to address questions such as what, how much, and how many?

Quantitative research is 'objective' in nature. Researchers who carry out this type of research start by coming up with a model that aims to explain a particular phenomenon like a social or human problem, and then deduce specific hypotheses, that are tested with empirical data (Bryman, 2012). Therefore, quantitative research involves the collection of numerical data that are analyzed with statistical procedures to determine whether the hypotheses or model, that is composed of variables, hold true (Naoum, 2007).

Quantitative research requires providing an explanation of how variables affect each other. Variables that are studied by researchers are regarded as attributes (e.g., attitude) or characteristics of individuals (e.g., gender). So, explaining the relationships among variables help in providing better understanding and determination of whether one or more variables might influence another variable (Creswell, 2012).

Given the above, the strategy of this research is based on the quantitative research method, hence, a deductive reasoning rather than inductive reasoning is pursued. A survey was undertaken using phone interviews and participants were asked to respond to a number of questions.

As described by McLafferty, the goal of doing survey work "is to acquire information about the characteristics, behaviours and attitudes of a population by administering a standardized questionnaire, or survey, to a sample of individuals" (McLafferty, 2003, p.87).

Bryman (2012) identified several advantages that are associated with conducting a survey through telephone interviews. These include, telephone interviews are cheaper and quicker to administer than other types of interviews especially when the sample is geographically dispersed, telephone interviews can reduce bias arising from the characteristics of the interviewers or interviewees. On the other hand, telephone interviews suffer from limitations like: people who do not have a telephone or cannot be contacted by phone cannot be part of the study, interviewers cannot respond to signs of puzzlement or unease on the face of the interviewees as they cannot see them, people with hearing impartments are likely to find telephone interviews difficult to conduct (Bryman, 2012).

3.2. Survey Design and Data Collection

According to Babbie "survey research is probably the best method available to the social scientist interested in collecting original data for describing a population too large to observe directly... Surveys are also excellent vehicles for measuring attitudes and orientations in a large population." (Babbie, 1999, p.234).

The data used in this study were collected via a survey which was originally developed and executed by PMG Intelligence, a Waterloo, Ontario based market research and data intelligence company. The company conducted a study on residential energy conservation to provide a benchmark of Canadians' perceptions and behaviors as it relates to energy and to establish a profile of residential energy users'

perceptions in terms of the importance of energy, energy issues, and energy conservation across Canada, as well as within the Region of Waterloo. The data were collected in Spring/Summer 2017 using PMG's national household panel with additional participants recruited in Waterloo Region to create a regional cohort. While the national sample contained a total of 813 Canadians who participated in the study, the Region of Waterloo sample contained a total of 401 participants from the ROW residents. At the end of section 3.3. of this chapter, table (x) provides a comparison between the national sample and the Region of Waterloo sample with regards to some of the socio-demographic, and situational characteristics.

The objectives of that study included:

- *Establishing a detailed profile of the general attitudes and behaviors of Canadians with respect to identification of key energy issues by source and levels of participation in energy conservation programs.*
- *Examining the perceptions of residential energy users as it relates to awareness and understanding of residential energy conservation programs and their effectiveness.*
- *Understanding residential energy user perceptions of the perceived role/responsibility of governments, energy industry stakeholders, and residents in energy conservation programs.*
- *Developing insights in terms of effectively engaging residential energy users in energy conservation programs including an understanding of preferred methods to receive information about or be engaged in these topics.*

It should be noted that, questions included in the original survey were reviewed by a number of Waterloo Region energy stakeholders including faculty members at the University of Waterloo, who played an important role selecting and improving the quality of the survey questions.

The types of questions contained in the original survey include open-ended as well as closed and multiple-choice questions. In some of the questions, the interviewers read statements to participants who were asked to indicate their reaction to those statements using a scale of 1 to 10. The do not know/unsure option was included in some of those questions. For example, in one of the attitudinal questions, the participants were asked the question: “using a scale of 1 to 10, where 1 is not at all a priority and 10 is an essential priority, please rate how much of a priority energy conservation and energy efficiency are to you personally?”. It should be noted that, for the purpose of this thesis, responses to questions that were on a 10-point scale were recoded into a five-point Likert scale. More specifically, responses that were originally coded as 1 or 2 became 1 in this work; similarly, 3 or 4 became 2; 5 or 6 became 3 and so on. As an example, the responses to the above- question were combined and converted into a five-point Likert scale with the following categories: “Essential Propriety (5)”, High priority (4)”, “Priority (3)”, “Low priority (2)”, “Not a priority at all (1)”. The do not know/unsure option was also included.

Additionally, the majority of questions with fixed-responses; an option to respond with either “Don’t know/ not sure” or “Prefer not to respond” was also provided. Furthermore, where applicable, respondents had the opportunity to select an “other‟ option “to allow for the fullest range of responses” (McLafferty, 2003, p.90).

In addition to questions that targeted areas like the knowledge and perceptions of energy sources, perceptions of energy conservation programs and support, home energy improvements, and energy conservation information, the survey contained questions that collected information on socio-demographic and situational variables like the marital status, household size, age, education level, employment status, income, dwelling type, home ownership, and the year in which dwellings were built.

3.3. Study Location and Participants

A total of 401 residents from the Region of Waterloo (RoW) participated in the study conducted by PMG Intelligence.

At the beginning of the survey – which was undertaken using phone interviews – the interviewer introduced him/herself and made the interviewee aware that he/she was contacted to conduct a survey as part of an important study on residential users and energy conservation in Canada. Moreover, the interviewee was informed that he/she will not be contacted as a result of the survey. Interviewees were assured that all information collected, used and/or disclosed will be used for research purposes only and is administered as per the requirements of the Canadian Privacy Act.

Prior to starting the survey and as a main requirement to proceed with the questions, interviewers asked to speak with the primary adult owner or renter of the residence who is involved in making energy related decisions that impact the household.

The information collected from the 401 respondents showed that age ranged from 18 to 93 years, with an average age of 57.3 years. In addition, around 40% of the respondents were males and 60% females. While around 23% indicated that they rent their current dwelling; participants were predominantly home owners representing 75%, the remaining 2% had other living arrangements. In terms of employment, 53.3% of respondents were either full-time, part-time, or self-employed. Those who indicated that they are married, co-habituating or common law represented 68% of the all participants. Table (x) provides a comparison between the national sample and the Region of Waterloo sample with regards to some of the socio-demographic, and situational characteristics. More details about the socio-demographic, situational, and psychological characteristics of the study participants (Region of Waterloo sample) are available in Chapter 4 – results.

Table 1 - Characteristics of the Study Participants (RoW sample) Relative to the National Sample (A Comparison Between the Region of Waterloo Sample and the National Sample.

	Items	Region of Waterloo (RoW) Sample	National Sample
	No. of participants	401	813
Socio-Demographics	Average age	57	49
	% of employed (self-employed, part-time, and full time)	53%	63%
	% of population with secondary school certificate or higher	93%	97%
	% of married/ cohabitating/common-law	68%	61%
	Household size (4 or less)	89%	93%
Situational characteristics	% of owned dwellings	75%	63%
	% of homes built before 1990	57%	61%
	% of (townhouses, single and semi-detached homes, and duplex or triples)	73%	82%
Energy-saving behaviors	Average no. of reported energy conservation behaviors	10.5/17	9.3/17
	Average no. of reported energy efficiency behaviors	10.6/18	-----

Although there seem to be some variations, but it can be argued that to a large extent the characteristics of RoW sample are similar to those of the national sample. I.e., findings and conclusions from this study may also apply to other areas/regions in Canada. For example, some socio-demographic and situational characteristics were found very similar in both samples with only 4% difference. Such characteristics or variables include the percentage of population with secondary school certificate or higher, the percentage of households with four members of less, the percentage of homes that were built before 1990. However, the difference was found larger in other characteristics like the average age, the percentage of employed people, and the percentage of married people. This can be attributed to factors like missing data, the relatively higher percentage of retired people in the RoW sample 38% compared to that in the national sample 21%. Additionally, the percentage of owned dwellings was also found higher in the RoW sample 75% compared to that in the national sample 63%. This may make it

reasonable to find a larger average number of reported energy conservation behaviors in the RoW sample compared to that in the national sample.

3.4. Rationale for the Selection of Questions from the Original Survey

For this thesis, several questions were carefully selected from the original survey which was developed and executed by PMG intelligence as described earlier in this chapter. Given the reviewed literature, including numerus publications that focus on household energy consumption and saving behaviors, it is believed that the selected questions will serve the purpose of this thesis, meet its objectives, and help answer the research question. The chosen questions provide valuable information and measure several attributes and variables that are expected to play a role and be associated with the residential sector's energy conservation and efficiency behaviors.

The selected questions, for this study, are organized into three main groups. Each group contained a specific number of questions that are expected to measure the influence of various psychological, situational, and socio-demographic variables on households' energy conservation and efficiency behaviors. Please see appendix A, which contains the chosen questions for this study.

Further details about those groups and the independent variables that fall under each group, as well as the questions used to measure each variable are provided below:

I. Independent Variables

- Group no. 1: Socio-Demographic Variables.

This group contained those questions which directly invited participants to answer questions about socio-demographics. The socio-demographic variables included in this study are: age, gender, relationship status, employment status, level of education, having children at home, the number of

people who live in the house. One question was used to measure each of these variables. (See Appendix A for more detail).

- Group no. 2: Situational Variables.

In addition to the socio-demographic variables, several situational variables were included in this study. The selected situational variables – that are assumed to have an influence on the number of energy conservation and efficiency behaviors that the study participant engage in include: information, dwelling type, home ownership, year home built, and the city/ town (classified as rural or urban). One question was used to measure each of these variables, except the variable "information" where two questions were used to examine its association with the energy conservation and efficiency behaviors. (See Appendix A for more detail).

- Group no. 3: Psychological Variables.

A varying number of questions were used to measure each psychological variable included in this study. The selected psychological variables are: attitudinal variables (four questions were used to measure attitudinal variables), knowledge (two questions were used to measure participants' knowledge), subjective norms (one question was used), and cost-benefit appraisal (two questions were used to measure the influence of the variable "cost-benefit appraisal" on the number of energy conservation and efficiency behaviors that the study participants engaged in). (See Appendix A for more detail).

II. Dependent Variables

Two questions were selected to measure the two dependent variables used in this study:

A. The number of energy conservation behaviors that the study participants regularly undertake in their homes, and

B. The number of energy efficiency improvements/behaviors that the study participants have already made to their homes.

The responses to those questions were first combined into six categories i.e., converted form the level of measurement (scale) into (ordinal) as follows: less than 4 behaviors, from 4 to 6 behaviors, from 7 to 9 behaviors, from 10 to 12 behaviors, from 13 to 15 behaviors, and more than 15 behaviors. As mentioned above, combining the responses into categories means that the dependent variables can be described and treated as ordinal variables. One reason for doing so is that ordinal variables are needed to perform the statistical tests/measures selected for this work e.g., Chi-Square test of independence. However, when some of the Chi-Square test were performed, a high number of cells with expected count less than 5 resulted. This means that one of the assumptions of the Chi-Square test of independence is violated, as the number of cells with expected count less than 5 should not exceed 20% of the total cells if the Pearson Chi-Square value will be interpreted. Given the above, one way to reduce the total number of cells with expected count less than 5 is by merging/combining categories. Therefore, the responses to the dependent variables, which were first grouped into 6 categories, were recoded into 4 categories. While, table (x) shows the frequency of the number of respondents in each the 6 categories, table (X) shows the number of respondents in each the 4 categories.

Table 2 - The Number of Energy Conservation and Efficiency Behaviors (6 Categories)

Energy conservation behaviors (6 categories)	**No. of respondents**		**Energy efficiency behaviors (6 categories)**	**No. of respondents**
Less than 4 behaviors	7		Less than 4 behaviors	80
From 4 to 6 behaviors	28		From 4 to 6 behaviors	64
From 7 to 9 behaviors	107		From 7 to 9 behaviors	103
From 10 to 12 behaviors	149		From 10 to 12 behaviors	104
From 13 to 15 behaviors	103		From 13 to 15 behaviors	47
More than 12 behaviors	7		More than 12 behaviors	3
Total	**401**		**Total**	**401**

Table 3 - The Number of Energy Conservation and Efficiency Behaviors (4 Categories)

Energy conservation behaviors (4 categories)	No. of respondents		Energy efficiency behaviors (4 categories)	No. of respondents
Less than 7 behaviors	35		Less than 7 behaviors	144
From 7 to 9 behaviors	107		From 7 to 9 behaviors	103
From 10 to 12 behaviors	149		From 10 to 12 behaviors	104
More than 12 behaviors	110		More than 12 behaviors	50
Total	**401**		**Total**	**401**

3.5. Data Analysis

After receiving the entire raw dataset of the original survey responses on a Microsoft Excel spread sheet, the responses to the selected questions of this work were analyzed using Statistical Package for Social Sciences (SPSS) software.

To understand whether there is an association between the independent variables and the two dependent variables, and in order to examine the strength of any identified relationship and/or the direction of that relationship, the following statistical tests were performed:

A nonparametric statistical measure (Kendall's tau-b correlation coefficient) was performed to see whether there was a relationship between independent variables that are described as being ordinal variables and the two dependent variables (the number of energy conservation and efficiency behaviors) that are described as being ordinal variables as well. According to Bryman (2012), the Kendall's tau-b correlation coefficient is designed for pairs of ordinal variables (see figure 6). The possible outcomes of the computed Kendall's tau-b can be positive or negative and varies from -1 (indicating a perfect negative relationship) to +1 (indicating a perfect positive relationship). The coefficient value of 0 indicates that there is no relationship (Bryman, 2012). So, the closer a positive coefficient is to +1, the stronger the relationship, and the closer a negative coefficient is to -1, the stronger the relationship. In both cases: the closer the coefficient is to zero, the weaker the relationship.

The other statistical test used in this study is the Chi-square test of independence. This test helped find out whether there is a significant relationship between independent variables that are described as being nominal variables and the two dependent variables (the number of energy conservation and efficiency behaviors) that are described as being ordinal variables. According to Bryman (2012), the Chi-square test of independence can be used to identify if there is a relationship between nominal and ordinal variables (see figure 6). It should be noted that, in this study, the Chi-square values as well as the Likelihood ratio values (where necessary) are interpreted in relation to an associated level of statistical significance $p \leq 0.05$. Moreover, where a statistically significant relationship was identified, Cramer's V was performed as a symmetric measure to examine the strength of the identified relationship. The coefficient of the Cramer's V is always positive, and it ranges from 0 to 1 (Bryman, 2012). Although there are no specific rules regarding what constitutes a weak versus a strong relationship, anything below 0.3 can be described as being a weak relationship, anything between 0.3 and 0.5 can be referred to as being a moderate relationship, and anything above 0.5 can be regarded as being a strong relationship (Colwell and Carter, 2012).

After carrying out the Chi-square test of independence, and where significant relationships were identified, ordinal regression was performed to understand the direction of the identified relationships.

In addition to the aforementioned statistical tests (Kendall's tau-b, Chi-Square, Cramer's V, and Ordinal regression), which were performed to **(A)** examine whether there is a relationship between each independent variable (IV) and the two dependent variables (DV) **(B)** examine the level of influence that each independent variable (i.e., separately) has on each dependent variable, two multiple regression models were run for each IV will be performed. The first multiple regression model was run to test the effects of the IVs on the number of energy conservation behaviors. The second model was run to test the effects of our IVs the number of reported energy efficiency behaviors. To perform these regressions, it was necessary to treat the dependent variables as scale/ interval variables i.e., the reported responses

to the dependent variable-questions were used before combining them into four groups/categories as explained earlier.

Conduction the two multiple regression models help determine how much of a variation in each dependent variable can be explained by all IV (i.e., together). These models also provide a test to find out which, if any, of the independent variables are significant predictors after controlling for the others. The multiple regression models will show how independent variables influence each other, and consequently the overall percentage of variation in the dependent variables. That is, not all those identified significant relationships (between the dependent variables and each independent variable i.e., separately) from the performed Kendall's tau_b correlation coefficient and the Chi-square tests, remained significant in the two overall multiple regression models. In other words, some of those identified significant relationships from the performed Kendall's tau_b correlation coefficient and the Chi-square tests became insignificant in the overall multiple regression models. Those models will be presented in section 4.6. of this work.

Figure 6 - Methods of bivariate analysis - (Bryman, 2012).

	Nominal	Ordinal	Interval/ratio
Nominal	Contingency table + chi-square (χ^2) + Cramér's *V*	Contingency table + chi-square (χ^2) + Cramér's *V*	Contingency table + chi-square (χ^2) + Cramér's *V*. If the interval/ratio variable can be identified as the dependent variable, compare means with eta.
Ordinal	Contingency table + chi-square (χ^2) + Cramér's *V*	Kendall's tau-b	Kendall's tau-b
Interval/ratio	Contingency table + chi-square (χ^2) + Cramér's *V*. If the interval/ratio variable can be identified as the dependent variable, compare means with eta.	Kendall's tau-b	Pearson's *r*

3.6. Limitations of the Study

Before presenting the results of the survey, some limitations of the study should be mentioned here. Firstly, since the original survey – that is partially used in this work – was not designed and developed based on a specific academic theoretical framework. This limited the researcher ability to address variables that are considered very important by some of the most influential and widely used frameworks like the TPB and the VBN theories. Such theories are usually used to explain a range of environmentally-friendly behaviors. Moreover, many other socio-demographic and situational variables were not examined in this study since they were not covered in the original survey.

Secondly, the behavior of the study participants was measured based on self-reported responses rather than on their actual behavior. This can be seen as a limitation or a concern when it comes to the validity and reliability of the obtained results.

Chapter 4: Results

4.1. Introduction and Chapter Outline

The purpose of this chapter is to present the results of the selected questions from the original survey conducted by PMG intelligence. This chapter will also include tables showing the results of the tests which were performed to examine whether there is a relationship between each of the independent and dependent variables.

Following this introductory section, section 4.2. presents the descriptive statistics including frequencies of the self-reported responses for each of the independent and dependent variables. This section is made up of five parts. Its starts with responses to questions inquiring about several socio-demographic variables, followed by the second part which contains responses to questions that serve as contextual and structural variables. Then the reported responses to psychological variables (e.g., attitude towards the environment, knowledge, subjective norms, etc.) are presented. The fourth part of this section shows the frequencies of the received responses to the study dependent variables. Part five shows how some of the demographic and household characteristics of the study participants compare with similar data for the Region of Waterloo.

. Then socio-demographics of the study participants are presented in the third part.

In section 4.3. the results of the examined relationships between the two dependent variables and the three groups of independent variables are presented. Thus, this section contains two sub-sections, and each of these sub-sections has three parts as summarized in table (4):

Table 4 – Content and Structure of Section 4.3. - Relationships

Sub-Sections →	**4.3.1. Energy conservation behavior**	**4.3.2. Energy efficiency behaviors**
Part 1 →	4.3.1.1. Relationship between conservation behaviors and socio-demographic variables	4.3.2.1. Relationship between efficiency behaviors and socio-demographic variables
Part 2 →	4.3.1.2. Relationship between conservation behaviors and situational variables	4.3.2.2. Relationship between efficiency behaviors and situational variables
Part 3 →	4.3.1.3. Relationship between conservation behaviors psychological variables	4.3.2.3. Relationship between efficiency behaviors and Psychological variables

Section 4.4. of this chapter shows the results of the performed ordinal regression. This section is made up of two sub-sections as well, and each of these sub-sections contains three parts as summarized in table (5):

Table 5 - Content and Structure of Section 4.4. - Ordinal Regression

Sub-Sections →	**4.4.1. Energy conservation behavior**	**4.4.2. Energy efficiency behaviors**
Part 1 →	4.4.1.1. Ordinal regression socio-demographic variables	4.4.2.1. Ordinal regression socio-demographic
Part 2 →	4.4.1.2. Ordinal regression situational variables	4.4.2.2. Ordinal regression situational variables
Part 3 →	4.4.1.3. Ordinal regression psychological variables	----------

A summary of the obtained results from the performed statistical tests/measures in this work (Kendall's tau_b correlation coefficient, Chi-Square test of independence, Cramer's V, and Ordinal regression) is presented in four tables included in section 4.5. Additionally, the results of the performed multiple regression models, which were run to test the effects of the IVs on the number of energy conservation and efficiency behaviors, as well as the effect of the IVs on each other, and how they predict/explain variations in the dependent variables, are presented in section 4.6.

4.2. Descriptive Statistics

4.2.1. Socio-Demographic Variables

In the survey, study participants were asked to provide responses to questions about their household and demographic profile. Also, the survey contained questions about situational (contextual and structural) characteristics that are expected to influence household energy related behaviors. Figures and tables showing frequencies and key findings as reported by the study participants are presented in this section.

I. Age

In what year were you born?

Figure 7 - Frequencies of the Independent Socio-Demographic Variable (Age of Participants)

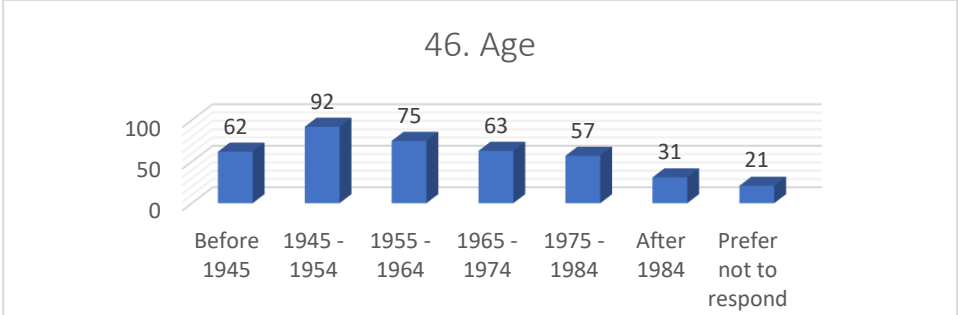


Table 6- Frequencies of the Independent Socio-Demographic Variable (Age of Participants)

46. Age

		Frequency	Percent	Valid Percent	Cumulative
Valid	Before 1945	62	15.5	16.3	16.3
	1945 - 1954	92	22.9	24.2	40.5
	1955 - 1964	75	18.7	19.7	60.3
	1965 - 1974	63	15.7	16.6	76.8
	1975 - 1984	57	14.2	15.0	91.8
	After 1984	31	7.7	8.2	100.0
	Total	380	94.8	100.0	
Missing	99	21	5.2		
Total		401	100.0		

One of the survey questions asked the study participants to indicate the year they were born in. The reported responses to this question were categorized as presented in figure (7) and table (6). According to the received responses, the study participants ranged in age from 18 years old to 93 years old. Out of the total 401 participants, 21 participants (round 5%) preferred not to respond to this question.

II. Income

Which of the following categories represents your total annual household income before taxes?

Figure 8 - Frequencies of the Independent Socio-Demographic Variable (Income)

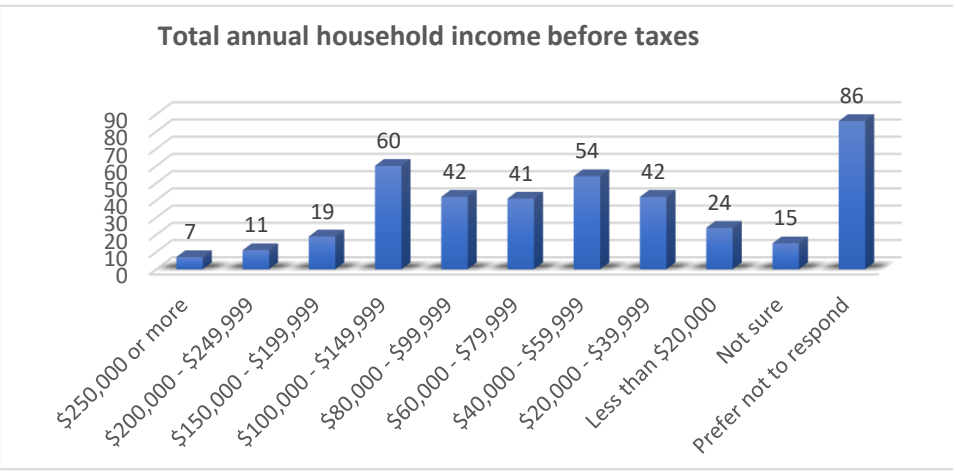


Table 7 - Frequencies of the Independent Socio-Demographic Variable (Income).

59. Income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than $20,000	24	6.0	8.0	8.0
	$20,000 - $39,999	42	10.5	14.0	22.0
	$40,000 - $59,999	54	13.5	18.0	40.0
	$60,000 - $79,999	41	10.2	13.7	53.7
	$80,000 - $99,999	42	10.5	14.0	67.7
	$100,000 - $149,999	60	15.0	20.0	87.7
	$150,000 - $199,999	19	4.7	6.3	94.0
	$200,000 - $249,999	11	2.7	3.7	97.7
	$250,000 or more	7	1.7	2.3	100.0
	Total	300	74.8	100.0	
Missing	99	101	25.2		
Total		401	100.0		

Figure (8) and table (7) summarize the responses to the question inquiring about total annual household income before taxes. Out of the total 401 participants 86 participants preferred not to respond to this question and 15 participants indicated that they were not sure.

III. Level of Education

What is the highest level of education you have completed?

Figure 9 - Frequencies of the Independent Socio-Demographic Variable (Level of Education)

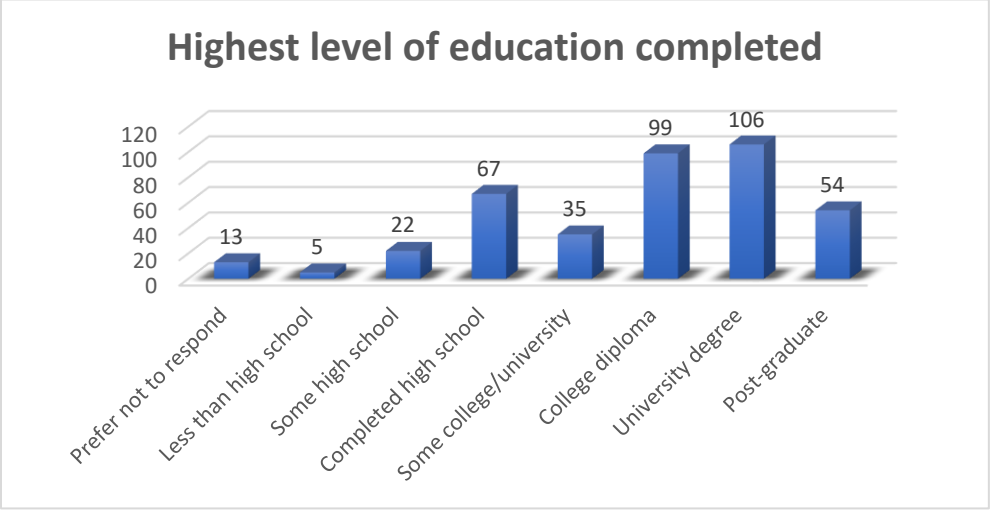


Table 8 - Frequencies of the Independent Socio-Demographic Variable (Level of Education)

47. Level of Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	5	1.2	1.3	1.3
	Some high school	22	5.5	5.7	7.0
	Completed high school	67	16.7	17.3	24.2
	Some college/university	35	8.7	9.0	33.2
	College diploma	99	24.7	25.5	58.8
	University degree	106	26.4	27.3	86.1
	Post-graduate	54	13.5	13.9	100.0
	Total	388	96.8	100.0	
Missing	99	13	3.2		
Total		401	100.0		

Generally speaking, the participants in this study held high levels of education. Around 66.7% of the 388 respondents completed at least college diploma and 9% have some collage/ university education. Figure (9) and table (8) summarize the various degrees and levels of education held by the study participants.

IV. Number of People in the Home

How many people, including yourself, currently live in your household?

Figure 10 - Frequencies of the Independent Socio-Demographic Variable (No. of people in the home)

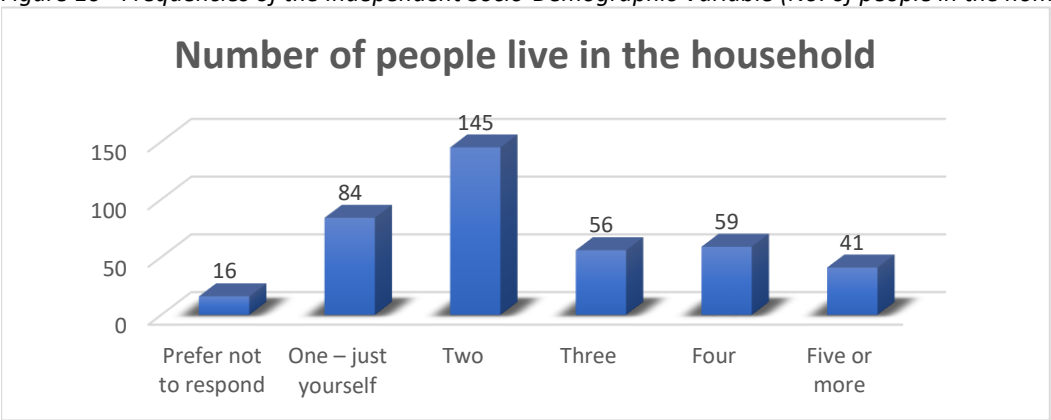


Table 9 - Frequencies of the Independent Socio-Demographic Variable (No. of people in the home)

50. No of people

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	One – just	84	20.9	21.8	21.8
	Two	145	36.2	37.7	59.5
	Three	56	14.0	14.5	74.0
	Four	59	14.7	15.3	89.4
	Five or more	41	10.2	10.6	100.0
	Total	385	96.0	100.0	
Missing	99	16	4.0		
Total		401	100.0		

With regards to the number of people live in the household, 84 (21.8%) of the total 385 respondents indicated that there is only one person lives in the household. 145 (37.7%) participants reported that there are two people live in the household. A summary of the self-reported responses is presented in figure (10) and table (9).

V. Having Children at Home

Do you have any children at home?

Figure 11 - Frequencies of the Independent Socio-Demographic Variable (Having Children at Home)

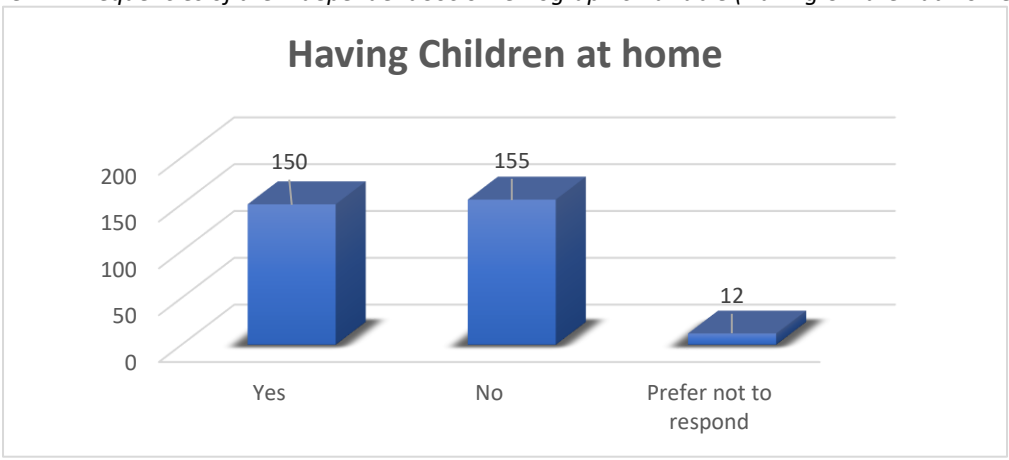


Table 10 - Frequencies of the Independent Socio-Demographic Variable (Having Children at Home)

51. Children at home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	155	38.7	50.8	50.8
	Yes	150	37.4	49.2	100.0
	Total	305	76.1	100.0	
Missing	99	96	23.9		
Total		401	100.0		

The study participants where asked whether they have children at home or not. Out of the 401 participants in this study, 96 preferred not to respond to this question. However, 155 respondents reported that they do not have children at home, and 150 said “yes” they have children at home. The frequencies of the self-reported responses to this question are provided in figure (11) and table (10).

VI. Gender

Figure 12 - Frequencies of the Independent Socio-Demographic Variable (Gender)

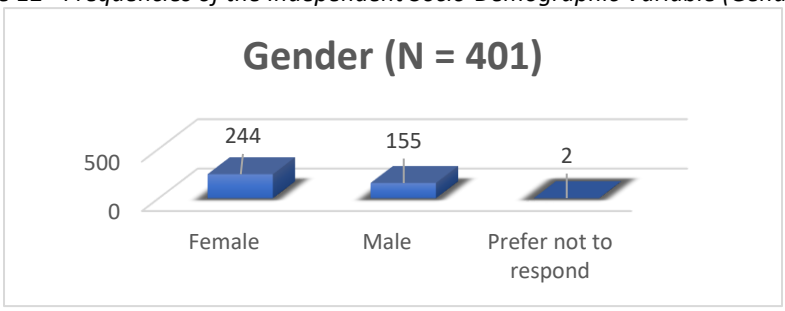


Table 11 - Frequencies of the Independent Socio-Demographic Variable (Gender).

60. Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	155	38.7	38.8	38.8
	Female	244	60.8	61.2	100.0
	Total	399	99.5	100.0	
Missi	99	2	.5		
Total		401	100.0		

When they were asked about their gender, 244 respondents indicated that they are females and 155 are males. Two participants preferred not to respond to this question. The frequencies of the received responses are provided in figure (12) and table (11).

VII. Employment Status

Would you describe yourself as… (employment)?

Figure 13 - Frequencies of the Independent Socio-Demographic Variable (Employment Status)

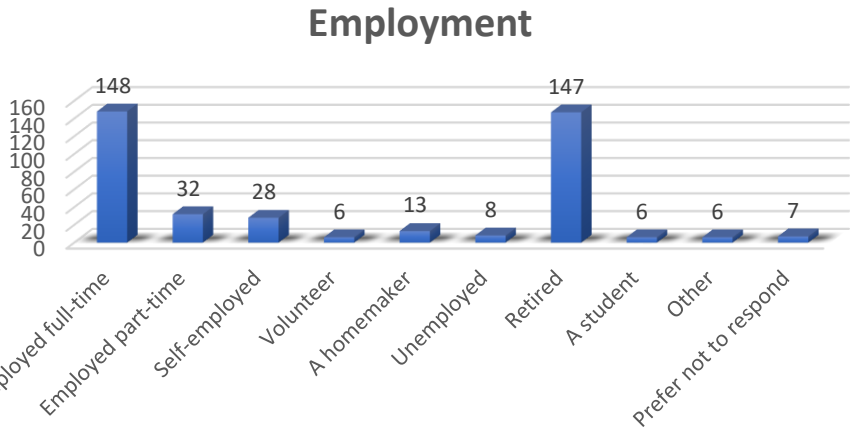


Table 12 - Frequencies of the Independent Socio-Demographic Variable (Employment Status).

48. Employment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A student	6	1.5	1.5	1.5
	A homemaker	13	3.2	3.4	4.9
	Unemployed	8	2.0	2.1	7.0
	Retired	147	36.7	37.9	44.8
	Volunteer	6	1.5	1.5	46.4
	Self-employed	28	7.0	7.2	53.6
	Employed part-time	32	8.0	8.2	61.9
	Employed full-time	148	36.9	38.1	100.0
	Total	388	96.8	100.0	
Missing	99	13	3.2		
Total		401	100.0		

The participants in this study were asked to describe themselves with regards to their employment status by choosing one of the answers offered with the question. Around (46.3%) of the 388 participants who responded to this question indicated that they were either full or part time employees. Almost 38% said that they are retired. More details about the reported responses are presented in figure (13) and table (12).

VIII. Relationship Status

Which of the following best describes your relationship status?

Figure 14 - Frequencies of the Independent Socio-Demographic Variable (Relationship Status)

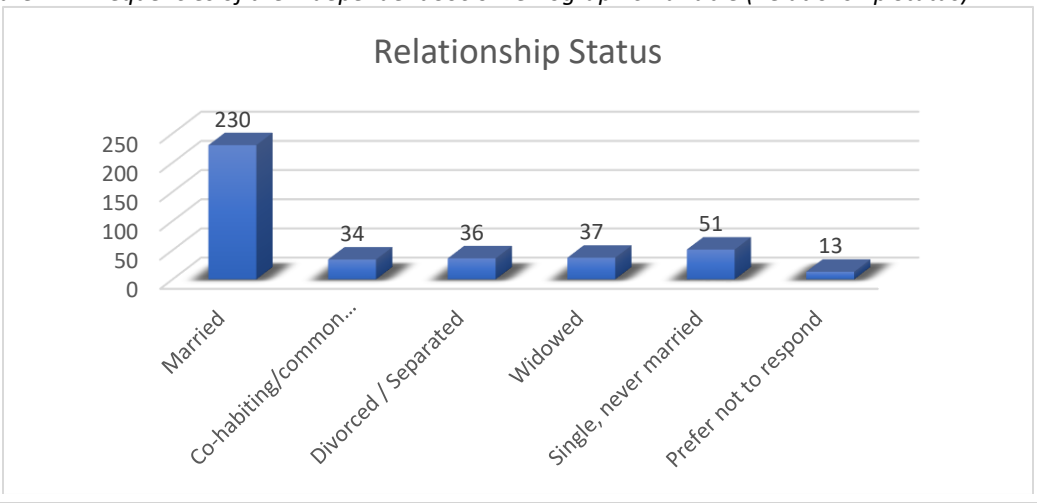


Table 13 - Frequencies of the Independent Socio-Demographic Variable (Relationship Status)

49. Relationship Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single, never married	51	12.7	13.1	13.1
	Divorced / Separated	36	9.0	9.3	22.4
	Widowed	37	9.2	9.5	32.0
	Co-habiting/common law	34	8.5	8.8	40.7
	Married	230	57.4	59.3	100.0
	Total	388	96.8	100.0	
Missing	99	13	3.2		
Total		401	100.0		

The self-reported responses on a question inquiring about the relationship status of the study participants showed that the majority of the respondents (59%) are married. The single and/or never married participants represented 13% of the 388 participants who responded to this question. More details are provided in figure (14) and table (13).

4.2.2. Situational Variables

I. Dwelling Type

Which of the following best describes your primary residence?

Figure 15 - Frequencies of the Independent Situational Variable (Dwelling Type)

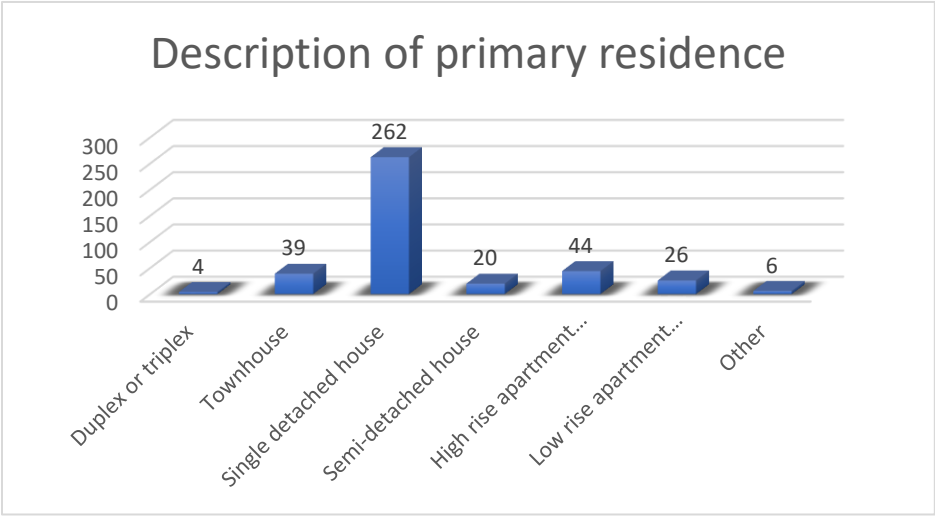


Table 14 - Frequencies of the Independent Situational Variable (Dwelling Type)

1. Dwelling Type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single detached house	262	65.3	66.3	66.3
	Semi-detached house	20	5.0	5.1	71.4
	Townhouse	39	9.7	9.9	81.3
	High rise apartment	44	11.0	11.1	92.4
	Low rise apartment building	26	6.5	6.6	99.0
	Duplex or triplex	4	1.0	1.0	100.0
	Total	395	98.5	100.0	
Missing	99	6	1.5		
Total		401	100.0		

The most common dwelling type, which was reported by most of the study participants as being their primary residence, was single-detached house representing 262 of the received responses. Figure (15) and table (14) show more details about the frequencies of the primary residence type as reported by the study participants. In this study and for analysis purposes, dwellings that are classified in the survey as

semi-detached houses, duplex or triplex, and townhouses were combined together and classified as townhouses.

II. Year Home was Built

To the best of your knowledge, approximately when was your home built?

Figure 16 - Frequencies of the Independent Situational Variable (Year Home was Built)

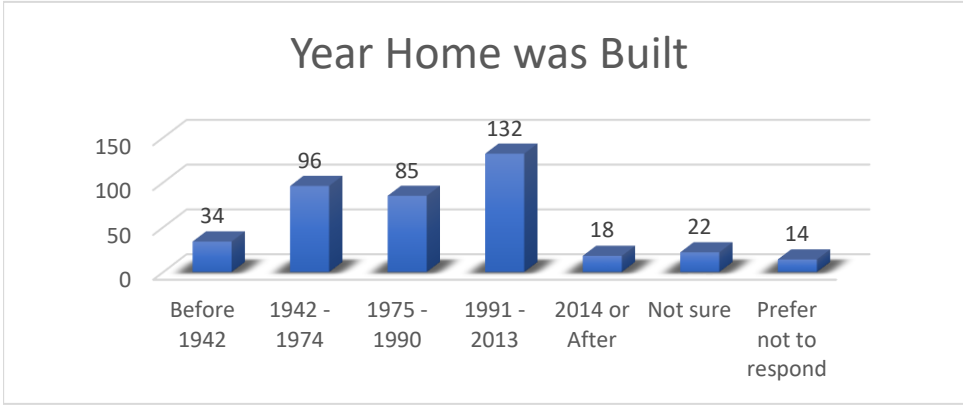


Table 15 - Frequencies of the Independent Situational Variable (Year Home was Built).

54. Year Home was Built

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Before 1942	34	8.5	9.3	9.3
	1942 - 1974	96	23.9	26.3	35.6
	1975 - 1990	85	21.2	23.3	58.9
	1991 - 2013	132	32.9	36.2	95.1
	2014 or later	18	4.5	4.9	100.0
	Total	365	91.0	100.0	
Missing	99	36	9.0		
Total		401	100.0		

When the study participants were asked about the year their homes were built, 150 participants indicated that their homes were built on or after the year 1991. Around 9% of the total 401 participants said that they were either not sure when their homes were built or preferred not to respond to the question. More details are provided in figure (16) and table (15).

III. Home Ownership

Do you own or rent your current dwelling?

Figure 17 - Frequencies of the Independent Situational Variable (Home Ownership)

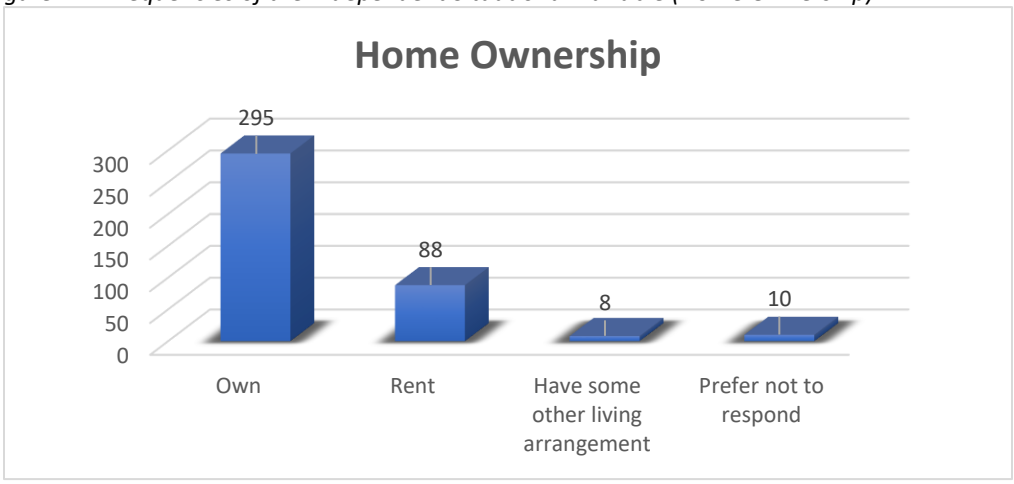


Table 16 - Frequencies of the Independent Situational Variable (Home Ownership)

53. Home Ownership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Have some other living	8	2.0	2.0	2.0
	Rent	88	21.9	22.5	24.6
	Own	295	73.6	75.4	100.0
	Total	391	97.5	100.0	
Missing	99	10	2.5		
Total		401	100.0		

While 295 (around 75.4%) of the respondents to a question about home ownership reported that they own their current dwellings, 88 respondents indicated that they rent their current dwellings. 10 out of the total 401 participants in the study preferred not to respond to this question. The remaining 8 participants said that they have other living arrangements. These results are presented in figure (17) and table (16).

IV. City/ Township

In which city or township do you reside?

Figure 18 - Frequencies of the Independent Situational Variable (City/Township)

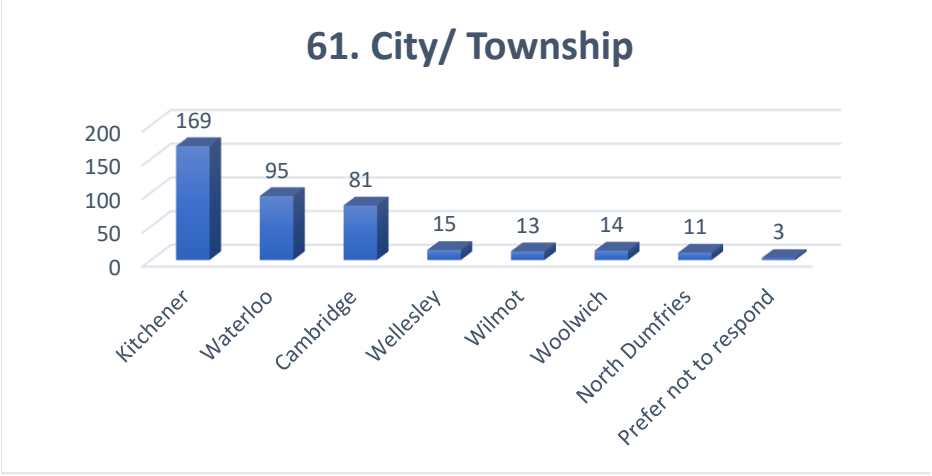


Table 17 Frequencies of the Independent Situational Variable (City/Township).

61. City/Township

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Kitchener	169	42.1	42.5	42.5
	Waterloo	95	23.7	23.9	66.3
	Cambridge	81	20.2	20.4	86.7
	Wellesley	15	3.7	3.8	90.5
	Wilmot	13	3.2	3.3	93.7
	Woolwich	14	3.5	3.5	97.2
	North Dumfries	11	2.7	2.8	100.0
	Total	398	99.3	100.0	
Missing	99	3	.7		
Total		401	100.0		

The frequencies of the self-reported responses to a question about the city/township that the study participants live in are presented in figure (18) and table (17). in this study, the three major cities (Kitchener, Waterloo, and Cambridge) are classified and treated as being urban areas, while the townships (Wellesley, Wilmot, Woolwich, and North Dumfries) are classified and treated as being rural areas.

V. Information:

a) Read Received Information

When you receive information about energy conservation and/or efficiency messaging in the mail, do you read it?

Figure 19 - Frequencies of the Independent Situational Variable (Information – Read Received Information)

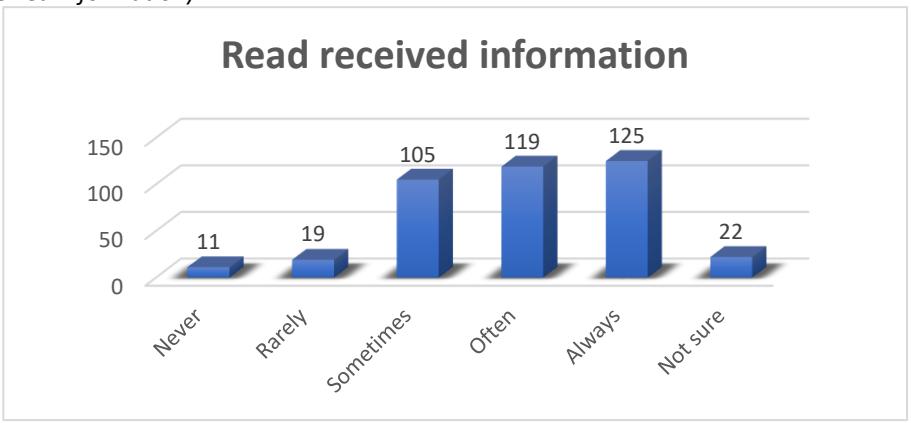


Table 18 - Frequencies of the Independent Situational Variable (Information – Read Received Information)

36. Read received information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	11	2.7	2.9	2.9
	Rarely	19	4.7	5.0	7.9
	Sometimes	105	26.2	27.7	35.6
	Often	119	29.7	31.4	67.0
	Always	125	31.2	33.0	100.0
	Total	379	94.5	100.0	
Missing	99	22	5.5		
Total		401	100.0		

While 226 respondents indicated that they often or always read information they receive in the mail about energy efficiency and/ or conservation, 30 respondents said that they never or rarely do that. More details about the reported responses are provided in figure (19) and table (18).

b) Information: Follow/Listen to Energy Conservation or Efficiency Information

How likely are you to follow/listen to information about energy conservation and/or efficiency that you may see or receive?

Figure 20 - Frequencies of the Independent Situational Variable (Information – Follow/Listen to Information)

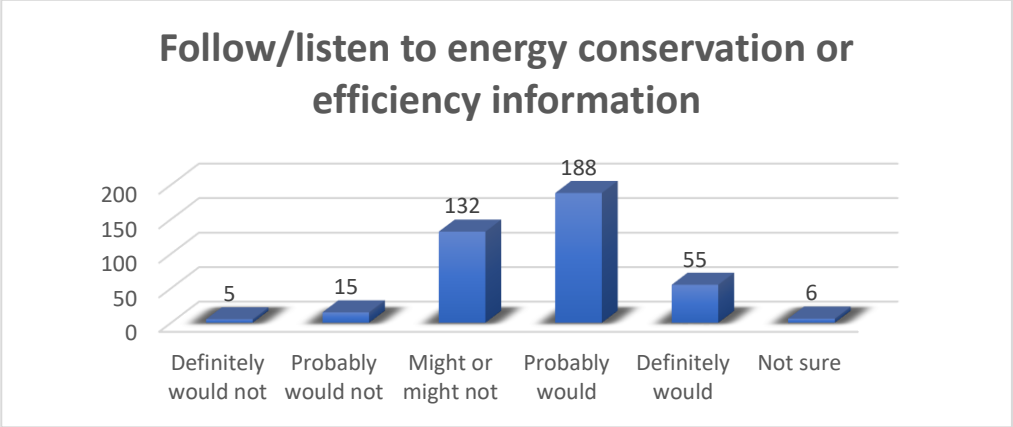


Table 19 - Frequencies of the Independent Situational Variable (Information – Follow/Listen to Information)

37. Follow/Listen to Info.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Defintely would not	5	1.2	1.3	1.3
	Probably would not	15	3.7	3.8	5.1
	Might or might not	132	32.9	33.4	38.5
	Probably would	188	46.9	47.6	86.1
	Definitely would	55	13.7	13.9	100.0
	Total	395	98.5	100.0	
Missing	99	6	1.5		
Total		401	100.0		

Of the 401 participants in this study, 243 respondents indicated that they probable would or definitely would follow/listen to energy efficiency or conservation information they may see or receive. However, 20 respondents reported that they definitely would not or probably would not do that. More details about the reported responses are provided in figure (20) and table (19).

4.2.3. Psychological Variables

In this section, the self-reported responses of the study participants on questions that address psychological variables will be presented.

I. Attitude: (four attitudinal variables are used in this work)

Three questions were used in this study to measure four attitudinal variables. The frequencies of the reported responses to these attitudinal variables are presented here.

a) Attitude: Priority of Energy Conservation

"Please rate how much of a priority energy conservation and energy efficiency are to you personally?"

Figure 21 - Frequencies of the Independent Psychological Variable (Priority of Energy Conservation)

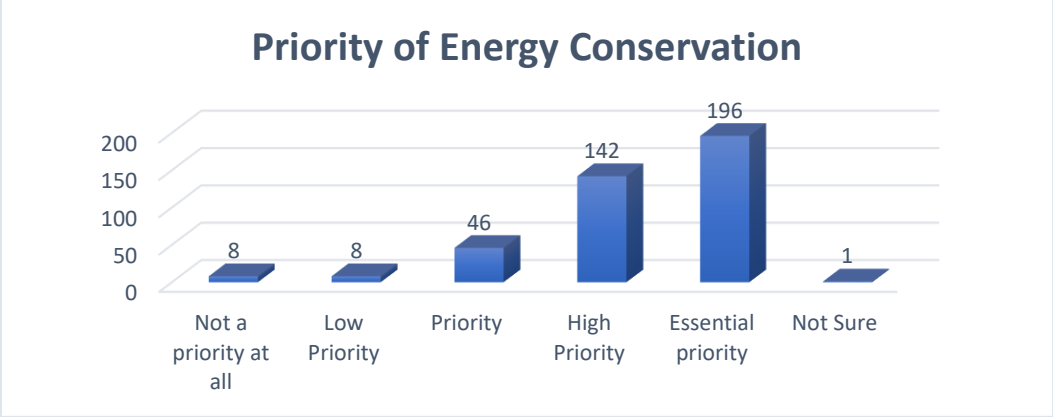


Table 20 - Frequencies of the Independent Psychological Variable (Attitude: Priority of Energy Conservation)

5C. Conservation Priority

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not a priority at all	8	2.0	2.0	2.0
	Low Priority	8	2.0	2.0	4.0
	Priority	46	11.5	11.5	15.5
	High Priority	142	35.4	35.5	51.0
	Essential priority	196	48.9	49.0	100.0
	Total	400	99.8	100.0	
Missing	Not Sure	1	.2		
Total		401	100.0		

According to the self-reported responses, out of the 401 participants in this study, 338 respondents indicated that they consider energy conservation as a high priority or an essential priority. Only 16 respondents reported that they consider energy conservation as a low priority or not a priority at all. Please see figure (21) and table (20).

b) Attitude: Priority of Energy Efficiency

"Please rate how much of a priority energy conservation and energy efficiency are to you personally?"

Figure 22 - Frequencies of the Independent Psychological Variable (Priority of Energy Efficiency)

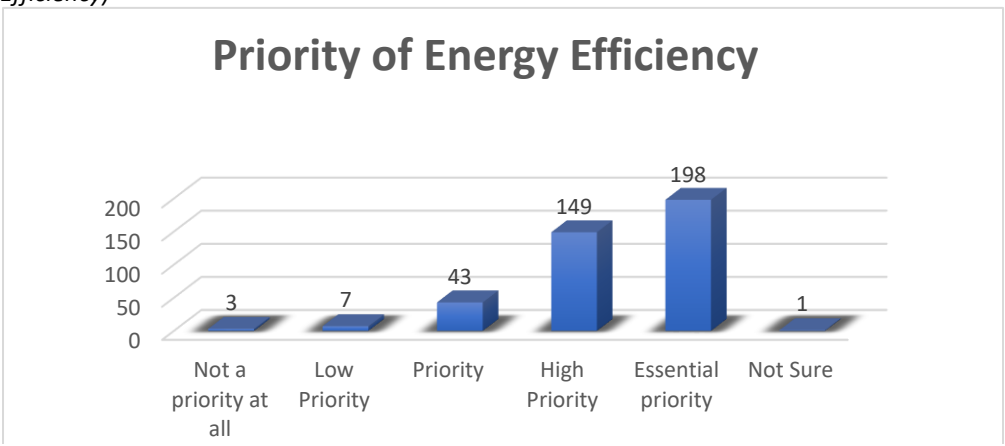


Table 21 - Frequencies of the Independent Psychological Variable (Priority of Energy Efficiency)

5E. Efficiency Priority

		Frequency	Percent	Valid Percent	Cumulative
Valid	Not a priority at all	3	.7	.8	.8
	Low Priority	7	1.7	1.8	2.5
	Priority	43	10.7	10.8	13.3
	High Priority	149	37.2	37.3	50.5
	Essential priority	198	49.4	49.5	100.0
	Total	400	99.8	100.0	
Missing	Not Sure	1	.2		

The self-reported responses show that out of the 401 participants in this study, 347 respondents indicated that they consider energy efficiency as a high priority or an essential priority. However, only 10

respondents reported that they consider energy efficiency as a low priority or not a priority at all. More details are provided in figure (22) and table (21).

c) Attitude: Environmental Views/ Concern

"Which of the following statements best describes your view of the environment?"

Figure 23 - Frequencies of the Independent Psychological Variable (Attitude: Environmental Views/ Concern)

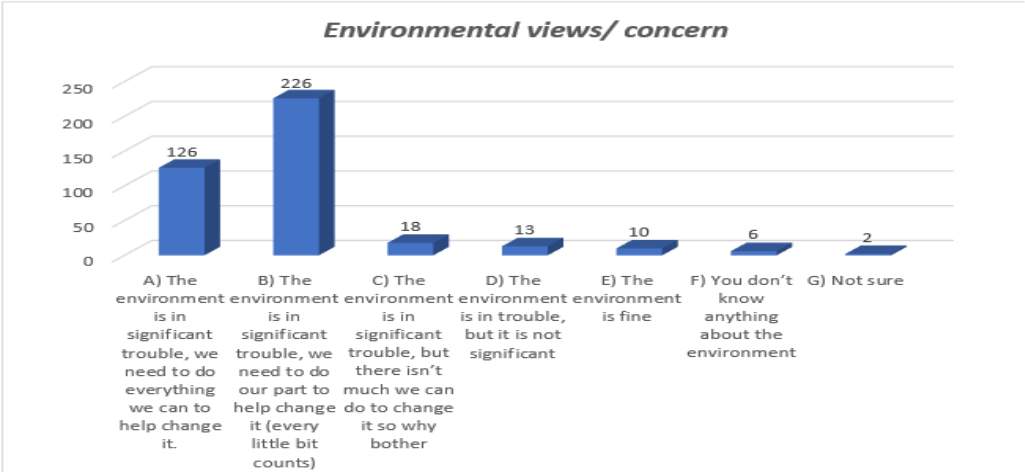


Table 22 - Frequencies of the Independent Psychological Variable (Attitude: Environmental Views/ Concern)

6. Attitude (Environmental Views/ Concern)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	You don't know anything about the environment	6	1.5	1.5	1.5
	The environment is fine	10	2.5	2.5	4.0
	The environment is in trouble, but it is not significant	13	3.2	3.3	7.3
	The environment is in significant trouble, but there isn't much we can do to change it so why bother	18	4.5	4.5	11.8
	The environment is in significant trouble, we need to do our part to help change it (every little bit counts)	226	56.4	56.6	68.4
	The environment is in significant trouble, we need to do everything we can to help change it	126	31.4	31.6	100.0
	Total	399	99.5	100.0	
Missing	99	2	.5		
Total		401	100.0		

The study participants were asked to select a statement that best describe their views of the environment. The statements along with the number of participants who selected each statement are

presented in figure (23) and table (22). The results show that most of the respondents (352) believe that the environment is in significant trouble. As it appears in figure (23) and table (22), 226 of the respondents indicated that "we need to do our part to help change it (every little bit counts)". 126 respondents said that "we need to do everything we can to help change it".

d) Attitude: Climate Change Views/ Concern

Which of the following statements best describes your view of climate change?

Figure 24 - Frequencies of the Independent Psychological Variable (Attitude: Climate Change Views/ Concern)

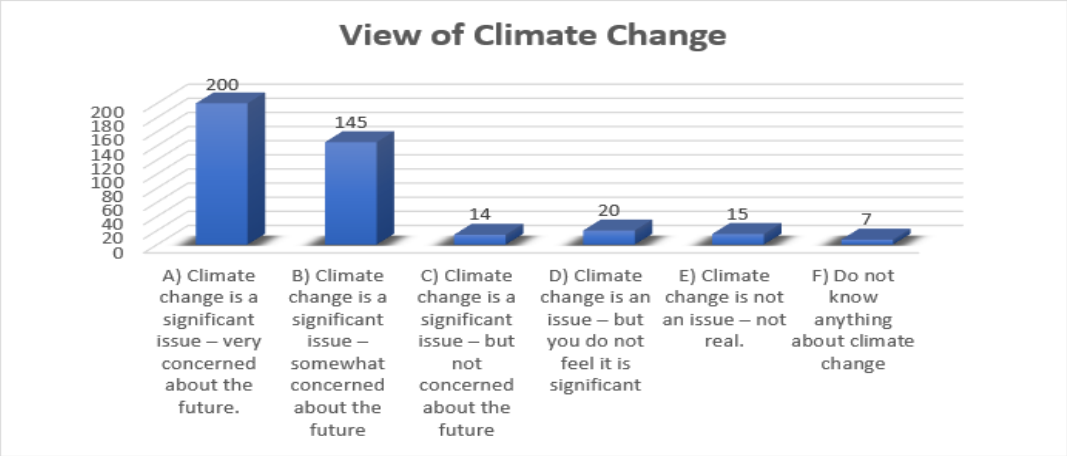


Table 23 - Frequencies of the Independent Psychological Variable (Attitude: Climate Change Views/ Concern)

7. Attitude (Climate Change)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	You don't know anything about climate change	7	1.7	1.7	1.7
	Climate change is not an issue / not real	15	3.7	3.7	5.5
	Climate change is an issue, but you do not feel it is significant	20	5.0	5.0	10.5
	Climate change is a significant issue, but you are not concerned about the future	14	3.5	3.5	14.0
	Climate change is a significant issue and you are somewhat concerned about the future	145	36.2	36.2	50.1
	Climate change is a significant issue and you are very concerned about the future	200	49.9	49.9	100.0
	Total	401	100.0	100.0	

In this question, the study participants were asked to indicate their views of one of the most important environmental problems; climate change, which is fundamentally an energy issue and being driven by the growing concentrations of anthropogenic greenhouse gases in the atmosphere.

Out of the 359 respondents who believe that climate change is a significant issue, 145 participants indicated that they are concerned about the future, and 200 reported that they are very concerned about the future. More details are provided in figure (24) and table (23).

II. Subjective Norms

a) Subjective Norms: Comparing Energy Consumption to Others in the Neighborhood

Would you be interested in knowing how your energy consumption compares to others in your neighborhood?

Figure 25 - Frequencies of the Independent Psychological Variable (Comparing Energy Consumption to Others in the Neighborhood)

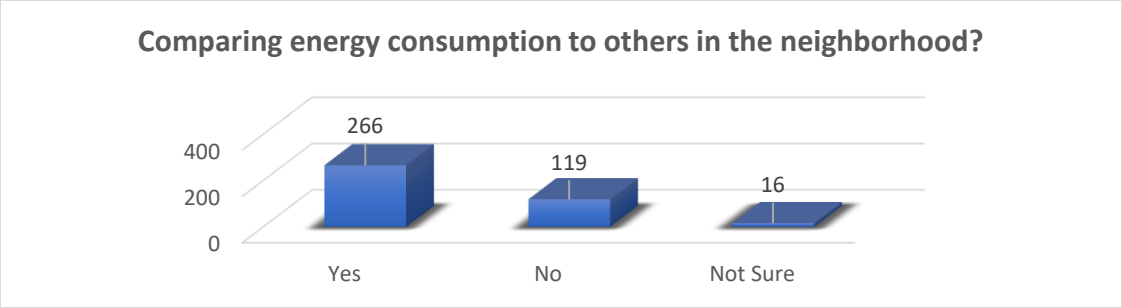


Table 24 - Frequencies of the Independent Psychological Variable (Comparing Energy Consumption to Others in the Neighborhood)

33. Subjective norms (Comparing Energy Consumption to Others in the Neighborhood)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	119	29.7	30.9	30.9
	Yes	266	66.3	69.1	100.0
	Total	385	96.0	100.0	
Missing	99	16	4.0		
Total		401	100.0		

Of the total respondents to this question, 266 showed an interest in knowing how their energy consumption compares to others in the neighborhood. The frequencies of the received responses are presented in figure (25) and table (24).

III. Knowledge: two questions were used to measure the participants' knowledge

a) Knowledge: Reduce Home Energy Usage

Do you feel you know how to effectively reduce your home's energy usage?

Figure 26 - Frequencies of the Independent Psychological Variable (Knowledge: Reduce Home Energy Usage)

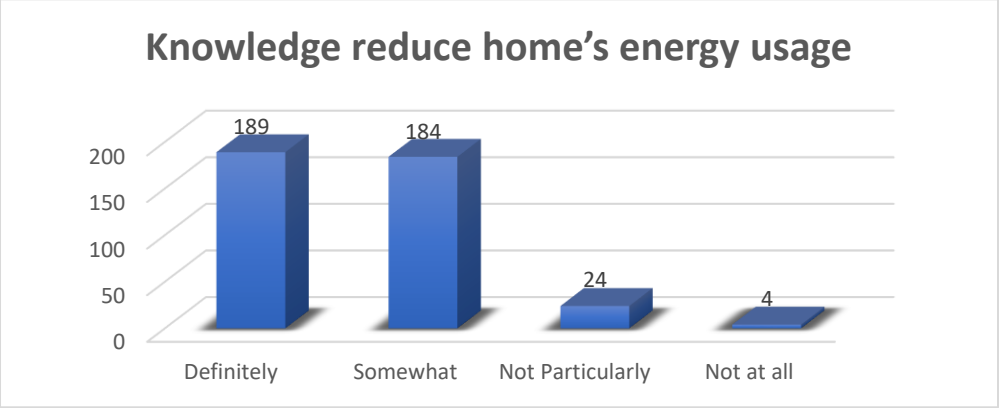


Table 25 - Frequencies of the Independent Psychological Variable (knowledge: Reduce Home Energy Usage)

22. knowledge (Reduce Home Energy Usage)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	4	1.0	1.0	1.0
	Not particularly	24	6.0	6.0	7.0
	Somewhat	184	45.9	45.9	52.9
	Definitely	189	47.1	47.1	100.0
	Total	401	100.0	100.0	
Total		401	100.0	100.0	

Out of the 401 participants who answered a question about their level of knowledge of how to effectively reduce home's energy usage, 189 participants, or 47% of respondents, said that they definitely know how to effectively reduce their homes' energy usage. Another 148 participants reported

that they somewhat know how to effectively reduce their homes' energy usage. Figure (26) and table (25) provide more details about the reported responses to this question.

b) Knowledge: Net Zero Energy

Have you ever heard of the term "Net Zero Energy" as it relates to conserving energy?

Figure 27 - Frequencies of the Independent Psychological Variable (Knowledge: Net Zero Energy)

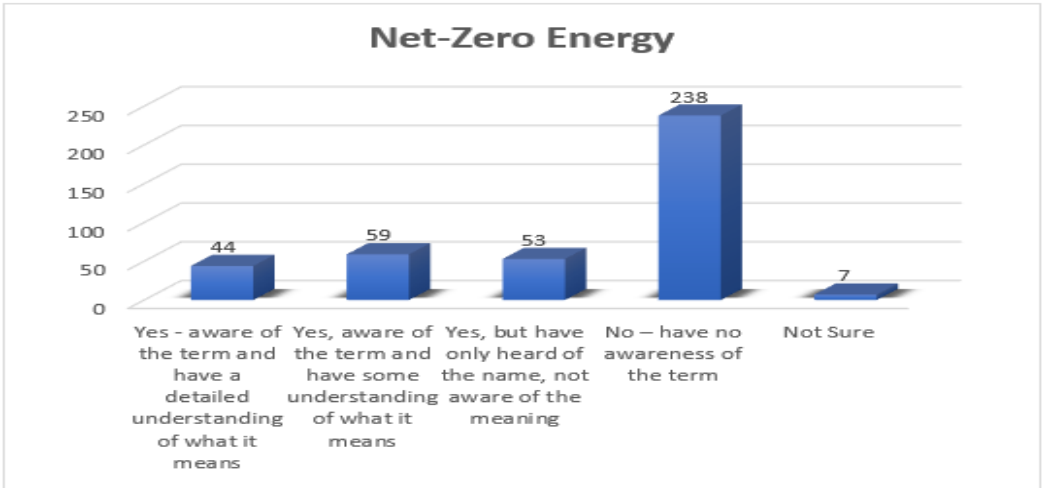


Table 26 - Frequencies of the Independent Psychological Variable (Knowledge: Net Zero Energy)

30. Knowledge - Net Zero Energy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No – have no awareness of the term	238	59.4	60.4	60.4
	Yes - but have only heard of the name; not aware of its meaning	53	13.2	13	73.9
	Yes - aware of the term and have some understanding of what it means	59	14.7	15.0	88.8
	Yes - aware of the term and have a detailed understanding of what it means	44	11.0	11.2	100.0
	Total	394	98.3	100.0	
Missing	99	7	1.7		
Total		401	100.0		

Most of the study participants (238 out of 401) reported that they are not aware of the term "Net Zero Energy". However, 156 participants indicated that they are either aware or at least have heard of the term. Only 44 participants, or 11% of respondents, said that they have detailed understanding of the

term “Net Zero Energy”. The frequencies of the self-reported responses to this question are provided in figure (27) and table (26).

IV. Cost-benefit appraisal

a) Cost-benefit appraisal: save energy to save money

Please indicate how much you agree or disagree with the following statement: “You try to save energy because it saves you money”

Figure 28 - Frequencies of the Independent Psychological Variable (Cost-Benefit Appraisal – Save Energy to Save Money)

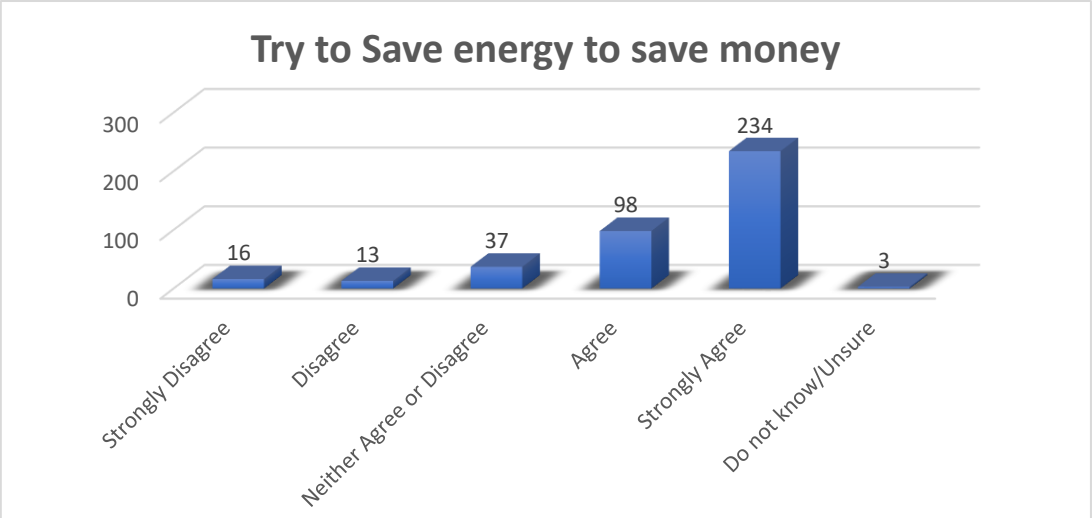


Table 27 - Frequencies of the Independent Psychological Variable (Cost-Benefit Appraisal – Save Energy to Save Money)

21B. Save energy - Save Money

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	16	4.0	4.0	4.0
	Disagree	13	3.2	3.3	7.3
	Neither agree nor disagree	37	9.2	9.3	16.6
	Agree	98	24.4	24.6	41.2
	Strongly Agree	234	58.4	58.8	100.0
	Total	398	99.3	100.0	
Missing	99	3	.7		
Total		401	100.0		

Of the 401 participants in this study, 332 at least agreed that they try to save energy because it saves them money. However, 29 respondents indicated that the either disagree or strongly disagree with that statements. The received responses are summarized in figure (28) and table (27).

b) Cost-Benefit Appraisal: Energy Efficiency and Conservation Can Help Reduce Utility Bills

Please indicate how much you agree or disagree with each of the following statement: "Energy efficiency and conservation can help reduce your utility bills"

Figure 29 - Frequencies of the Independent Psychological Variable (Cost-Benefit Appraisal - Energy Efficiency and Conservation Can Help Reduce Utility Bills)

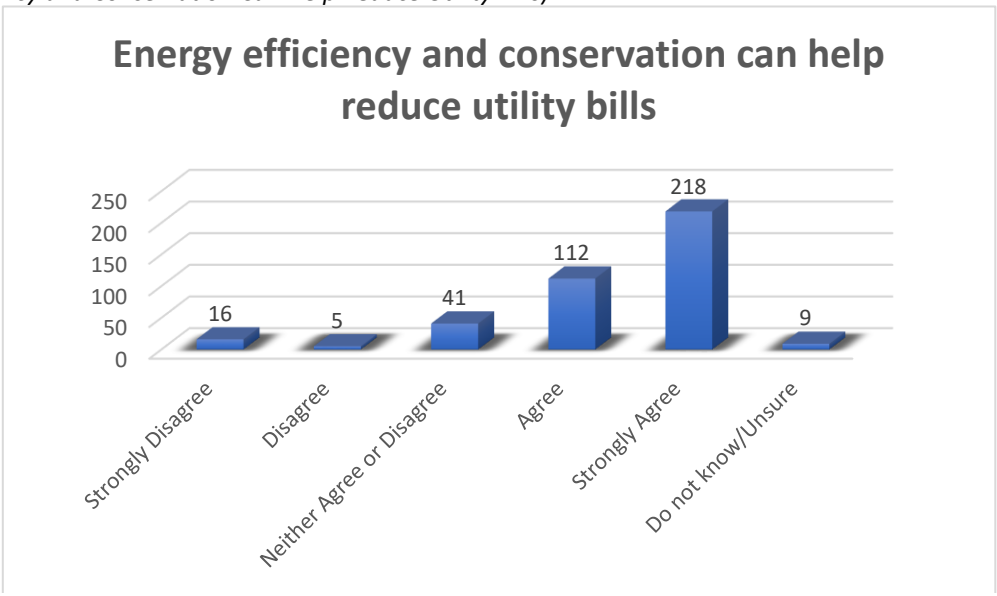


Table 28 - Frequencies of the Independent Psychological Variable (Cost-Benefit Appraisal - Energy Efficiency and Conservation Can Help Reduce Utility Bills)

21E. Energy Efficiency and Conservation help reduce utility bills

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	16	4.0	4.1	4.1
	Disagree	5	1.2	1.3	5.4
	Neither agree nor disagree	41	10.2	10.5	15.8
	Agree	112	27.9	28.6	44.4
	Strongly Agree	218	54.4	55.6	100.0
	Total	392	97.8	100.0	
Missing	99	9	2.2		
Total		401	100.0		

When they were asked to indicate their level of agreement with the statement that “energy efficiency and conservation can help reduce their utility bills”, 330 respondents at least agreed with that statement. However, out of the 401 participants in this study 21 said that they either disagree or strongly disagree with that statements. More details are provided in figure (29) and table (28).

4.2.4. Dependent Variables

The number of energy conservation behaviors that the study participants regularly take in their homes, and the number of energy efficiency improvements they have already made to their homes are the two dependent variables used in this study. From a list of energy conservation and efficiency behaviors, the study participants were asked to report all the energy conservation behaviors they regularly take in their homes, as well as all the energy efficiency improvements they have already made to their homes. The frequencies of the self-reported energy conservation and efficiency behaviors are provided in table (29) and table (30) respectively.

Table 29 - Frequencies of the Dependent Variable (Energy Conservation Behaviors Regularly Taken by the study participants in their homes)

I. Frequencies of energy conservation behaviors					
			Responses		Percent of Cases
			N	Percent	
Energy Conservation Behaviors	1	Turn off lights when not in the room	387	9.20%	96.5%
	2	Recycle as much as possible	383	9.10%	95.5%
	3	Adjust your thermostat to use less heating and/or air conditioning	325	7.70%	81.0%
	4	Turn off the water when brushing your teeth	322	7.60%	80.3%
	5	Run your laundry at off-peak hours	320	7.60%	79.8%
	6	Turn off the water when washing dishes / use a partially filled sink	305	7.20%	76.1%
	7	Use a green bin or compost as much as possible	300	7.10%	74.8%
	8	Wash your clothes in cold water	298	7.10%	74.3%
	9	Take short showers	295	7.00%	73.6%
	10	Run your dishwasher at off-peak hours	249	5.90%	62.1%
	11	Run your other appliances at off-peak hours	207	4.90%	51.6%
	12	Reduce the number of times you flush your toilet	197	4.70%	49.1%
	13	Hang your clothes out to dry rather than using a dryer	194	4.60%	48.4%
	14	Drive a compact car rather than a full-size sedan, SUV or truck	154	3.70%	38.4%
	15	Unplug any electronics like TVs or computers when they are not in use or hook them up to a power bar with a timer	130	3.10%	32.4%
	16	Use a rain barrel to collect rain water to be used outside to water the gardens in lieu of a hose	129	3.10%	32.2%
	17	Drive a hybrid or electric car	21	0.50%	5.20%
Total			4216	100.0 %	1051.4%

Table 30 - Frequencies of the Dependent Variable (Energy Efficiency Behaviors/Improvements that the study participants have already made to their homes)

II. Frequencies of energy efficiency behaviors/ improvements					
			Responses		Percent of Cases
			N	Percent	
Energy Efficiency Behaviors/ Improvements	1	Install low energy light bulbs	350	8.21%	87.3%
	2	Purchase and use alternate sources of energy (i.e. solar panels, geothermal, windmill	286	6.71%	71.3%
	3	Install Tankless Water Heaters	272	6.38%	67.8%
	4	Install electric water heater blanket	270	6.33%	67.3%
	5	Upgrade to programmable thermostats	262	6.14%	65.3%
	6	Install Efficient Showerheads	259	6.07%	64.6%
	7	Install weather stripping around windows and doors	238	5.58%	59.4%
	8	Install home automation system (e.g. automatic temperature and lighting controls)	236	5.53%	58.9%
	9	Install a high-efficiency furnace	234	5.49%	58.4%
	10	Replace old, working appliances with Energy Star appliances	324	7.60%	58.4%
	11	Install Energy Star Water heaters	210	4.92%	52.4%
	12	Install power bars with integrated timer or auto shut-off	209	4.90%	52.1%
	13	Replace windows or doors to reduce drafts in the home	209	4.90%	52.1%
	14	Install insulation in walls, attic, and/or basement	208	4.88%	51.9%
	15	Install a high-efficiency central air conditioning system	194	4.55%	48.4%
	16	Install energy-efficient lighting controls	173	4.06%	43.1%
	17	Install Efficient Kitchen and Bathroom Aerators	170	3.99%	42.4%
	18	Install hot water pipe wrap	160	3.75%	39.9%
Total			4264	100.0 %	1041.0 %

4.2.5. Characteristics of the Study Participants Relative to the RoW Population

Table no. 31 shows how some of the demographic and household characteristics of the study participants compare with similar data for the Region of Waterloo – from Statistics Canada, Census Profile, 2016 Census - Waterloo, Regional municipality.

Table 31 - Characteristics of the Study Participants Relative to the RoW Population

Characteristic \ City/Location		(Region of Waterloo) RoW[1]	Study Participants
Total Population size (0 years old and over)		535,155	401
Male to Female split of total population (0 years old and over)		49.4% to 50.6%	38.8% to 61.2%
Average Age of total population (0 years old or over)		39.1	57.3
Population size (over 14 years old)		95,380	0
Population size (over 14 years old)		439,775	401
Male to Female split of population (over 14 years old)		49% to 51%	38.8% to 61.2%
% of people who are 65 years or over (out of those who are over 14 years old)		21.3%	35%
% of population employed (out of those who are over 14 years old)		64.3%	53.5%
% of population with post-secondary certificate, diploma, degree (out of those who are over 14 years old)		52.5%	79.1%
% Married / co-habitating /common law (out of those who are over 14 years old)		58.3%	68.1%
Average household size		2.6	2.6
Housing (home ownership)	% Owned	68.2% N= 139070	75.4 % N= 295
	% Rented	31.8% N= 64760	22.5% N= 88

1- 2016 Census, (Statistics Canada, 2016)

As shown the table 31, the average age of the study participants (57.3 years) was higher than the average age of the total population (39.1 years). This was expected since the broader population

average included members of society younger than the age of 18, while the age of the youngest participant in this study was 18. Only one participant in this study indicated that she was 18 years old. Out of the total 535,155 people living in the Region of Waterloo, 95,380 are either 14 years old or younger (Statistics Canada, 2016). This number goes up to 128,990 if members of the society who are 19 years old or younger are included (Statistics Canada, 2016).

The percentage of male in the study sample is somewhat lower than that of the Region of waterloo population who are over 14 years old. However, the percentage of females in the study sample is somewhat higher than that of the Region of waterloo population who are over 14 years old.

In addition to the above, out of the 439,775 members of the society within the Region of Waterloo who are over 14 years old, 21% are either 65 years or older (Statistics Canada, 2016). This percentage is lower than that of the study participants, which is equal to 35%. This difference helps explain the high parentage of retired people in the study sample - around 38%.

Differences between the characteristics of the study participants and the population of the Region of Waterloo who are over 14 years old continue to appear in table 31. While the percentage of the employed people in the Region of Waterloo seems to be higher than that of the study participants, the table shows higher percentages for the study participants with respect to the level of education and percentage of married/ co-habitating, or common law partners.

However, the average household size of the study sample is similar to that of the total population in the Region of Waterloo.

4.3. Relationships between Independent and Dependent Variables

The results of the examined relationships between the independent variables (socio-demographics, situational, and psychological variables) and the two dependent variables (the number of energy

conservation behaviors, and the number of energy efficiency behaviors/improvements) will be presented in this section which includes two sub-sections. The results of the relationships between the independent variables and the number of energy conservation behaviors that the study participants regularly take in their homes will be presented in the first sub-section (Section 4.3.1.). The relationships between the independent variables and the number of energy efficiency behaviors that the study participants have already made to their home will be presented in the second sub-section of section 4.3. (i.e., section 4.3.2).

4.3.1. Energy Conservation Behaviors

4.3.1.1. Socio-Demographic Variables and the Number of Energy Conservation Behaviors

I. Age and Conservation

To examine whether there is an association between the age of the study participants and the number of energy conservation behaviors they regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 32). The test showed that there was no statistically significant relationship between the age of the study participants and the number of energy conservation behaviors they regularly take in their homes.

Table 32 - Kendall's tau_b Correlation Coefficient – Age of Participants and the Number of Energy Conservation Behaviors.

Correlations

			No. of Conservation Behaviors	46. Age
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.016
		Sig. (2-tailed)	.	.700
		N	401	401
	46. Age	Correlation Coefficient	.016	1.000
		Sig. (2-tailed)	.700	.
		N	401	401

II. Income Level and Conservation

To examine whether there is an association between the income level of the study participants and the number of energy conservation behaviors they regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 33). The test showed that there was a statistically significant positive relationship between the income level and the number of energy conservation behaviors that the study participants regularly take in their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= 0.157 showed that the relationship was weak.

Table 33 - Kendall's tau_b Correlation Coefficient – Income Level and the Number of Energy Conservation Behaviors.

Correlations

			No. of Conservation Behaviors	59. Income
Kendall's tau_b	No. of Conservation Behaviors	Correlation	1.000	.157**
		Sig. (2-tailed)	.	.001
		N	401	300
	59. Income	Correlation	.157**	1.000
		Sig. (2-tailed)	.001	.
		N	300	300

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

III. Level of Education and Conservation

To examine whether there is an association between the level of education that the study participants hold and the number of energy conservation behaviors they regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 34). The test showed that there was a statistically significant positive relationship between the level of education and the number of energy conservation behaviors that the study participants regularly take in their homes at the 0.05 level of significance. However, the Kendall's tau_b correlation coefficients= 0.097 showed that the relationship was weak.

Table 34 - Kendall's tau_b Correlation Coefficient – Level of Education of Participants and the Number of Energy Conservation Behaviors.

Correlations

			No. of Conservation Behaviors	47. Education Level
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.097*
		Sig. (2-tailed)	.	.021
		N	401	388
	47. Education Level	Correlation Coefficient	.097*	1.000
		Sig. (2-tailed)	.021	.
		N	388	388

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

IV. Number of People at Home and Conservation

To examine whether there is an association between the number of people at home and the number of energy conservation behaviors that the study participants regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 35). The test showed that there was a statistically significant positive relationship between the number of people at home and the number of energy conservation behaviors that the study participants regularly take in their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= 0.149 showed that the relationship was weak.

Table 35 - Kendall's tau_b Correlation Coefficient – Number of People at Home and the Number of Energy Conservation Behaviors

Correlations

			No. of Conservation Behaviors	50. No of people
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.149**
		Sig. (2-tailed)	.	.000
		N	401	385
	50. No of people	Correlation Coefficient	.149**	1.000
		Sig. (2-tailed)	.000	.
		N	385	385

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

V. Having Children at Home and Conservation

To examine whether there is an association between having children at home and the number of energy conservation behaviors that the study participants regularly take in their homes, a Chi-Square test of independence was performed (Table 36). The test showed that the number of energy conservation behaviors that the study participants regularly take in their homes was independent of whether they have children at home or not, i.e., there was no statistically significant relationship between the independent variable (having children at home) and the number of energy conservation behaviors.

Table 36 - Chi-Square Test (Having Children at Home and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.754[a]	3	.191
Likelihood Ratio	4.783	3	.188
Linear-by-Linear Association	4.080	1	.043
N of Valid Cases	305		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.34.

VI. Gender and Conservation

To examine whether there is an association between the gender of the study participants and the number of energy conservation behaviors they regularly take in their homes, a Chi-Square test of independence was performed (Table 37). The test showed that the number of energy conservation behaviors that the study participants regularly take in their homes was independent of the gender of the study participants, i.e., there was no significant relationship between the gender and the number of energy conservation behaviors.

Table 37 - Chi-Square Test (Gender and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.812[a]	3	.846
Likelihood Ratio	.826	3	.843
Linear-by-Linear Association	.265	1	.607
N of Valid Cases	399		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.21.

VII. Employment and Conservation

To examine whether there is an association between the employment status of the study participants and the number of energy conservation behaviors they regularly take in their homes, a Chi-Square test of independence was performed (Table 38). The results showed that one of the assumptions of the chi-square test of independence was violated. More specifically, the results showed that 56.3% of the cells (i.e., more than 20%) had expected count less than 5. Therefore, the value of the Likelihood ratio was interpreted instead of the Pearson Chi-square value and it was compared to the level of significance 0.05. Consequently, the test showed that the number of energy conservation behaviors that the study participants regularly take in their homes is independent of their employment status, i.e., there was no statistically significant relationship between the employment status and the number of energy conservation behaviors.

Table 38 - Chi-Square Test (Employment Status and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.823[a]	21	.118
Likelihood Ratio	26.910	21	.174
Linear-by-Linear Association	7.337	1	.007
N of Valid Cases	388		

a. 18 cells (56.3%) have expected count less than 5. The minimum expected count is .48.

VIII. Relationship Status and Conservation

To examine whether there is an association between the relationship status of the participants and the number of energy conservation behaviors they regularly take in their homes, a Chi-Square test of independence was performed (Table 39). The test showed that there was a statistically significant relationship between the relationship status of the participants and the number of energy conservation behaviors they regularly take in their homes at the 0.05 level of significance. $\chi 2$ (12) = 29.356, p= 0.003. Cramer's V (Table 40) showed that the relationship is weak, Cramer's V= 0.159.

Table 39 - Chi-Square Test (Relationship Status and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	29.356[a]	12	.003
Likelihood Ratio	29.440	12	.003
Linear-by-Linear Association	15.982	1	.000
N of Valid Cases	388		

a. 4 cells (20.0%) have expected count less than 5. The minimum expected count is 2.98.

Table 40 - Cramer's V, Relationship Status and the Number of Energy Conservation Behaviors

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.275	.003
	Cramer's V	.159	.003
N of Valid Cases		388	

4.3.1.2. Situational Variables and the Number of Energy Conservation Behaviors

I. Dwelling Type and Conservation

To examine whether there is an association between home ownership and the number of energy conservation behaviors that the study participants regularly take in their homes, a Chi-Square test of independence was performed (Table 41). The test showed that there was a significant relationship between the dwelling type and the number of energy conservation behaviors that the study participants

regularly take in their homes at the 0.05 level of significance. $\chi 2$ (9) = 49.628 p= 0.000. Cramer's V (Table 42) showed that the relationship was weak, Cramer's V= 0.205.

Table 41 - Chi-Square Test (Dwelling Type and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	49.628[a]	9	.000
Likelihood Ratio	49.189	9	.000
Linear-by-Linear Association	22.161	1	.000
N of Valid Cases	395		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 2.30.

Table 42 - Cramer's V, Dwelling Type and the Number of Energy Conservation Behaviors

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.354	.000
	Cramer's V	.205	.000
N of Valid Cases		395	

II. Year Home was Built and Conservation

To examine whether there is an association between the age of the home (considering the date/year the dwelling was built) that the study participants reside in and the number of energy conservation behaviors they regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 43). The test showed that there was a statistically significant negative relationship between the year home was built and the number of energy conservation behaviors that the study participants regularly take in their homes at the 0.05 level of significance. However, the Kendall's tau_b correlation coefficients= - 0.092 showed that the relationship was weak.

Table 43 - Kendall's tau_b Correlation Coefficient – Year Home was Built and the Number of Energy Conservation Behaviors.

Correlations

			No. of Conservation	54. Home Age
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	-.092*
		Sig. (2-tailed)	.	.038
		N	401	365
	54. Home Age	Correlation Coefficient	-.092*	1.000
		Sig. (2-tailed)	.038	.
		N	365	365

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

III. Home Ownership and Conservation

To examine whether there is an association between home ownership and the number of energy conservation behaviors that the study participants regularly take in their homes, a Chi-Square test of independence was performed (Table 44). The results showed that one of the assumptions of the chi-square test of independence was violated. More specifically, the results showed that around 33% of the cells (i.e., more than 20%) had expected count less than 5. Therefore, the value of the Likelihood ratio was interpreted instead of the Pearson Chi-square value, and it was compared to the level of significance 0.05. Consequently, the test showed that there was a significant relationship between home ownership and the number of energy conservation behaviors that the study participants regularly take in their homes. LR (6) = 35.312, p= 0.000. Cramer's V (Table 45) showed that the relationship was weak, Cramer's V= 0.223.

Table 44 - Chi-Square Test (Home Ownership and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.866[a]	6	.000
Likelihood Ratio	35.312	6	.000
Linear-by-Linear Association	27.372	1	.000
N of Valid Cases	391		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is .68.

Table 45 - Cramer's V, Home Ownership and the Number of Energy Conservation Behaviors

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.315	.000
	Cramer's V	.223	.000
N of Valid Cases		391	

IV. City/Township (Rural vs Urban) and Conservation

To examine whether there is an association between the city/township in which the study participants reside and the number of energy conservation behaviors they regularly take in their homes, a Chi-Square test of independence was performed (Table 46). The test showed that the number of energy conservation behaviors that the study participants regularly take in their homes is independent of the city/township they reside in, i.e., there was no significant relationship between the city/township and the number of energy conservation behaviors. It should be noted however, when the analysis was performed; the four rural areas (Wellesley, Wilmot, Woolwich, North Dumfries) within the Region of Waterloo were grouped into one category (Rural). The three major cites (Kitchener, Waterloo, and Cambridge) were not grouped together due to their high population and the relatively higher number of respondents from those cities. These three cities were described as (Urban).

Table 46 - Chi-Square Test (City/Township - rural vs urban- and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.622[a]	9	.055
Likelihood Ratio	19.679	9	.020
Linear-by-Linear Association	2.222	1	.136
N of Valid Cases	398		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 4.66.

V. Information and Conservation

To examine whether there is an association between the availability and access to information on the number of reported energy conservation behaviors that the study participants regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 47). The test showed that there were statistically significant positive relationships between the two questions used in this study (to measure the variable "information") and the number of energy conservation behaviors that the study participants regularly take in their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= 0.168 and 0.199 showed that the relationships were weak.

Table 47 - Kendall's tau_b Correlation Coefficient – Information and the Number of Energy Conservation Behaviors

Correlations

			No. of Conservation Behaviors	36. Read received info.	37. Follow/Listen to Info.
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.168**	.199**
		Sig. (2-tailed)	.	.000	.000
		N	401	379	395
	36. Read received info.	Correlation Coefficient	.168**	1.000	.380**
		Sig. (2-tailed)	.000	.	.000
		N	379	379	378
	37. Follow/Listen to Info.	Correlation Coefficient	.199**	.380**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	395	378	395

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

4.3.1.3. Psychological Variables and the Number of Energy Conservation Behaviors

I. Attitudinal Variables and Conservation

To examine whether there is an association between the attitude of the study participants and the number of energy conservation behaviors they regularly take in their homes; a nonparametric test (the Kendall's tau-b correlation coefficient) was performed (Table 48). The test showed that there was a significant positive relationship between each of the four attitudinal variables - used in this study - and

the number of energy conservation behaviors that the study participants regularly take in their homes. and the number of energy conservation behaviors that the study participants regularly take in their homes. That is, all of the attitudinal variables used in this study have a statistically significant positive relationship with the number of energy conservation behaviors at the 0.01 level of significance. However, the Kendall's tau-b correlation coefficient showed that the relationships were weak.

Table 48 - Kendall's tau_b Correlation Coefficient – Attitudinal Variables and the Number of Energy Conservation Behaviors.

Correlations

			No. of Conservation Behaviors	5C. Conservation Priority	5E. Efficiency Priority	6. Attitude (Environmental views/ concern)	7. Attitude (Climate Change views/
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.250**	.215**	.191**	.158**
		Sig. (2-tailed)	.	.000	.000	.000	.000
		N	401	400	400	399	401
	5C. Conservation Priority	Correlation Coefficient	.250**	1.000	.728**	.227**	.324**
		Sig. (2-tailed)	.000	.	.000	.000	.000
		N	400	400	400	398	400
	5E. Efficiency Priority	Correlation Coefficient	.215**	.728**	1.000	.253**	.304**
		Sig. (2-tailed)	.000	.000	.	.000	.000
		N	400	400	400	398	400
	6. Attitude (Environmental views/ concern)	Correlation Coefficient	.191**	.227**	.253**	1.000	.526**
		Sig. (2-tailed)	.000	.000	.000	.	.000
		N	399	398	398	399	399
	7. Attitude (Climate Change views/ concern)	Correlation Coefficient	.158**	.324**	.304**	.526**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.
		N	401	400	400	399	401

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

II. Subjective Norms and Conservation

To examine whether there is an association between the independent variables (subjective norms) and the number of energy conservation behaviors that the study participants regularly take in their homes, a Chi-Square test of independence was performed (Table 49). The test showed that there was a significant relationship between the variable subjective norms and the number of energy conservation behaviors that participants regularly take in their homes. $\chi 2$ (3) = 8.621, p= 0.035. Cramer's V (Table 50) showed that the relationship was weak, Cramer's V= 0.150.

Table 49 - Chi-Square Test (Subjective Norms and the Number of Energy Conservation Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.621[a]	3	.035
Likelihood Ratio	8.838	3	.032
Linear-by-Linear Association	7.899	1	.005
N of Valid Cases	385		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.20.

Table 50 - Cramer's V, Subjective Norms and the Number of Energy Conservation Behaviors

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.150	.035
	Cramer's V	.150	.035
N of Valid Cases		385	

III. Knowledge and Conservation

To examine whether there is an association between the knowledge that the study participants have and the number of energy conservation behaviors they regularly take in their homes; a nonparametric test (the Kendall's tau-b correlation coefficient) was performed (Table 51). The test showed that there were statistically significant positive relationships between the two knowledge variables used in this study (to measure the respondents' knowledge) and the number of energy conservation behaviors that

the study participants regularly take in their homes. However, the Kendall's tau-b correlation coefficients= 0.181 and 0.188 showed that the relationships were weak

Table 51 - Kendall's tau_b Correlation Coefficient – Knowledge and the Number of Energy Conservation Behaviors

Correlations

			No. of Conservation Behaviors	22. knowledge (Reduce Home Energy Usage)	30. Knowledge - Net Zero
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.199**	.104*
		Sig. (2-tailed)	.	.000	.018
		N	401	401	394
	22. knowledge (Reduce Home Energy Usage)	Correlation Coefficient	.199**	1.000	.008
		Sig. (2-tailed)	.000	.	.857
		N	401	401	394
	30. Knowledge - Net Zero	Correlation Coefficient	.104*	.008	1.000
		Sig. (2-tailed)	.018	.857	.
		N	394	394	394

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

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

IV. Cost-Benefit Appraisal and Conservation

To examine whether there is an association between the psychological variable (cost-benefit appraisal) and the number of energy conservation behaviors that the study participants regularly take in their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 52). The test showed that there was a statistically significant positive relationship between the cost-benefit appraisal and the number of energy conservation behaviors that the study participants regularly take in their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= 0.146 and 0.126 showed that the relationships were weak

Table 52 - Kendall's tau_b Correlation Coefficient – Cost-Benefit Appraisal and the Number of Energy Conservation Behaviors

Correlations

			No. of	21B. Save	21E. Energy
Kendall's tau_b	No. of Conservation Behaviors	Correlation Coefficient	1.000	.146**	.126**
		Sig. (2-tailed)	.	.001	.005
		N	401	398	392
	21B. Save energy - Save Money	Correlation Coefficient	.146**	1.000	.462**
		Sig. (2-tailed)	.001	.	.000
		N	398	398	392
	21E. Energy Eff. & Con. reduce bills	Correlation Coefficient	.126**	.462**	1.000
		Sig. (2-tailed)	.005	.000	.
		N	392	392	392

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

4.3.2. Energy Efficiency Behaviors

4.3.2.1. Socio-Demographic Variables and the Number of Energy Efficiency Behaviors

I. Age and Efficiency

To examine whether there is an association between the age of the study participants and the number of energy efficiency improvements they have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 53). The test showed that there was no statistically significant relationship between the age of the participants and the number of energy efficiency improvements they have already made to their homes.

Table 53 - Kendall's tau_b Correlation Coefficient – Age of Participants and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency Behaviors	46. Age
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.027
		Sig. (2-tailed)	.	.503
		N	401	401
	46. Age	Correlation Coefficient	.027	1.000
		Sig. (2-tailed)	.503	.
		N	401	401

II. Income Level and Efficiency

To examine whether there is an association between the income level of the study participants and the number of energy efficiency improvements they have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 54). The test showed that there was a statistically significant positive relationship between the income level and the number of energy efficiency improvements that the study participants have already made to their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= 0.281 showed that the relationship was weak.

Table 54 - Kendall's tau_b Correlation Coefficient – Income Level and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency Behaviors	59. Income
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.281**
		Sig. (2-tailed)	.	.000
		N	401	300
	59. Income	Correlation Coefficient	.281**	1.000
		Sig. (2-tailed)	.000	.
		N	300	300

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

III. Level of Education and Efficiency

To examine whether there is an association between the level of education that the study participants hold and the number of energy efficiency improvements they have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 55). The test showed that there was no statistically significant relationship between the level of education and the number of energy efficiency improvements that the study participants have already made to their homes.

Table 55 - Kendall's tau_b Correlation Coefficient – Level of Education and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency Behaviors	47. Education Level
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.074
		Sig. (2-tailed)	.	.078
		N	401	388
	47. Education Level	Correlation Coefficient	.074	1.000
		Sig. (2-tailed)	.078	.
		N	388	388

IV. Number of People at Home and Efficiency

To examine whether there is an association between the number of people at home and the number of energy efficiency improvements that the study participants have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 56). The test showed that there was a statistically significant positive relationship between the number of people at home and the number of energy efficiency improvements that the study participants have already made to their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= 0.212 showed that the relationship was weak.

Table 56 - Kendall's tau_b Correlation Coefficient – Number of People at Home and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency	50. No of people
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.212**
		Sig. (2-tailed)	.	.000
		N	401	385
	50. No of people	Correlation Coefficient	.212**	1.000
		Sig. (2-tailed)	.000	.
		N	385	385

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

V. Having Children at Home and Efficiency

To examine whether there is an association between having children at home and the number of energy efficiency improvements that the study participants have already made to their homes, a Chi-Square test of independence was performed (Table 57). The test showed that the number of energy efficiency improvements that the study participants have already made to their homes was independent of whether they children at home or not, i.e., there was no statistically significant relationship between having children at home and the number of energy efficiency improvements.

Table 57 - Chi-Square Test (Having Children at Home and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.619[a]	3	.655
Likelihood Ratio	1.623	3	.654
Linear-by-Linear	.836	1	.360
N of Valid Cases	305		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.62.

VI. Gender and Efficiency

To examine whether there is an association between the gender of the study participants and the number of energy efficiency improvements they have already made to their homes, a Chi-Square test of independence was performed (Table 58). The test showed that the number of energy efficiency improvements that the study participants have already made to their homes was independent of their

gender, i.e., there was no statistically significant relationship between the gender of the respondents and the number of energy efficiency behaviors.

Table 58 - Chi-Square Test (Gender and the Number of Energy Efficiency Behaviors)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.437[a]	3	.329
Likelihood Ratio	3.444	3	.328
Linear-by-Linear Association	1.452	1	.228
N of Valid Cases	399		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.42.

VII. Employment Status and Efficiency

To examine whether there is an association between the employment status of the study participants and the number of energy efficiency improvements they have already made to their homes. a Chi-Square test of independence was performed (Table 59). The results showed that one of the assumptions of the chi-square test of independence was violated. More specifically, the results showed that 56.3% of the cells (i.e., more than 20%) had expected count less than 5. Therefore, the value of the Likelihood ratio was interpreted instead of the Pearson Chi-square value, and it was compared to the level of significance 0.05. Consequently, the test showed that the number of energy efficiency improvements that the study participants have already made to their homes was independent of their employment status, i.e., there was no statistically significant relationship between the employment status of the respondents and the number of energy efficiency improvements.

Table 59 - Chi-Square Test (Employment Status and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.651[a]	21	.884
Likelihood Ratio	14.659	21	.840
Linear-by-Linear Association	2.312	1	.128
N of Valid Cases	388		

a. 18 cells (56.3%) have expected count less than 5. The minimum expected count is .77.

VIII. Relationship Status and Efficiency

To examine whether there is an association between the relationship status of the study participants and the number of energy efficiency improvements they have already made to their homes, a Chi-Square test of independence was performed (Table 60). The test showed that there was a statistically significant relationship between the relationship status of the participants and the number of energy efficiency behaviors they have already made tow their homes. $\chi 2$ (12) = 53.349, p= 0.000. Cramer's V (Table 61) showed that the relationship was weak, Cramer's V= 0.214.

Table 60 - Chi-Square Test (Relationship Status and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	53.349[a]	12	.000
Likelihood Ratio	53.983	12	.000
Linear-by-Linear Association	42.188	1	.000
N of Valid Cases	388		

a. 3 cells (15.0%) have expected count less than 5. The minimum expected count is 4.29.

Table 61 - Cramer's V, Relationship Status and the Number of Energy Efficiency Improvements

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.371	.000
	Cramer's V	.214	.000
N of Valid Cases		388	

4.3.2.2. Situational Variables and the Number of Energy Efficiency Behavior

I. Dwelling Type and Efficiency

To examine whether there is an association between home ownership and the number of energy conservation behaviors that the study participants regularly take in their homes, a Chi-Square test of independence was performed (Table 62). The test showed that there was a statistically significant relationship between the dwelling type and the number of energy efficiency behaviors/improvements

that the study participants have already made to their homes at the 0.05 level of significance. $\chi 2$ (9) = 100.270 p= 0.000. Cramer's V (Table 63) showed that the relationship was weak, Cramer's V= 0.291.

Table 62 - Chi-Square Test (Dwelling Type and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	100.270[a]	9	.000
Likelihood Ratio	106.361	9	.000
Linear-by-Linear Association	24.885	1	.000
N of Valid Cases	395		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 3.29.

Table 63 - Cramer's V, Dwelling Type and the Number of Energy Efficiency Improvements

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.504	.000
	Cramer's V	.291	.000
N of Valid Cases		395	

II. Year Home was Built and Efficiency

To examine whether there is an association between the age of the home (considering the year/ date it was built) that the study participants live in and the number of energy efficiency improvements they have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 64). The test showed that there was a statistically significant negative relationship between the home age and the number of energy efficiency improvements that the study participants

have already made to their homes at the 0.01 level of significance. However, the Kendall's tau_b correlation coefficients= - 0.152 showed that the relationship was weak.

Table 64 - Kendall's tau_b Correlation Coefficient – Year Home was Built and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency Behaviors	54. Home Age
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	-.152**
		Sig. (2-tailed)	.	.001
		N	401	365
	54. Home Age	Correlation Coefficient	-.152**	1.000
		Sig. (2-tailed)	.001	.
		N	365	365

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

III. Home Ownership and Efficiency

To examine whether there is an association between home ownership and the number of energy efficiency improvements that the study participants have already made to their homes, a Chi-Square test of independence was performed (Table 65). The results showed that one of the assumptions of the chi-square test of independence was violated. More specifically, the results showed that around 33% of the cells (i.e., more than 20%) had expected count less than 5. Therefore, the value of the Likelihood ratio will be interpreted instead of the Pearson Chi-square value, and it will be compared to the level of significance 0.05. Consequently, the test showed that there was a statistically significant relationship between home ownership and the number of energy conservation behaviors that the study participants regularly take in their homes. LR (6) = 95.916, p= 0.000. Cramer's V (Table 66) showed that the relationship is moderate, Cramer's V= 0.333.

Table 65 - Chi-Square Test (Home Ownership and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	86.731[a]	6	.000
Likelihood Ratio	95.916	6	.000
Linear-by-Linear Association	59.602	1	.000
N of Valid Cases	391		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.00.

Table 66 - Cramer's V, Home Ownership and the Number of Energy Efficiency Improvements

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.471	.000
	Cramer's V	.333	.000
N of Valid Cases		391	

IV. City/Township (Rural vs Urban) and Efficiency

To examine whether there is an association between the city/township in which the study participants reside and the number of energy efficiency improvements they have already made to their homes, a Chi-Square test of independence was performed (Table 67). The test showed that the number of energy efficiency improvements that the study participants have already made to their homes was independent of the city/township they reside in - i.e., the was no statistically significant relationship between the city/township and the number of energy efficiency improvements. It should be noted however, when the analysis was performed; the four rural areas (Wellesley, Wilmot, Woolwich, North Dumfries) within the region of waterloo were grouped into one category (Rural). The three major cites (Kitchener, Waterloo, and Cambridge) were not grouped together due to their high population and the relatively higher number of respondents from those cities. These three cities are described as (Urban).

Table 67 - Chi-Square Test (City/ Township and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.009[a]	9	.275
Likelihood Ratio	11.238	9	.260
Linear-by-Linear Association	5.453	1	.020
N of Valid Cases	398		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.53.

V. Information and Efficiency

To examine whether there is an association between the availability and access to information on the number of energy efficiency improvements that the study participants have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 68). The test showed that there were statistically significant positive relationships between the two questions used in this study (to measure the variable "information") and the number of energy efficiency improvements that the study participants have already made to their homes at the 0.05 level of significance. However, the Kendall's tau_b correlation coefficients= 0.096 and 0.093 showed that the relationships were weak.

Table 68 - Kendall's tau_b Correlation Coefficient – Information and the Number of Energy Efficiency Improvements.

Correlations

			No. of	36. Read	37.
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.096*	.093*
		Sig. (2-tailed)	.	.028	.034
		N	401	379	395
	36. Read received info.	Correlation Coefficient	.096*	1.000	.380**
		Sig. (2-tailed)	.028	.	.000
		N	379	379	378
	37. Follow/Listen to Info.	Correlation Coefficient	.093*	.380**	1.000
		Sig. (2-tailed)	.034	.000	.
		N	395	378	395

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

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

4.3.2.3. Psychological Variables and the Number of Energy Efficiency Behaviors

I. Attitudinal Variables and Efficiency

To examine whether there is an association between the attitude of the study participants and the number of energy efficiency improvements they have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 69). The test showed that there was no statistically significant relationship between any of the four attitudinal variables - used in this study as explained earlier in Chapter 3 - and the number of energy efficiency improvements that the study participants have already made to their homes. That is, none of the attitudinal variables used in this study had a statistically significant relationship with the number of energy efficiency improvements at the 0.01 level of significance.

Table 69 - Kendall's tau_b Correlation Coefficient – Attitudinal Variables and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency Behaviors	5C. Conservation Priority	5E. Efficiency Priority	6. Attitude (Environmental views/ concern)	7. Attitude (Climate Change views/ concern)
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.037	.071	.065	.061
		Sig. (2-tailed)	.	.399	.105	.143	.163
		N	401	400	400	399	401
	5C. Conservation Priority	Correlation Coefficient	.037	1.000	.728**	.227**	.324**
		Sig. (2-tailed)	.399	.	.000	.000	.000
		N	400	400	400	398	400
	5E. Efficiency Priority	Correlation Coefficient	.071	.728**	1.000	.253**	.304**
		Sig. (2-tailed)	.105	.000	.	.000	.000
		N	400	400	400	398	400
		Correlation Coefficient	.065	.227**	.253**	1.000	.526**
		Sig. (2-tailed)	.143	.000	.000	.	.000

	6. Attitude	N	399	398	398	399	399
	7. Attitude (Climate Change views/ concern)	Correlation Coefficient	.061	.324**	.304**	.526**	1.000
		Sig. (2-tailed)	.163	.000	.000	.000	.
		N	401	400	400	399	401

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

II. Subjective Norms and Efficiency

To examine whether there is an association between subjective norms and the number of energy efficiency improvements that the study participants have already made to their homes, a Chi-Square test of independence was performed (Table 70). The test showed that the number of energy efficiency improvements that the study participants have already made to their homes was independent of the variable subjective norms, i.e., the was no significant relationship between subjective norms and the number of energy efficiency improvements.

Table 70 - Chi-Square Test (Subjective Norms and the Number of Energy Efficiency Improvements)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.461[a]	3	.691
Likelihood Ratio	1.472	3	.689
Linear-by-Linear Association	.855	1	.355
N of Valid Cases	385		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected

III. Knowledge and Efficiency

To examine whether there is an association between the knowledge that the study participants have and the number of energy efficiency improvements they have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 71). The test

showed that there were statistically significant positive relationships between the two questions used in this study (to measure the respondents' knowledge) and the number of energy efficiency improvements that the study participants have already made to their homes. However, the Kendall's tau_b correlation coefficients= 0.181 and 0.188 showed that the relationships were weak

Table 71 - Kendall's tau_b Correlation Coefficient – Knowledge and the Number of Energy Efficiency Iimprovements.

Correlations

			No. of Efficiency Behaviors	22. knowledge (Reduce Home Energy Usage)	30. Knowledge - Net Zero
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.187**	.108*
		Sig. (2-tailed)	.	.000	.013
		N	401	401	394
	22. knowledge (Reduce Home Energy Usage)	Correlation Coefficient	.187**	1.000	.008
		Sig. (2-tailed)	.000	.	.857
		N	401	401	394
	30. Knowledge - Net Zero	Correlation Coefficient	.108*	.008	1.000
		Sig. (2-tailed)	.013	.857	.
		N	394	394	394

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

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

IV. Cost-Benefit Appraisal and Efficiency

To examine whether there is an association between the psychological variable (cost-benefit appraisal) and the number of energy efficiency improvements that the study participants have already made to their homes; a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Table 72). The test showed that there was no statistically significant relationship between the cost-benefit appraisal as reported by the respondents and the number of energy efficiency improvements they have already made to their homes.

Table 72 - Kendall's tau_b Correlation Coefficient – Cost-Benefit Appraisal and the Number of Energy Efficiency Improvements.

Correlations

			No. of Efficiency Behaviors	21B. Save energy - Save Money	21E. Energy Eff. & Con. reduce bills
Kendall's tau_b	No. of Efficiency Behaviors	Correlation Coefficient	1.000	.064	.081
		Sig. (2-tailed)	.	.141	.065
		N	401	398	392
	21B. Save energy - Save Money	Correlation Coefficient	.064	1.000	.462**
		Sig. (2-tailed)	.141	.	.000
		N	398	398	392
	21E. Energy Eff. & Con. reduce bills	Correlation Coefficient	.081	.462**	1.000
		Sig. (2-tailed)	.065	.000	.
		N	392	392	392

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

4.4. Ordinal Regression

4.4.1. Energy Conservation Behaviors

4.4.1.1. Socio-Demographic Variables and Energy Conservation Behaviors

I. Relationship Status and Energy Conservation

PLUM - Ordinal Regression

Model Fitting Information

According to the obtained results in (table 73), the significant chi-square statistic (p=0.001) indicates that the final model provides a significant improvement over the baseline intercept-only model. This means that the model provides better predictions than guessing based on the marginal probabilities for the outcome categories.

Table 73 - Model Fitting Information, Relationship Status and Energy Conservation Behaviors.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	87.363			
Final	68.205	19.158	4	.001

Link function: Logit.

Pseudo R-Square

What constitutes a "good" R2 (Table 74) value depends upon the nature of the outcome and the explanatory variable. Here, the pseudo R2 values (Nagelkerke = 5.2%) indicates that the variable (relationship status) can explain around 5.2% of the variation between respondents in terms of the number of energy conservation behaviors they regularly take in their homes.

Table 74 - R-Square, Relationship Status and Conservation Behaviors

Pseudo R-Square

Cox and Snell	.048
Nagelkerke	.052
McFadden	.019

Link function: Logit.

To understand the direction of the identified relationship between the independent variable (relationship status) and the number of energy conservation behaviors, ordinal regression was performed. The obtained results as shown in the parameter estimates (Table 75), which explains the change in the response associated with a one-unit change of the independent variable, indicate that the direction of the association, starting with those who are likely to engage in larger number of conservation behaviors to those who are likely to engage in lower number is as follows: married, co-habiting/ common law, divorced/ separated, single/never married, widowed.

Table 75 - Parameter Estimates - Relationship Status and Energy Conservation Behaviors

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower	Upper
Threshold	[Q23_4cat = 1]	-2.705	.206	172.304	1	.000	-3.109	-2.301
	[Q23_4cat = 2]	-.886	.136	42.237	1	.000	-1.154	-.619
	[Q23_4cat = 3]	.743	.134	30.858	1	.000	.481	1.006
Location	[Q49_Relationship=1]	-.847	.284	8.879	1	.003	-1.404	-.290
	[Q49_Relationship=2]	-.753	.328	5.281	1	.022	-1.396	-.111
	[Q49_Relationship=3]	-1.056	.326	10.486	1	.001	-1.696	-.417
	[Q49_Relationship=4]	-.151	.335	.203	1	.652	-.808	.506
	[Q49_Relationship=5]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

4.4.1.2. Situational Variables and Energy Conservation Behaviors

II. Home Ownership and Dwelling Type with Conservation

PLUM - Ordinal Regression

Model Fitting Information

According to the obtained results in (table 76), the significant chi-square statistic (p=0.000) indicates that the final model provides a significant improvement over the baseline intercept-only model. This means that the model provides better predictions than guessing based on the marginal probabilities for the outcome categories.

Table 76 - Model Fitting Information, Situational Variables (Home Ownership and Dwelling Type) and Conservation Behaviors.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	142.360			
Final	99.935	42.425	5	.000

Link function: Logit.

Pseudo R-Square

What constitutes a "good" R2 (Table 77) value depends upon the nature of the outcome and the explanatory variables. Here, the pseudo R2 values (Nagelkerke = 11.3%) indicates that the variable (homeownership and dwelling type) can explain around 11.3% of the variation among respondents in terms of the number of energy conservation behaviors they regularly take in their homes.

Table 77 - R-Square, Situational Variables (Home Ownership and Dwelling Type) and Conservation

Pseudo R-Square

Cox and Snell	.104
Nagelkerke	.113
McFadden	.043

Link function: Logit.

To understand the direction of the identified relationship between the independent variables (home ownership and dwelling type) and the number of energy conservation behaviors, an ordinal regression was performed. The obtained results as shown in the parameter estimates (Table 78), which explains the change in the response associated with a one-unit change of the independent variables, indicate that respondents who own their dwellings are more likely to engage in energy conservation behaviors than renters do.

Additionally, according to the obtained results, residents who live in single detached houses tend to engage in more conservation behaviors than those who live in townhouses. The latter are followed by those living in high-rise apartment buildings (greater than 4 stories), then by residents living in low-rise apartment buildings (4 stories or less) who tend to participate in the lowest number of energy conservation behaviors compared to the other groups.

Table 78 - Parameter Estimates - Situational Variables (Dwelling Type Home Ownership) and Conservation Behaviors

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Q23_4cat = 1]	-1.389	.476	8.495	1	.004	-2.322	-.455
	[Q23_4cat = 2]	.571	.473	1.457	1	.227	-.356	1.499
	[Q23_4cat = 3]	2.254	.481	21.924	1	.000	1.311	3.198
Location	[Q53_Home_Ownership=	-1.012	.658	2.364	1	.124	-2.301	.278
	[Q53_Home_Ownership=	-.574	.330	3.027	1	.082	-1.221	.073
	[Q53_Home_Ownership=	0[a]	.	.	0	.	.	.
	[Dwelling_type_r=1]	1.496	.478	9.771	1	.002	.558	2.433
	[Dwelling_type_r=2]	1.515	.479	9.995	1	.002	.576	2.454
	[Dwelling_type_r=3]	.646	.459	1.977	1	.160	-.254	1.545
	[Dwelling_type_r=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

4.4.1.3. Psychological Variables and Energy Conservation Behaviors

III. Subjective Norms with Conservation

PLUM - Ordinal Regression

Model Fitting Information

According to the obtained results in (table 79), the significant chi-square statistic (p=0.004) indicates that the final model provides a significant improvement over the baseline intercept-only model. This means that the model provides better predictions than guessing based on the marginal probabilities for the outcome categories.

Table 79 - Model Fitting Information, Subjective Norms and Energy Conservation Behaviors.

Model Fitting Information

Model	-2 Log	Chi-Square	df	Sig.
Intercept Only	38.844			
Final	30.517	8.327	1	.004

Link function: Logit.

Pseudo R-Square

What constitutes a "good" R2 (Table 80) value depends upon the nature of the outcome and the explanatory variable. Here, the pseudo R2 values (Nagelkerke = 2.3%) indicates that the variable (subjective norms) can explain around 2.3% of the variation between respondents in terms of the number of energy conservation behaviors they regularly take in their homes.

Table 80 - R-Square, Subjective Norms and Conservation

Pseudo R-Square

Cox and Snell	.021
Nagelkerke	.023
McFadden	.008

Link function: Logit.

To understand the direction of the identified relationship between the independent variable (subjective norms) and the number of energy conservation behaviors, an ordinal regression was performed. The

obtained results as shown in the parameter estimates (Table 81), which explains the change in the response associated with a one-unit change of the independent variable, show that respondents who said “yes” i.e., indicated an interest in knowing how their energy consumption compares to others in the neighborhood are more likely to participate in more conservation activities that those who said “no” - So, the variable subjective norms has an influence on the number of conservation activities that people regularly take in their home. The results indicate that those who said yes, were 57.8% more likely to participate in conservation activities than those who said “no”.

Table 81 - Parameter Estimates, Subjective Norms and Conservation

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Q23_4cat = 1]	-2.579	.199	168.515	1	.000	-2.968	-2.189
	[Q23_4cat = 2]	-.844	.128	43.700	1	.000	-1.094	-.594
	[Q23_4cat = 3]	.763	.126	36.576	1	.000	.516	1.011
Location	[Q33_Subjective_norms=0	-.578	.202	8.183	1	.004	-.975	-.182
	[Q33_Subjective_norms=1	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

4.4.2. Energy Efficiency Behaviors

4.4.2.1. Socio-Demographic Variables and Efficiency Behaviors

I. Relationship Status and Efficiency

PLUM - Ordinal Regression

Model Fitting Information

According to the obtained results in (table 82), the significant chi-square statistic (p=0.001) indicates that the final model provides a significant improvement over the baseline intercept-only model. This means that the model provides better predictions than guessing based on the marginal probabilities for the outcome categories.

Table 82 - Model Fitting Information, Relationship Status and Energy Efficiency Behaviors.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	109.493			
Final	56.794	52.698	4	.000

Link function: Logit.

Pseudo R-Square

What constitutes a "good" R2 (Table 83) value depends upon the nature of the outcome and the explanatory variable. Here, the pseudo R2 values (Nagelkerke = 13.7%) indicates that the variable (relationship status) can explain around 13.7% of the variation between respondents in terms of the number of energy efficiency behaviors they regularly take in their homes.

Table 83 - R-Square, Relationship Status and Efficiency Behaviors

Pseudo R-Square

Cox and Snell	.127
Nagelkerke	.137
McFadden	.051

Link function: Logit.

To understand the direction of the identified relationship between the independent variable (relationship status) and the number of energy conservation behaviors, ordinal regression was performed. The obtained results as shown in the parameter estimates (Table 84), which explains the change in the response associated with a one-unit change of the independent variable, indicate that the direction of the association, starting with those who are likely to engage in higher number of efficiency behaviors to those who are likely to engage in lower number is as follows: married, then co-habiting/ common law, followed by Divorced/ Separated, then widowed, and finally single/never married respondents.

Table 84 - Parameter Estimates - Relationship Status and Energy Efficiency Behaviors

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower	Upper
Threshold	[Q26_4Cat = 1]	-1.120	.142	62.369	1	.000	-1.398	-.842
	[Q26_4Cat = 2]	.023	.128	.033	1	.855	-.227	.274
	[Q26_4Cat = 3]	1.568	.163	92.048	1	.000	1.248	1.889
Location	[Q49_Relationship=1	-1.784	.318	31.414	1	.000	-2.408	-1.160
	[Q49_Relationship=2	-1.114	.337	10.920	1	.001	-1.775	-.453
	[Q49_Relationship=3	-1.570	.352	19.890	1	.000	-2.260	-.880
	[Q49_Relationship=4	-.517	.333	2.414	1	.120	-1.170	.135
	[Q49_Relationship=5	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

4.4.2.2. Situational Variables and Efficiency Behaviors

II. Home Ownership and Dwelling Type and efficiency

PLUM - Ordinal Regression

Model Fitting Information

According to the obtained results in (table 85), the significant chi-square statistic (p=0.000) indicates that the final model provides a significant improvement over the baseline intercept-only model. This means that the model provides better predictions than guessing based on the marginal probabilities for the outcome categories.

Table 85 - Model Fitting Information, Situational Variables (Home Ownership and Dwelling Type) and Efficiency Behaviors

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	191.801			
Final	77.735	114.066	5	.000

Link function: Logit.

Pseudo R-Square

What constitutes a “good” R2 (Table 86) value depends upon the nature of the outcome and the explanatory variables. Here, the pseudo R2 values (Nagelkerke = 27.6%) indicates that the variable

(homeownership and dwelling type) can explain around 27.6% of the variation among respondents in terms of the number of energy efficiency behaviors they have already made to their homes.

Table 86 - R-Square, Situational Variables (Home Ownership and Dwelling Type) and Efficiency.

Pseudo R-Square

Cox and Snell	.256
Nagelkerke	.276
McFadden	.111

Link function: Logit.

Additionally, the results shown in the parameter estimates (table 87) indicate that, residents who live in single detached houses tend to engage in more efficiency behaviors than those who live in townhouses. The latter are followed by those living in low-rise apartment buildings (4 stories or less), then by residents living in high-rise apartment buildings (greater than 4 stories) who tend to participate in the lowest number of energy efficiency behaviors compared to the other groups. Moreover, respondents who own their dwelling are more likely to engage in more efficiency behaviors than those who rent their dwellings.

Table 87 -Parameter Estimates - Situational Variables (Dwelling Type and Home Ownership) and Efficiency Behaviors

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[O26_4Cat = 1]	.570	.604	.893	1	.345	-.613	1.754
	[O26_4Cat = 2]	1.918	.608	9.942	1	.002	.726	3.111
	[O26_4Cat = 3]	3.515	.621	32.048	1	.000	2.298	4.732
Location	[O53_Home_Ownership=0]	-1.158	.665	3.028	1	.082	-2.462	.146
	[O53_Home_Ownership=1]	-1.231	.358	11.803	1	.001	-1.933	-.529
	[O53_Home_Ownership=2]	0[a]	.	.	0	.	.	.
	[Dwelling_type_r=1]	1.366	.612	4.971	1	.026	.165	2.566
	[Dwelling_type_r=2]	1.978	.610	10.507	1	.001	.782	3.173
	[Dwelling_type_r=3]	-.042	.668	.004	1	.949	-1.352	1.267
	[Dwelling_type_r=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

4.5. Summary of Findings/Results

4.5.1. Energy Conservation Behaviors

Table (88) shows a summary of the obtained results from the performed statistical tests (Kendall's tau_b correlation coefficient, Chi-Square test of independence, Cramer's V, and Ordinal regression) between the several independent variables and the number of reported energy conservation behaviors that the study participants regularly take in their homes.

Table 88 - Summary of Results - Energy Conservation (Kendall's tau_b/ Chi-Square/ Cramers' V)

	Determinants/ Variables		Statistical Test	Association/ Relationship	Kendall's tau-b Value (-1 to +1) (Correlation Coefficient)	Pearson Chi-Square	Likelihood Ratio	Cramer's V (0 to +1)	Description (Strength of Association)	Direction
Socio-Demographic variables	Q46) Age		kendall's tau-b	Insignificant	0.016	N/A	N/A	N/A	N/A	N/A
	59) Income		kendall's tau-b	Significant	.157**	N/A	N/A	N/A	weak	positive
	Q47) Education		kendall's tau-b	Significant	.097*	N/A	N/A	N/A	weak	positive
	50) No. of people at Home		kendall's tau-b	Significant	.149**	N/A	N/A	N/A	weak	positive
	Q51) Having Children at Home		of Independence	Insignificant	N/A	0.191	N/A	N/A	N/A	N/A
	Q60) Gender		of Independence	Insignificant	N/A	0.846	N/A	N/A	N/A	N/A
	Q48) Employment		of Independence	Insignificant	N/A	0.118	0.174	N/A	N/A	N/A
	Q49) Relationship Status		of Independence	Significant	N/A	0.003	N/A	0.159	weak	N/A
Situational Variables	Q1) Dwelling Type		Chi-Square test of	Significant	N/A	0.00	0.00	0.213	weak	N/A
	Q54) Year home was built		Kendall's tau-b	Significant	-.092*	N/A	N/A	N/A	weak	Negative
	Q53) Home Ownership		Chi-Square test of	Significant	N/A	0.00	0.00	0.223	weak	N/A
	Q60) City/Township (Urban vs. Rural)		Chi-Square test of	Insignificant	N/A	0.055	N/A	N/A	N/A	N/A
	Information	Q36) Read received info.	Kendall's tau-b	Significant	.168**	N/A	N/A	N/A	weak	positive
		Q37) Follow/Listen to Info.		Significant	.199**	N/A	N/A	N/A	weak	positive
Psychological Variables	Attitudinal variables	Energy Conservation Priority	Kendall's tau-b	Significant	.250**	N/A	N/A	N/A	Weak	Positive
		Energy Efficiency Priority		Significant	.215**	N/A	N/A	N/A	Weak	Positive
		Environmental Concern		Significant	.191**	N/A	N/A	N/A	Weak	Positive
		Climate Change Concern		Significant	.158**	N/A	N/A	N/A	Weak	Positive
	Subjective Norms	Q33) energy consumption compared to neighborhood	Chi-Square test	Significant	N/A	0.035	N/A	0.15	Weak	N/A
	Knowledge	Q22) Know how to reduce your home's energy usage	Kendall's tau-b	Significant	.199**	N/A	N/A	N/A	weak	positive
		Q30) Net Zero Energy		Significant	.104*	N/A	N/A	N/A	weak	positive
	Cost-benefit appraisal	21 B) save energy to save money	Kendall's tau-b	Significant	.146**	N/A	N/A	N/A	weak	positive
		21 E) Energy Efficiency and conservation can help reduce utility bills		Significant	.126**	N/A	N/A	N/A	weak	positive

Table (89) show the obtained results from the performed ordinal regression between those IVs that were found to have a statistically significant relationship (based on the performed Chi-Square test on independence) between them and the number of reported energy conservation behaviors that the study participants regularly take in their homes.

Table 89 - Summary of Results - Energy Conservation (Ordinal Regression)

Variable/ Determinant	Code	Option	Estimate value	Exponantial value of estimate	Ordered exponantial values - Descending	Order of participation (Descending)	No. of Activities	Average No. of Activities	No. of Respondents
Subjective Norms	1	Yes	0	1	1	yes	2888	10.857	266
	0	No	-0.578	0.561019284	0.561019	No	1188	9.983	119
Relationship Status	1	Single, never married	-0.847	0.428699102	1	Married	2520	10.956	230
	2	Divorced/ Separated	-0.753	0.470951577	0.859848	Co-habiting/ common law	368	10.823	34
	3	Widowed	-1.056	0.347844409	0.470952	Divorced/ Separated	355	9.861	36
	4	Co-habiting/ common law	-0.151	0.859847699	0.428699	Single, Never married	485	9.5	51
	5	Married	0	1	0.347844	Widowed	343	9.27	37
Dwelling Type	1	Townhouse (Townhouse, Semi-detached house, Duplex or triplex)	1.496	4.46379812	4.549421	Single detached house	2870	10.954	262
	2	Single detached house	1.515	4.549421127	4.463798	Townhouse (Townhouse, Semi-detached house, Duplex or triplex)	666	10.14	63
	3	High rise apartment building (greater than 4 stories)	0.646	1.90789397	1.907894	High rise apartment building (greater than 4 stories)	398	9.045	44
	4	Low rise apartment building (4 stories or less)	0	1	1	Low rise apartment building (4 stories or less)	217	8.346	26
Home Ownership	0	Have some other living arrangement	-1.012	0.36349127	1	Own	3238	10.976	295
	1	Rent	-0.574	0.563267855	0.563268	Rent	797	9.056	88
	2	Own	0	1	0.363491	Have Other living arrangements	77	9.625	8

4.5.2. Energy Efficiency Behaviors

Table (90) shows a summary of the obtained results from the performed statistical tests (Kendall's tau_b correlation coefficient, Chi-Square test of independence, Cramer's V, and Ordinal regression) between the several independent variables and the number of reported energy efficiency behaviors that the study participants have already made to their homes.

Table 90 - Summary of Results - Energy Efficiency (Kendall's tau_b/ Chi-Square/ Cramers' V)

	Determinants/ Variables		Statistical Test	Association/ Relationship	Kendall's tau-b Value (-1 to +1) (Correlation Coefficient)	Pearson Chi-Square	Likelihood Ratio	Cramer's V (0 to +1)	Description (Strength of Association)	Direction
Socio-Demograpic Variables	Q46) Age		kendall's tau-b	Insignificant	0.027	N/A	N/A	N/A	N/A	N/A
	59) Income		kendall's tau-b	Significant	.281**	N/A	N/A	N/A	weak	positive
	Q47) Education		kendall's tau-b	Insignificant	0.074	N/A	N/A	N/A	N/A	N/A
	50) No. of people at Home		kendall's tau-b	Significant	.212**	N/A	N/A	N/A	weak	positive
	Q51) Having Children at Home		of Independence	Insignificant	N/A	0.655	N/A	N/A	N/A	N/A
	Q60) Gender		of Independence	Insignificant	N/A	0.329	N/A	N/A	N/A	N/A
	Q48) Employment		of Independence	Insignificant	N/A	0.884	0.840	N/A	N/A	N/A
	Q49) Relationship Status		of Independence	Significant	N/A	0.00	N/A	0.214	weak	N/A
Situational Variables	Q1) Dwelling Type		Chi-Square test of	Significant	N/A	0.00	0.00	0.299	weak	N/A
	Q54) Year home was built		Kendall's tau-b	Significant	-.152**	N/A	N/A	N/A	weak	Negative
	Q53) Home Ownership		Chi-Square test of	Significant	N/A	0.00	0.00	0.333	Moderate	N/A
	Q60) City/ Township (Urban vs. Rural)		Chi-Square test of	Insignificant	N/A	0.275	N/A	N/A	N/A	N/A
	Information	Q36) Read received info.	Kendall's tau-b	Significant	.096*	N/A	N/A	N/A	weak	positive
		Q37) Follow/Listen to Info.		Significant	.093*	N/A	N/A	N/A	weak	positive
Psychological Variables	Attitudinal variables	Energy Conservation Priority	Kendall's tau-b	Insignificant	0.037	N/A	N/A	N/A	N/A	N/A
		Energy Efficiency Priority		Insignificant	0.071	N/A	N/A	N/A	N/A	N/A
		Environmental Concern		Insignificant	0.065	N/A	N/A	N/A	N/A	N/A
		Climate Change Concern		Insignificant	0.061	N/A	N/A	N/A	N/A	N/A
	Subjective Norms	Q33) energy consumption compared to neighborhood	Chi-Square test	Insignificant	N/A	0.691	N/A	N/A	N/A	N/A
	Knowledge	Q22) Know how to reduce your home's energy usage	Kendall's tau-b	Significant	.187**	N/A	N/A	N/A	weak	positive
		Q30) Net Zero Energy		Significant	.108*	N/A	N/A	N/A	weak	positive
	Cost-benefit appraisal	21 B) save energy to save money	Kendall's tau-b	Insignificant	0.064	N/A	N/A	N/A	N/A	N/A
		21 E) Energy Efficiency and conservation can help reduce utility bills		Insignificant	0.081	N/A	N/A	N/A	N/A	N/A

Table (91) show the obtained results from the performed ordinal regression between those IVs that were found to have a statistically significant relationship (based on the performed Chi-Square test on independence) between them and the number of reported energy efficiency behaviors that the study participants have already made to their homes.

Table 91 - Summary of Results - Energy Efficiency (Ordinal Regression)

Variable/ Determinant	Code	Option	Estimate value	Exponantial value of estimate	Ordered exponantial values - Descending	Order of participation (Descending)	No. of Activities	Average No. of Activities	No. of Respondents
Relationship Status	1	Single, never married	-1.784	0.167964942	1	Married	2056	8.939	230
	2	Divorced/ Separated	-1.114	0.328243358	0.596307	Co-habiting/ common law	260	7.647	34
	3	Widowed	-1.57	0.208045182	0.328243	Divorced/ Separated	221	6.138	36
	4	Co-habiting/ common law	-0.517	0.596306788	0.208045	Widowed	204	5.513	37
	5	Married	0	1	0.167965	Single, Never married	246	4.823	51
Dwelling Type	1	Townhouse (Townhouse, Semi-detached house, Duplex or triplex)	1.366	3.919640734	7.228272	Single detached house	2380	9.083	262
	2	Single detached house	1.978	7.228271975	3.919641	Townhouse (Townhouse, Semi-detached house, Duplex or triplex)	148	5.86	63
	3	High rise apartment building (greater than 4 stories)	-0.042	0.958869781	1	Low rise apartment building (4 stories or less)	101	3.884	26
	4	Low rise apartment building (4 stories or less)	0	1	0.95887	High rise apartment building (greater than 4 stories)	148	3.363	44
Home Ownership	0	Have some other living arrangement	-1.158	0.314113781	1	Own	2624	8.894	295
	1	Rent	-1.231	0.292000431	0.314114	Have Other living arrangements	47	5.875	8
	2	Own	0	1	0.0292	Rent	341	3.87	88

4.6. Overall Multiple Regression Models

4.6.1. Overall Multiple Regression Model (Energy Conservation Behaviors)

According to the outputs of the model summary (table 92), the model is significant, and the R Square value is 0.276. This indicates that 27.6% of the variation in the dependent variable (the number of reported energy conservation behaviors) is explained or predicated by independent variables included in the model. Since the value of the R2 tends to be somewhat inflated (this can be attributed to the relatively small sample size and/or the large number of variables), a more realistic estimate is the Adjusted R Square value which is in this model has a value of 0.183 or 18.3%.

Table 92 - Multiple Regression - Energy Conservation - Model Summary

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.526[a]	.276	.183	2.416	.276	2.949	22	170	.000

a. Predictors: (Constant), 21E. Energy Eff. & Con. reduce bills, 46. Age, 54. Year Home was Built, 30. Knowledge - Net Zero, 53. Home Ownership, 37. Follow/Listen to Info., 60. Gender, 33. Subjective norms, Dwelling Type R, 5C. Conservation Priority, 7. Attitude (Climate Change), 47. Education Level, 59. Income, 22. knowledge (Reduce Home Energy Usage), 49. Relationship Status, 21B. Save energy - Save Money, 48. Employment, 36. Read received info., 51. Children at home, 6. Attitude (Environment), 5E. Efficiency Priority, 50. No of people

The ANOVA section (Table 93) of the overall multiple regression model (conservation) indicates a significance or P-value of 0.000 which is the significance value of the model as whole. This means that the findings of the model as a whole (which includes all variables addressed in this study: socio-demographics, situational, and psychological) have a probability of less than 1 in 1000 of being due to chance.

Table 93 - Multiple Regression - Energy Conservation - ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	378.614	22	17.210	2.949	.000[b]
	Residual	991.966	170	5.835		
	Total	1370.580	192			

a. Dependent Variable: Conservation_Behavior - N = 193

b. Predictors: (Constant), 21E. Energy Eff. & Con. reduce bills, 46. Age, 54. Year Home was Built, 30. Knowledge - Net Zero, 53. Home Ownership, 37. Follow/Listen to Info., 60. Gender, 33. Subjective norms, Dwelling Type R, 5C. Conservation Priority, 7. Attitude (Climate Change), 47. Education Level, 59. Income, 22. knowledge (Reduce Home Energy Usage), 49. Relationship Status, 21B. Save energy - Save Money, 48. Employment, 36. Read received info., 51. Children at home, 6. Attitude (Environment), 5E. Efficiency Priority, 50. No of people

The coefficient section (Table 94) of the multiple regression model (conservation) shows a list of the independent variables and whether each of those variables is a significant predictor that can contribute to explaining variation in the dependent variable (the number of reported energy conservation behaviors). The unstandardized coefficient values represent the estimated change in the dependent variable for each unit change in the independent variable. Additionally, the table also includes the standardized coefficients (*beta weights*) which indicates the change in the dependent variable for every standard deviation increase or decrease in the independent variable (significant predictor). Moreover, the significance level of each independent variable is also included in the table. These values represent the probability of the association between each independent variable and the dependent variable in the model as whole.

Table 94 - Multiple Regression - Energy Conservation - Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.260	2.931		.430	.668
	46. Age	-.015	.188	-.008	-.080	.936
	59. Income	-.067	.116	-.045	-.579	.564
	47. Education Level	.065	.134	.035	.488	.626
	50. No of people	-.158	.293	-.064	-.538	.591
	51. Children at home	.388	.623	.073	.622	.534
	60. Gender	.338	.383	.063	.882	.379
	48. Employment	.076	.113	.056	.675	.501
	49. Relationship Status	-.152	.192	-.064	-.788	.432
	Dwelling Type R	-.255	.404	-.044	-.632	.528
	54. Year Home was Built	-.456	.171	-.188	-2.671	.008
	53. Home Ownership	.706	.536	.110	1.317	.190
	36. Read received info.	.364	.221	.137	1.645	.102
	37. Follow/Listen to Info.	.048	.293	.014	.163	.871
	5C. Conservation Priority	.533	.307	.168	1.733	.085
	5E. Efficiency Priority	.046	.368	.012	.124	.901
	6. Attitude (Environment)	.441	.262	.154	1.685	.094
	7. Attitude (Climate Change)	-.367	.200	-.165	-1.833	.069
	33. Subjective norms	.551	.448	.087	1.231	.220
	22. knowledge (Reduce	.681	.372	.139	1.832	.069
	30. Knowledge - Net Zero	-.064	.172	-.027	-.375	.708
	21B. Save energy - Save	.499	.224	.179	2.227	.027
	21E. Energy Eff. & Con.	.180	.215	.065	.838	.403

a. Dependent Variable: Conservation_Behavior – N = 193

Summary of the Results: Overall Multiple Regression Model (Energy Conservation Behaviors)

Multiple regression analysis was used to test if various socio-demographic, situational, and psychological variables significantly predicted the number of energy conservation behaviors that the study participants regularly take in their homes. The results of the regression indicated that the two predictors explained 18.3% of the variance ($R2= 0.276$, $F (22, 170) = 2.949$, $p<0.001$). it was found that the variable "year home was built" significantly predicted the number of energy conservation behaviors that the study participants regularly take in their homes ($\beta = -0.188$, $P<0.05$), as did the cost benefit appraisal variable: save energy to save money ($\beta = 0.179$, $P<0.05$). In addition to these two independent variables which were found to be significant predictor of the dependent variable at the 0.05 level, it is reasonable to report four other independent variables as being moderately significant predictors of the dependent variable (the number of energy conservation behaviors that the study participants regularly take in their homes) at the 0.1 level of significance. Specifically, it was found that the attitudinal variable: conservation priority was moderately significant predictor of the dependent variable ($\beta = 0.168$, $p<.1$), as did another two attitudinal variables: environmental concern ($\beta = 0.154$, $p<.1$), and climate change ($\beta = -0.165$, $p<.1$). The knowledge variable: know how to reduce home energy usage was also found moderately significant predictor of the dependent variable ($\beta = 0.139$, $p<.1$).

4.6.2. Overall Multiple Regression Model (Energy Efficiency Behaviors)

According to the outputs of the model summary (table 95), the model is significant, and the R Square value is 0.298. This indicates that 29.8% of the variation in the dependent variable (the number of reported energy efficiency behaviors) is explained or predicated by independent variables included in the model. Since the value of the R2 tends to be somewhat inflated (this can be attributed to the relatively small sample size and/or the large number of variables), a more realistic estimate is the Adjusted R Square value which is in this model has a value of 0.207 or 20.7%.

Table 95 - Multiple Regression - Energy Efficiency - Model Summary

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.546[a]	.298	.207	3.038	.298	3.278	22	170	.000

a. Predictors: (Constant), 21E. Energy Eff. & Con. reduce bills, 46. Age, 54. Year Home was Built, 30. Knowledge - Net Zero, 53. Home Ownership, 37. Follow/Listen to Info., 60. Gender, 33. Subjective norms, Dwelling Type R, 5C. Conservation Priority, 7. Attitude (Climate Change), 47. Education Level, 59. Income, 22. knowledge (Reduce Home Energy Usage), 49. Relationship Status, 21B. Save energy - Save Money, 48. Employment, 36. Read received info., 51. Children at home, 6. Attitude (Environment), 5E. Efficiency Priority, 50. No of people

The ANOVA section (Table 96) of the overall multiple regression model (efficiency) indicates a significance or P-value of 0.000 which is the significance value of the model as whole. This means that the findings of the model as a whole (which includes all variables addressed in this study - socio-demographics, situational, and psychological) have a probability of less than 1 in 1000 of being due to chance.

Table 96 - Multiple Regression - Energy Efficiency - ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	665.666	22	30.258	3.278	.000[b]
	Residual	1569.350	170	9.231		
	Total	2235.016	192			

a. Dependent Variable: Efficiency_Behavior – N = 193

b. Predictors: (Constant), 21E. Energy Eff. & Con. reduce bills, 46. Age, 54. Year Home was Built, 30. Knowledge - Net Zero, 53. Home Ownership, 37. Follow/Listen to Info., 60. Gender, 33. Subjective norms, Dwelling Type R, 5C. Conservation Priority, 7. Attitude (Climate Change), 47. Education Level, 59. Income, 22. knowledge (Reduce Home Energy Usage), 49. Relationship Status, 21B. Save energy - Save Money, 48. Employment, 36. Read received info., 51. Children at home, 6. Attitude (Environment), 5E. Efficiency Priority, 50. No of people

The coefficient section (Table 97) of the multiple regression model (efficiency) shows a list of the independent variables and whether each of those variables is a significant predictor that can contribute to explaining variation in the dependent variable (the number of reported energy conservation behaviors). The unstandardized coefficient values represent the estimated change in the dependent variable for each unit change in the independent variable. Additionally, the table also includes the standardized coefficients (*beta weights*) which indicates the change in the dependent variable for every standard deviation increase or decrease in the independent variable (significant predictor). Moreover, the significance level of each independent variable is also included in the table. These values represent the probability of the association between each independent variable and the dependent variable in the model as whole.

Table 97 - Multiple Regression - Energy Efficiency - Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-2.074	3.687		-.563	.574
	46. Age	-.310	.237	-.128	-1.309	.192
	59. Income	.262	.145	.139	1.800	.074
	47. Education Level	.053	.168	.022	.312	.755
	50. No of people	.635	.369	.201	1.722	.087
	51. Children at home	-.609	.784	-.089	-.777	.438
	60. Gender	-.681	.482	-.099	-1.412	.160
	48. Employment	-.080	.142	-.046	-.567	.572
	49. Relationship Status	-.284	.242	-.093	-1.173	.242
	Dwelling Type R	-.836	.509	-.113	-1.643	.102
	54. Year Home was Built	-.527	.215	-.170	-2.452	.015
	53. Home Ownership	2.478	.674	.303	3.678	.000
	36. Read received info.	-.088	.278	-.026	-.318	.751
	37. Follow/Listen to Info.	.504	.369	.112	1.366	.174
	5C. Conservation Priority	.151	.387	.037	.392	.696
	5E. Efficiency Priority	.122	.463	.026	.264	.792
	6. Attitude (Environment)	-.514	.329	-.141	-1.560	.121
	7. Attitude (Climate Change)	.356	.252	.125	1.414	.159
	33. Subjective norms	1.145	.564	.142	2.032	.044
	22. knowledge (Reduce Home Energy Usage)	1.546	.468	.248	3.307	.001
	30. Knowledge - Net Zero	-.112	.216	-.037	-.520	.604

	21B. Save energy - Save Money	.173	.282	.048	.612	.541
	21E. Energy Eff. & Con. reduce bills	.422	.271	.120	1.559	.121

a. Dependent Variable: Efficiency_Behavior – N = 193

Summary of the Results: Overall Multiple Regression Model (Energy Efficiency Behaviors

Multiple regression analysis was used to test if various socio-demographic, situational, and psychological variables significantly predicted the number of energy conservation behaviors that the study participants regularly take in their homes. The results of the regression indicated that the two predictors explained 20.7% of the variance (R2= 0.298, F (22, 170) = 3.278, p<0.001). It was found that four independent variables significantly predicted the number of energy efficiency behaviors that the study participants have already made to their homes. The independent variable "year home was built" significantly predicted the dependent variable (β = -0.170, P<0.05), as did the significant predictor "home ownership" (β = 0.303, P<0.001). The independent variable "subjective norms" was also found as being a significant predictor of the dependent variable (β = 0.142, P<0.05), as did the knowledge variable: know how to reduce home energy usage (β = 0.248, P<0.05). In addition to these for significant predictors, two other independent variables were found as being moderately significant predictors of the dependent variable (the number of energy efficiency behaviors that the study participants have already made to their homes) at the 0.1 level of significance. Specifically, it was found that the income level of the study participants was moderately significant predictor of the dependent variable (β = 0.139, p<.1), as did the number of people at home (β = 0.201, p<.1).

Chapter 5: Discussion

5.1. Introduction and Chapter Outline

As presented earlier in the literature review chapter of this work, many variables may influence people's decisions to engage in a wide-range of environmentally friendly behaviors, like the energy saving-behaviors, which include energy conservation and efficiency behaviors.

Given the reviewed literature, the variables were grouped into three main categories: socio-demographic, situational, and psychological variables. One can think of these variables as being intrinsic or extrinsic drivers or barriers that may motivate or prevent people from engaging in such behaviors. However, findings differ among studies, and researchers were generally very cautious to generalize findings or draw conclusions regarding the level of influence and the strength of the association that variables may have on peoples' decisions to participate in different types of environmentally friendly behaviors, including energy-related behaviors.

In this thesis, several variables that fall under the umbrella of each of the three main categories (socio-demographics, situational, and psychological variables) were examined to explore the association between them and both; the number of energy conservation behaviors that the study participants regularly take in their homes, and the number of energy efficiency behaviors or improvements they (i.e., the study participants) have already made to their homes.

In this chapter, the findings from the survey will be discussed to help meet the objectives of this work and answer the research question. Therefore, it's worthwhile here to revisit the research question and objectives that were stated at the end of chapter 1.

The objectives of this study include providing better understanding of the energy conservation and efficiency behaviors in the residential sector, as well as the various factors or variables influencing households' energy related-behaviors. The study also aims to help develop a better understanding of

how to increase peoples' decisions to reduce energy consumption, and to do that we need to understand their relationship with energy.

Research question:

What are the determinates or characteristics that help predict people who are likely to engage in energy conservation and efficiency behaviors in the residential sector?

A discussion of the relationships between the examined socio-demographic variables and the number of energy conservation and efficiency behaviors that householders, within the Region of Waterloo, engage in will be presented in section 5.2. of this chapter. Additionally, the identified relationships between the studied situational variables and both; the number of energy conservation behaviors and the number of energy efficiency improvements/ behaviors will be discussed in section 5.3. In section 5.4. the relationships between several psychological variables and the number of reported energy conservation and efficiency behaviors will be discussed.

5.2. Socio-Demographic Variables

5.2.1. Age

Surprisingly, according to the obtained results, the age of the study participants was not associated with their level of participation in energy saving behaviors. That is no statistically significant relationship was found between the age of the respondents and the number of reported energy conservation and efficiency behaviors. This contradicts results obtained by numerous researches.

Although findings from the literature regarding the relationship between the age of study participants and their engagement in environmentally friendly behaviors like the energy saving behaviors are rather mixed, but such a relationship tends to be small and/or statistically insignificant. For example, Hirst,

Goeltz, & Carney (1982) argued that age has a curvilinear relationship with conservation behavior, according to the findings of their study, young and elderly households take fewer actions than those in their middle age. In another study by Barr et al. (2005), it was found that, compared to younger age groups; people with a mean age of 55 years were more likely to participate in both investment and non-investment energy measures. This is in line with results from previous studies (e.g., Painter et al., 1983; Ritchie et al., 1981) which that those in higher age groups were more likely to be energy savers. Moreover, in a study that involved Canadian households Walsh (1989) claimed that younger heads of households were more likely to adopt energy improvements, while older people were less likely to do that because they expected a relatively lower rate of return from energy improvements than do other age cohorts.

5.2.2. Income

In terms of finding an association between the independent variable (income level) and both dependent variables (the number of energy conservation behaviors that the study participants regularly take in their homes, and the number of energy efficiency improvements they have already made to their homes), this study found that there were statistically significant and positive correlations between the income level and each of the dependent variables at the 0.01 level of significance. However, the relationships were found weak.

Because this independent variable and both dependent variables were classified as ordinal variables, a nonparametric test (the Kendall's tau_b correlation coefficient) was performed (Bryman, 2012). The value of the Kendall's tau_b between income level and the number of energy conservation behaviors was 0.157. Since squaring the Kendall's tau-b produces statistics that measure how much of the variation in one variable can be explained by the other variable (Bryman, 2012). We can say that, income

can explain 2.46% of the variation in the number of energy conservation behaviors that the study participants regularly take in their homes.

With regards to the number of energy efficiency behaviors, the value of the Kendall's tau_b was 0.281. So, income can explain around 7.9 % of the variation in the number of energy efficiency behaviors that the study participants have already made to their homes.

Given these results, even though the identified relationships were weak, it's reasonable to say that people with higher income level tend to participate in more energy conservation and efficiency behaviors. In fact, it is not surprising to identify a significant positive relationship between the income level of the study participants and their engagement in energy-saving behaviors. Identifying such a relationship is consistent with findings from previous research. . Similar findings were reported by Olsen (1983) who found that the relationship between annual income and the acceptance of conservation strategies was very weak. Sardianou (2007), also provided an evidence that income is a statistically significant variable of the reported number of energy-conserving actions. That is households with higher income level may be more willing to conserve energy because they can afford the financial costs associated with energy-saving investments, such as purchasing new efficient technology.

5.2.3. Level of Education

The obtained results of examining the association between the highest level of education that the study participants hold and the specific type of energy saving behavior they engaged in are rather mixed. More specifically, while a statistically significant and positive relationship was identified between the level of education and the number of reported energy conservation measures that the study participants regularly take in their homes at the 0.05 level of significance, the results also indicated that

there is no significant relationship between the level of education and the number of reported energy efficiency measures that the study participants have already made to their homes.

It should be noted however that, the identified relationship between the level of education and the number of energy conservation behaviors was very weak. The results suggest that the level of education can explain less than 1% of the variation among the respondents in terms of the number of energy conservation behaviors. Additionally, the positive relationship indicates that the higher the level of education that the study participants hold, the more likely they are to take more energy conservation behaviors.

Findings form the reviewed literature show that the examined relationships between the level of education and the engagement in environmentally friendly behaviors are rather mixed as well. However, the majority of the reviewed studies suggest a positive association between the level of education and the engagement in pro-environmental behaviors.

In a study by Fisher et al. (2012) that involved an assessment of the relationship between the level of education and a number of green behaviors, it was found that none of the tested behaviors were significantly related to education level, except the use of recyclable bags. Curtis et al. (1984), reported that there is no significant relationship between the level of education and the number of energy saving measures taken by the study participants. In another study by Ferguson (1993), the level of education was reported as a variable that did not distinguish households that made home retrofitting improvements, as an energy-saving housing improvement, from non-retrofitters.

Hirst et al. (1982) identified a positive relationship between the level of education and energy saving activities. Scott (1997) also indicated that higher levels of education are associated with greater adoption of energy efficient technologies. Mills and Schleich (2012) claimed that the level of education showed a strong positive impact on the adoption of energy-efficient technologies and the use of energy

conservation practices. Olsen (1983), also reported that the level of education is positively associated with the acceptance of energy conservation strategies.

5.2.4. Number of People at Home

The findings of this thesis indicate that there are statistically significant and positive relationships between the number of people in the household and the two dependent variables in this study (the number of energy conservation behaviors that the study participants regularly take in their homes, and the number of energy efficiency improvements they have already made to their homes) at the 0.01 level of significance. However, the identified relationships were weak. The value of the Kendall's tau_b between the number of people in the household and the number of energy conservation behaviors was 0.149. this means that this independent variable can explain around 2.22% of the variation in the number of energy conservation behaviors that the study participants regularly take in their homes.

The value of the Kendall's tau_b for the identified association between the number of people who live in the household and the number of energy efficiency behaviors was .212, so this independent variable can explain around 4.5% of the variation in the number of energy efficiency behaviors that the study participants have already made to their homes.

Based on the reviewed literature, it was expected to identify such a positive relationship between the household size and the engagement in energy-saving behaviors. The obtained results are similar to those identified by Barr et al. (2005) who found that there was a significant relationship between household size and the number of reported energy saving behaviors (habitual behaviors and purchase decisions). In another study by Curtis et al. (1984) that was based on a sample of 473 Canadian households, it was concluded that the number of people in the household is significantly associated with the number of energy conservation actions reported by the study participants. Additionally, the results

of this thesis, with regards to the number of people at home, are in line with the findings of Dupont (2004) who found a positive association between the number of children at home and the number of adopted energy conservation and efficiency behaviors.

5.2.5. Having Children at Home

The findings of this study show that there is no association between the dependent variables (the number of reported energy conservation and efficiency measures) and the independent variable (having children at home). i.e., in terms of the number of reported energy saving measures, there is no difference between residents having children at home and those who do not.

These obtained results are in contrast with results from previous studies (e.g., Laroche, Bergeron, & Barbaro-Forleo, 2001; Loureiro, McCluskey, & Mittelhammer, 2002) who found that people with children in their households were more likely to exhibit environmentally friendly behaviors. When Laroche et al. (2001) measured behavior toward the environment including the recycling and the purchase of environmentally unfriendly products, the writer found that married females who have at least on child living at home exhibited willingness to pay more for environmentally friendly products. Similarly, Loureiro et al. (2002), who measured the willingness to pay for food products that are labeled as environmentally friendly, found that females with children under the age of 18 were the most willing to pay for those environmentally friendly food products.

5.2.6. Gender

The findings of this study show that there was no statistically difference between males and females with regards to the number of environmentally friendly behaviors they participate in. More specifically, the number of reported energy saving-behaviors i.e., the number of energy conservation behaviors that

the respondents regularly take in their homes, as well as the number of energy efficiency improvements they have already made to their homes is independent of their gender. Although mixed findings were identified in the literature regarding the relationship between gender and pro-environmental behaviors, but most of the literature reported weak or statistically insignificant relationship between those variables. So, it was not surprising – in this work – to find a statistically insignificant relationship between the independent variable (gender) and the two dependent variables (the number of reported energy conservation and efficiency behaviors). This insignificant relationship is consistent with numerous previous studies. For example, a study by Olsen (1983) revealed that the gender of the respondents was not statistically significantly related to the acceptance of energy conservation strategies. Similar findings were reported by (Abrahamse & Steg, 2011; Poortinga et al., 2003).

However, the findings of a survey analysis by Fisher, Bashyal, & Bachman (2012) showed that females were more likely to exhibit pro-environmental behaviors than males do. It is also worth noting that, in another study by Straughan and Roberts (1999) where gender was found significantly correlated with ecologically conscious consumer behavior (ECCB), this variable i.e., gender became no longer significant when other variables were included in the analysis.

5.2.7. Employment Status

As expected, the relationships between the reported employment status of the study participants and the number of energy conservation and efficiency behaviors were not statistically significant. These findings are in line with the findings of Curtis et al. (1984) who reported that the occupation of the respondents had no significant influence on the number of households' energy conservation actions. Similarly Van Raaij & Verhallen (1983b), reported that the occupational level did not show a significate difference between conservers who use less energy and spenders who use more energy than the average group.

However, a study by Olsen (1983) found that people having higher status of occupation, exhibit more acceptance of energy conservation strategies.

5.2.8. Relationship Status

An examination of the association between the relationship status of the study participants and the number of energy conservation and efficiency behaviors revealed a statistically significant association between the relationship status of the respondents and their engagement in energy saving behaviors. However, the obtained vales of Cramer's V indicate that the relationships between this independent variable and the two dependent variables (the numbers of energy conservation and efficiency behaviors) were weak. According to these values, around 2.5% of the variance in the number of energy conservation behaviors can be explained by the marital status of the participants. Similarly, around 4.5% of the in the number of energy efficiency behaviors can be explained by the marital status of the participants.

The performed ordinal regression indicated that the direction of the association starting with those who are likely to engage in higher number of conservation behaviors to those who are likely to engage in lower number is as follows: married, co-habiting/ common law, divorced/ separated, single/never married, widowed. With regards to the number of energy efficiency behaviors, the order starts with married respondents, then co-habiting/ common law, followed by widowed, and then single/never married respondents.

According to the obtained results of the ordinal regression, the pseudo R2 values (Nagelkerke) indicate that the relationship status of the respondents can explain around 5.2%, and 13.7% of the variation

among respondents in terms of the number of energy conservation and efficiency behaviors respectively.

The association between the relationship status and the involvement in environmentally-related behaviors has been addressed by numerous studies. For example, in line with the findings of this study, Mills and Schleich (2012) found that married couples are more prone to behave in an ecologically conscious fashion than others. However, Long (1993) found that there was no statistically significant relationship between married couple households and other family types in terms of households' energy conservation expenditure.

5.3. Situational Variables

5.3.1. Dwelling Type

The examination of the relationship between dwelling type and residents' adoption of energy saving behaviors (the number of conservation and efficiency behaviors) revealed that there is a statistically significant relationship between these variables. However, the obtained vales of Cramer's V indicate that the relationships between the independent variable and the two dependent variables (no. of energy conservation and efficiency behaviors) were weak.

With respect to number of adopted energy conservation behaviors, findings from the conducted ordinal regression show that residents who live in single detached houses tend to engage in more conservation behaviors than those who live in townhouses. The latter are followed by those living in high-rise apartment buildings (greater than 4 stories), then by residents living in low-rise apartment buildings (4 stories or less) who tend to participate in the lowest number of energy conservation behaviors compared to the other groups.

With regards to the number of energy efficiency behaviors, the order of these dwellings starts with single detached houses, then townhouses, which is followed by low-rise apartment buildings (4 stories or less), and then high-rise apartment buildings (greater than 4 stories) where residents tend to participate in the lowest number of energy efficiency behaviors.

It was expected to identify a significant relationship between the dwelling type and the engagement in energy-saving behaviors. As identified in the literature, people residing in larger, free-standing homes may feel that their household consumes significant amounts of energy, which may lead to high energy bill. Thus, energy savings and home improvements are usually considered by those households as desirable or even necessary options.

Accordingly, it can be argued that finding similar results between this work and previous works from the literature is not surprising. For example, identifying a significant relationship between the dwelling type and the performance of such an environmentally friendly behavior is in line with the findings of a study by Sardianou (2007) who reported that households living in detached houses are more willing to participate in energy conservation activities than those living in apartment blocks. Holloway and Bunker (2006) indicate that households lived in in multi-unit dwellings consumed 74 percent less electricity than those lived in detached houses, semi-detached dwellings, and townhouses. Powers (1992) explains that residing in a larger dwelling may suggest to the residents that their household uses considerable energy, and thus adopting energy saving activities becomes desirable or necessary.

5.3.2. Year Home was Built

As expected, the findings of this study indicate that the relationship between the independent variable (year it was built) and both dependent variables (the number of adopted energy conservation and efficiency behaviors) was found statistically significant and negative. That is residents who reside in

older dwellings tend to engage in more energy saving behaviors than those living in newer dwellings. However, the relationships were found weak.

The value of the Kendall's tau_b between the year home was built and the number of energy conservation behaviors was -0.92. This means that this independent variable can explain less than 1% of the variation in the number of energy conservation behaviors that the study participants regularly take in their homes.

The value of the Kendall's tau_b for the identified association between the year home was built and the number of energy efficiency behaviors was -0.152, so this independent variable can explain around 2.3% of the variation in the number of energy efficiency behaviors that the study participants have already made to their homes.

The obtained results appear to be consistent with those observed in the literature. For instance, reasoning that old dwellings may be in physically or aesthetically in poorer condition, Nair et al. (2010) reported that those who reside in buildings older than 35 years, were more likely to undertake major buildings renovations and adopt other energy efficiency measures as well. Similarly, Walsh (1989) concluded that households who live in older dwellings are more likely to implement energy saving activities.

5.3.3. Home Ownership

With regards to the relationship between the independent variables (home ownership) and the number of reported energy conservation and efficiency behaviors. The results of this study showed that the number of reported energy saving measures is dependent on home ownership. While the Cramer's V indicate a weak relationship between home ownership and the number of reported conservation

measures, the Cramer's V of the relationship between home ownership and the number of reported efficiency measures shows a moderate relationship.

With respect to the direction of the relationship, the performed ordinal regression indicates that those respondents who own their dwellings tend to engage in more conservation and efficiency behaviors than renters do. It should also be noted that (along with the dwelling type variable) the pseudo R2 values (Nagelkerke = 11.3%) indicates that those two variables can explain 11.3% of the variation among respondents in terms of the number of energy conservation behaviors. Similarly, for both variables (home ownership and dwelling type) the pseudo R2 values (Nagelkerke = 27.6%) indicates that the analyzed factors can explain around 27.6% of the variation among the respondents in terms of the number of energy efficiency behaviors.

Given the reviewed literature, it was expected to identify a significant relationship between the variable (home ownership) and the engagement in energy-saving behaviors. Additionally, it was not surprising to find out that homeowners tend to engage in more energy-saving behaviors than renters do. These results correspond with the findings of several previous studies, for example based on the answers of 478 participants in a study conducted by Black et al. (1985), the writers argued that home ownership had the strongest direct effect on residents' investment in efficiency measures. In another study by Barr et al. (2005), the writers found that home ownership was a significant factor to energy-saving measures, where homeowners appeared to be more energy conscious. Costanzo et al. (1986), Frederiks et al. (2015), and Sardianou (2007) argued that homeowners are more likely to adopt energy efficiency measures than renters do. They attributed that to greater financial capital that homeowners have, and to the longer tenure they hold compared to renters who are more transient, usually poorer and cannot afford some investments that involve expensive technologies and major home upgrades. Costanzo et al., (1986) also argued that, even long-term renters with high income are unlikely to be motivated to invest and perform efficiency improvements on a dwelling owned by someone else. Another reason to explain

this is provided by Brandon and Lewis (1999), who pointed out that residents of rented dwellings might not have the right, as tenants, or the incentive to invest in energy saving for their homes

However, though the findings of a study by Curtis et al. (1984) showed that home ownership was not significantly associated with number of reported energy conservation actions, the results indicated that those who owned their dwellings declared a slightly greater number of actions than renters.

5.3.4. Information

As expected, a statistically significant positive relationship was identified in this work between the independent variable (information) and the participants' engagement in energy saving behaviors. The findings of this study regarding the relationship between the role of energy-related information and the number of adopted energy conservation and efficiency measures are consistent with the findings of many previously conducted studies that addressed this relationship with various environmentally friendly behaviors. For example, after sending a booklet of energy-saving tips and a shower flow control device to 4.5 million households and launching a mass media campaign, Hutton and McNeill (1981) carried out a study involved a telephone survey to assess the success of the campaign. The writers concluded that households who had received the booklet and the shower device reported implementing the energy-saving tips more than households who had not. In another study by Hirst and Grady (1982-1983) that involved comparing the gas consumption of households who had received home audits to those who had not, it was found that households in the audited group reported applying more energy-saving measures than the control group.

It should be made clear that – in this study – two questions were used to understand the relationship between the role of information and the adoption of energy saving measures. The results of the study revealed that there are statistically significant positive relationships between the independent variable

(information) and the two dependent variables used in this work. However, the relationships were found weak.

More specifically, the results show that the variables information can explain around 6.78% of the variation among the respondents in terms of the number of energy conservation behaviors. Additionally, according to the reported answers, the same variables can explain around 1.78% of the variation among the respondents in terms of the number of energy efficiency behaviors.

Given the above, it can be argued that the better access to energy-related information and the more frequently people will follow this type of information, the more likely they are to participate in larger number of energy conservation and efficiency behaviors. In short, people with better access to energy conservation and efficiency information are more likely to act on it.

5.4. Psychological Variables

5.4.1. Attitude

Four questions were used in this study to measure the relationship between the attitude of the study participants and their engagement in energy conservation and efficiency behaviors.

In line with findings from the literature, the identified relationships between the attitude of the study participants and their engagement in energy conservation and efficiency behaviors are rather mixed. On one hand, the results revealed that the four attitudinal variables were statistically significantly and positively associated with the number of energy conservation behaviors that the respondents regularly take in their homes at the 0.01 level of significance. Although the relationship between each of the four attitudinal variables and the number of conservation behaviors can be described as weak, these four

attitudinal variables can explain around 17% of the variation among the study participants with regards to the number of energy conservation behaviors they regularly take in their homes. On the other hand, the results showed that there was no statistically significant relationship between any of the four attitudinal variables and the number of energy efficiency behaviors that the study participants have already made to their homes.

Based on the type of the identified relationships, it is reasonable to say that respondents with higher levels of attitude and concern towards the environment, as well as towards the energy and climate change tend to participate in more energy conservation behaviors than those who reported lower levels of attitude and concern towards the environment and energy. However, in terms of the number of energy efficiency behaviors, the reported levels of attitude towards the environment and energy seem to have no statistically significant relationship with the number of energy efficiency behaviors that the study participants have already made to their homes.

As stated earlier, findings from the literature regarding the relationship between attitude and behavior are rather mixed, and the strength of the association between attitude and behavior is inconsistent, weak, and/or insignificant. In a study by Poortinga et al. (2003) where the results seemed counter-intuitive, respondents with high environmental concern considered measures with small energy savings as being relatively more acceptable than measures with large energy savings, whereas the opposite applied to respondents with low environmental concern. In a meta-analysis study by Hines et al. (1987), a positive association between attitude and the pro-environmental behavior was reported. In Hines et al. (1987) study, several attitudinal variables were assessed. These were categorized into general and specific attitudes toward the environment and ecology, attitudes toward energy crisis, and attitudes toward taking environmental action. The results of that study showed that people with more positive attitudes were more likely to engage in responsible environmental behaviors than those with less positive attitude. In another study by Abrahamse and Steg (2009), that used four items to measure

respondents' attitude toward energy conservation, it appeared that household energy savings are mostly associated with psychological variables (including attitude), whereas socio-demographics did not come into play. Similarly, in a field study that involved 120 households in Bath, U.K., Brandon and Lewis (1999) found that energy savings were related to attitudes, and not to socio-demographics.

Rowlands, Scott, & Parker (2000) identified a weak positive correlation between self-reported home energy conservation measures and general pro-environmental attitudes, with a slightly higher positive correlation between climate change attitudes and conservation measures.

Other studies by (Gatersleben et al., 2002; Geller, 1981; McDougall et al., 1982) showed that having a positive attitude toward the environment does not lead to reduced energy consumption. Additionally, Black et al. (1985) argued that, generalized concern about the national energy situation does not influence behavior directly, instead the behavior is influenced indirectly by affecting personal norms.

5.4.2. Subjective Norms

One question was used in this work to study the relationship between subjective norms as an independent variable with the two dependent variables (the number of reported energy conservation and efficiency behaviors). Although significant positive relationships were expected appear between subjective norms and both dependent variables, the identified relationships in this work are rather mixed. According to the self-reported answers, while a significant but weak (Cramer' V = 0.15) relationship was found between the subjective norms and the number of energy conservation behaviors that the respondents regularly take in their homes, the results showed that number of energy efficiency behaviors that the study participants have already made to their homes is independent of the variable subjective norms.

Furthermore, the findings from the ordinal regression indicate that, respondents who were interested in knowing how their energy consumption compares to others in their neighborhood were 57.8% more likely to participate in energy conservation behaviors than those who were not interested in that. The pseudo R2 values (Nagelkerke) indicate that the variable (subjective norms) can explain around 2.3% of the variation among respondents in terms of the number of energy conservation behaviors that respondents regularly take in their homes.

Based on these findings, it's reasonable to say that social influence by significant others and neighbors can help improve peoples' engagement in energy conservation behaviors. Significant others and neighbors may facilitate the formation of beliefs about possible outcomes, and reduce the fatigue associated with the decision-making process (Fornara et al., 2016).

Finding a positive relationship between subjective norms and energy conservation behaviors is consistent with the findings of Nolan, Schultz, Cialdini, Goldstein, & Griskevicius (2008) who found that providing people with information about descriptive norms (what people actually do) like supplying messages containing details of one's energy consumption or conservation relative to neighbors resulted in motivating people to save energy. Allcott (2011) also claimed that providing descriptive normative information can lead to an average residential energy saving of 2%.

5.4.3. Knowledge

To examine the relationship between the respondents' knowledge and their participation in energy conservation and efficiency behaviors, two questions were used in this study. Unexpectedly, based on the self-reported answers, statistically significant positive relationships were identified between the independent variable (Knowledge) and both dependent variables (the numbers of reported energy conservation, and efficiency behaviors). In view of the reviewed literature, no significant relationship

was expected to be found between the level of knowledge that the study participants hold and their engagement in energy saving behaviors. This is usually referred to in the literature as “knowledge-action gap”. However, the identified relationships were found weak.

Given the obtained Kendall’s tau-b values, it can be argued that one of the two knowledge variables was able to explain around 4% and 3.5% of the variation among the study participants in terms of the number of energy conservation and efficiency behaviors respectively at the 0.05 level of significance. The results also showed that the other variable was able to explain 1% and 1.1% of the variation among the study participants in terms of the number of energy conservation and efficiency behaviors respectively at the 0.01 level of significance.

Considering these findings, one can argue that respondents with higher levels of knowledge on how to reduce homes’ energy consumption, and of the term Net-Zero homes tend to engage in more energy conservation and efficiency behaviors than respondents with lower levels of knowledge.

These findings correspond with findings from other studies. In a meta-analysis study by Hines et al. (1987), knowledge was found to be associated with responsible environmental behavior. The writers emphasized the importance of knowledge as individuals must be cognizant of the existence of the problem and the available courses of action which will be most effective in a given situation. Scott (1997) also observed that household knowledge about potential energy savings was associated with higher adoption of energy efficient technologies.

However, according to the findings of their study, Maleki & Karimzadeh (2011) claimed that, there was no statistically significant relationships between environmental knowledge (either systematic knowledge or behavioral knowledge) and the environmental behavior of the participants.

5.4.4. Cost-Benefit Appraisal/ Trad-Offs

It is commonly known that people are often motivated by self-interest and try to adopt alternatives that may result in the highest benefits for the lowest cost. However, it should be made clear that, although the terms “benefits” and “costs” are often used to refer to a variety of scarce or valued resources such as time, effort, social status/acceptance, money, convenience, comfort and so forth, mainly the economic perspective i.e., the financial costs (or benefits) that include the monetary expenses (or potential savings) are considered in this study.

Given the above, two questions were employed in this thesis to examine the relationship between the independent psychological variable (cost-benefit appraisal) and the dependent variables (the numbers of reported energy conservation and efficiency behaviors).

In term of the number of energy conservation behaviors that the study participants regularly take in their homes, statistically significant positive relationships were identified between both questions that were used to measure the variable cost-benefit appraisal and the number of energy conservation behaviors regularly taken by respondents in their homes. However, the relationships were found to be weak. Considering the obtained Kendall’s tau-b values, it can be argued that, the two cost-benefit appraisal measures used in this study were jointly able to explain around 3.72% of the variation among respondents in terms of the number of energy conservation behaviors at the 0.01 level of significance.

However, in terms of the number of energy efficiency behaviors that the study participants have already made to their homes, the obtained results showed that there was no statistically significant relationship between any of the two cost-benefit appraisal variables and the number of energy efficiency behaviors that the study participants have already made to their homes.

Based on the self-reported answers, the stronger the respondents agree that energy conservation and efficiency can help reduce their utility bills and that they try to save energy because it saves them money, the more likely they are to engage in more energy conservation behaviors. However, this is not necessarily the case with respect to the number of energy efficiency improvements since no statistically significant relationship was found between the cost benefit appraisal and the number of energy efficiency behaviors.

Accordingly, it can be argued that the cost-benefit appraisal can be named as one of the variables that may influence the number of energy conservation behaviors that the study participants regularly take in their homes, but it has no influence on the number of energy efficiency improvements they have already made to their homes. Among the expected reasons for such findings is that people who consider the energy prices very high and/or believe that the expected benefits (saving money and reducing utility bills) of engaging in energy conservation behaviors will exceed any associated cost such as efforts, money, loss of comfort, inconvenience, may see such behaviors as drivers to take more energy conservation behaviors in their homes. However, people who consider the energy prices very cheap or see that the cost of adopting various energy efficiency improvements very high, especially when there is a very long payback period, might not see the adoption of various energy efficiency improvements in their homes as in incentive to make such improvements. Even though the cost-benefit trad-offs or the economic motivation play a role in energy consumption, the literature, as presented in chapter 2 of this work, showed that there are other variables which may influence or be more significant in the decision-making process that is associated with the participation in energy conservation and efficiency behaviors.

Chapter 6: Conclusion, Practical Implications, Recommendations, and Future Research

6.1. Conclusions and Summary of Key Findings

It was the purpose of this study to provide a better understanding of the energy conservation and efficiency behaviors, as well as of the various determinants influencing such environmentally friendly behaviors of households in the Region of Waterloo. This is made evident in the study's research question, 'what are the various determinates or characteristics that help predict people who are likely engage in energy conservation and efficiency behaviors in the residential sector?'. To meet the objectives of the study and answer the research question; this study examined the relationship of several psychological, situational, and socio-demographic variables with both: the number of self-reported energy conservation behaviors that the study participants regularly take in their homes, and the number of self-reported energy efficiency behaviors/ improvements that the study participants have already made to their homes. Although a large number of variables – that fall under the umbrella of each of the main three variable-categories: socio-demographics, situational, and psychological variables, were identified in the literature, only a sub-set of these variables were examined in this thesis. These independent variables as well as the two dependent variables studied in this work are presented earlier in figure (5), which shows the proposed integrative conceptual framework used in this thesis.

For the purpose of this study, a number of questions were carefully selected out of an original survey that was conducted by PMG Intelligence through phone interviews. The received responses on those questions were analyzed using Statistical Package for Social Sciences (SPSS) software. Similar to what is observed in the literature, the obtained results from this work confirm the difficulty of generalizing conclusions and explaining households' energy consumption and saving behaviors. This underscores the

complexity associated with households' energy-related behaviors and the variables influencing such behaviors.

Generally speaking, although there are similarities, but the identified relationships between each of the independent variables and the number of reported energy conservation behaviors that the study participants regularly take in their homes are inconsistent with those relationships identified between the same independent variables and the number of reported energy efficiency behaviors that the study participants have already made to their homes. Many of the examined variables were found to have no statistically significant relationship with the household energy saving behaviors. However, for those variables were significant relationships were identified, these relationships were found weak except for the relationship between home ownership and the number of reported energy efficiency behaviors, which was found moderate.

6.1.1. Socio-Demographic Variables and the Number of Reported Energy Conservation and Efficiency Behaviors

The relationships between several socio-demographic variables and the number of reported energy conservation and efficiency behaviors were examined in this study. A number of those variables (age, employment status, having children at home, and gender) appeared to have no statistically significant relationship with the number of reported energy saving behaviors. However, other socio-demographics (number of people in the home, income, relationship status) were found to have statistically significant, but weak relationships with the number of reported energy conservation and efficiency behaviors. While the number of people in the home and income were able to explain around 2.22%, 2.46% of the variation among respondents with regards to the number of reported energy conservation behaviors respectively, the relationship status of the respondents was able to explain around 2.5% of that variation. Similarly, and following the same order, these variables were able to explain 4.5%, 7.9 %, and 4.5% of the variation among respondents with regards to the number of reported energy efficiency

behaviors. According to the obtained results, the larger the number of people reside in the home and the higher annual income, the larger the number of energy conservation and efficiency behaviors that the study participants engage in. Additionally, married respondents were found to engage in more energy saving behaviors than respondents with other relationship status.

Moreover, while the reported level of education had a statistically significant positive relationship with the number of reported energy conservation behaviors, this variable had no statistically significant relationship with the number of reported energy efficiency behaviors. That is occupants holding higher levels of education tend to perform more energy conservation behaviors, but this is not necessarily the case with the number of energy efficiency behaviors.

6.1.2. Situational Variables and the Number of Reported Energy Conservation and Efficiency Behaviors

With regards to the examined situational variables (information, home age, home ownership, dwelling type, and city/township), to a certain extent, the identified relationships between these situational variables and both: the number of reported energy conservation and efficiency behaviors are somewhat similar. More specifically, statistically significant positive, but weak, relationship was identified between the variable (information) and the number of reported energy conservation and efficiency behaviors. It was found that this variable was able to explain around 6.78% and 1.78% of the variation among the respondents in terms of the number of energy conservation and efficiency behaviors respectively. According to the findings of this study, respondents who read, receive, follow, and listen to information about energy conservation and efficiency tend to engage in more energy saving activities. Therefore, it is reasonable to suggest that households should have access to quality information about how to effectively perform energy conservation measures and how to identify and implement energy efficiency projects in their homes.

The dwelling type was also found to have statistically significant relationships with the number of reported energy conservation and efficiency behaviors. The findings suggest that respondents residing in larger free-standing dwellings (single detached houses, townhouses) tend to implement more energy conservation and efficiency behaviors than those residing in multi-unit dwellings (high and low-rise apartments and units). However, that does not necessary imply that their actual energy consumption is lower.

With respect to the variable (home ownership), statistically significant, but weak, relationships were found with the number of reported energy conservation and efficiency behaviors. Those who owned their dwellings were more likely to engage in more conservation and efficiency behaviors than renters do. Both variables (home ownership and dwelling type) were found to be able to explain around 11.6% and 27.8% of the variation among respondents with regard to the number of reported energy conservation and efficiency behaviors respectively.

Additionally, the variable (year home was built) was also found to have a statistically significant relationship with both: the number of reported energy conservation and efficiency behaviors. However, the relationships were found negative and weak. That is the older the home, the more likely that the study participant will engage in more conservation and efficiency behaviors. The findings show that this variable can explain around less than 1%, and around 2.3% of the variation among the respondents in terms of the number of energy conservation and efficiency behaviors respectively.

6.1.3. Psychological Variables and the Number of Reported Energy Conservation and Efficiency Behaviors

In terms of the relationship between the number of energy conservation behaviors and the psychological variables (attitude, knowledge, and cost-benefit appraisal), statistically significant positive relationships were identified. However, the relationships were found weak. The four attitudinal

variables used in this study were able to explain around 17% of the variation among the study participants with regards to the number of reported energy conservation behaviors. The other two psychological variables (knowledge and cost-benefit appraisal) were able to explain around 5% and 3.72% of the variation respectively. Additionally, a statistically significant, but weak relationship was identified between the psychological variables (subjective norms) and the number of energy conservation behaviors. Respondents who were interested in knowing how their energy consumption compares to others in their neighborhood were 57.8% more likely to participate in energy conservation behaviors than those who were not interested in that. This variable (subjective norms) can explain around 2.3% of the variation among respondents with respect to the number of energy conservation behaviors they regularly take in their homes.

In terms of the relationships between the number of energy efficiency behaviors that the study participants have already made to their homes and the examined psychological variables (attitude, knowledge, cost-benefit appraisal, and subjective norms), a statistically significant relationship was identified only between respondents' knowledge and the number of energy efficiency behaviors. This variable was able to explain around 4.6% of the variation among respondents. More specifically, no statistically significant relationship was identified between any of the other psychological variables (attitude, cost-benefit appraisal, and subjective norms) and the number of reported energy efficiency behaviors.

Based on these findings, it is reasonable to suggest that respondents with stronger attitude and higher concern towards the environment and climate change are more likely to engage in energy conservation behaviors, but this is not the case with the number of energy efficiency behaviors, since no statistically significant relationship was identified between attitude and the number of efficiency behaviors. The same thing can be concluded about the variables cost-benefit appraisal and subjective norms. However,

the higher the level of knowledge that respondents have about energy-related issues, the more likely they are to engage in more conservation and efficiency behaviors.

6.2. Practical Implications, Recommendations, and Future Research

This study demonstrated that there are a number of variables that may play a significant role in driving households' energy consumption and saving behaviors. While many studies in the reviewed literature focused only on one or two of the main three variable-categories (socio-demographic, situational, and psychological variables) influencing household energy-related behaviors, this thesis examined several variables that go under each of the main three categories. In doing so, this study confirms the importance of taking multiple variables into consideration when examining household energy-related behaviors, as well as when designing and implementing strategies and interventions that aim at lowering household energy consumption through energy conservation and efficiency measures.

Accordingly, the findings of this thesis are assumed to be very useful for energy practitioners, utility providers, and policymakers as these findings offer insights and provide quality information about the unique household profiles exist in their targeted population, which is in this work households residing in the Region of Waterloo. So, better opportunities can be identified, and more effective policies and interventions can be designed, developed, and implemented to achieve the desired reductions in household energy consumption, and to encourage sustainable behavior pattern. According to Steg and Vlek (2009), for an effective behavioral intervention, four key issues need to be addressed. These include: (1) the identification of the behavior that contribute to the environmental problem and need to be changed, (2) an examination of the main determinants underlying that behavior, (3) the implementation of interventions to change the relevant behaviors and their determinants, (4) the evaluation of the how effective the implemented interventions on that behavior and its determinants, as well as on the environmental quality, and human quality of life.

In view of the obtained findings of this work and based on the identified significant relationships between independent and dependent variables, peoples' participate in more energy conservation and efficiency behaviors can be encouraged and improved by ensuring that policies and interventions will take those significant relationships into consideration. For example, the number of energy conservation and efficiency behaviors that people may engage in can be improved if their level of knowledge and awareness of various energy issues, as well as of the various ways to reduce energy consumption is improved. Therefore, psychological interventions that convey information to households through workshops, mass media campaigns, and through tailored information - that is specific and highly personalized – can designed, developed, and applied to achieve the desired results.

Additionally, policies need to target large households with high income level, as well as homeowners residing in larger, older free-standing homes. The identified significant relationship between the cost-benefit appraisal and the number of reported energy conservation behaviors suggests that, increasing the energy prices will also motivate people to engage in more energy conservation behaviors to save money and reduce their utility bills. According to the obtained results, targeting highly educated people and those having higher concern about the environment and climate change is expected to result in increasing peoples' engagement in more energy conservation behaviors.

It is also assumed that, this work is useful for academic researchers since this thesis adds to the growing body of literature exploring determinants influencing household energy consumption and saving behaviors. So, this thesis is expected to be useful when conducting futures research, that address households energy-related behaviors.

Given the above and considering the complex nature of human behavior that involves a number of interacting variables, it is recommended that future studies should address additional determinates – not examined in this work – that are involved in occupants' energy-related behaviors in order to

reach a more comprehensive understanding of their energy consumption and saving behaviors. Some of the important variables that are not examined in this thesis include, but not limited to the perceived behavioral control, laws and regulations, energy prices, availability of technology, goals and intentions. Examining and understanding the influence of these and many other variables on occupants' energy-related behaviors can help identify opportunities to improve the participation in energy saving behaviors.

It is also recommended and advisable for future studies to measure the actual energy behavior of households whenever possible, and to give particular attention to the validity and reliability of self-reported energy behaviors.

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Appendix A – Selected Survey Questions

Hi. My name is _____ and I'm calling on behalf of PMG Intelligence, a Canadian market research company. We need your help. We are not selling anything, nor will anyone contact you as a result of this survey. We are conducting an important study on residential energy users and energy conservation in Canada. All information collected, used and/or disclosed will be used for research purposes only and administered as per the requirements of the Canadian Privacy Act.

Could I please speak with the primary adult owner or renter of this residence that is involved in making energy related decisions that impact the household?

SOLICIT PARTICIPATION:

a) Yes
b) No – **TERMINATE**

Sr. no.	**Order/ no. of question in the original survey**	**Question**
Group 1	**(Independent Variables - Socio-demographic variables)**	
1	Q46	In what year were you born?
2	Q47	What is the highest level of education you have completed? a) Less than high school b) Some high school c) Completed high school d) Some college/university e) College diploma f) University degree g) Post graduate h) Prefer not to respond
3	Q48	Would you describe yourself as…? a) Employed full-time b) Employed part-time c) Self employed d) Volunteer e) Retired

		f) Unemployed g) A homemaker h) A student i) Other (DO NOT SPECIFY) j) Prefer not to respond
4		Which of the following best describes your relationship status? a) Married b) Co-habiting/ common law c) Widowed d) Divorced/ Separated e) Single, never married f) Prefer not to respond
5	Q50	How many people, including yourself, currently live in your household? a) One - just yourself b) Two c) Three d) Four e) Five or more f) Prefer not to respond
6	Q51	Do you have any children at home? a) Yes b) No c) Prefer not to respond
7	Q59	Which of the following categories represents your total annual household income before taxes? a) Less than 20,000 b) 20,000 – 39,000 c) 40,000 – 59,999 d) 60,000 – 79,999 e) 80,000 – 99,999 f) 100,000 – 149,999 g) 150,000 – 199,999 h) 200,000 – 249,999 i) 250,000 or more j) Not sure k) Prefer not to respond
8	Q60	Gender? a) Male

		b) Female c) Prefer not to respond
Group 2	**(Independent Variables – Situational: Contextual and structural variables)**	
9	Q1	Which of the following best describes your primary residence? a) Single detached house b) Semi-detached house c) Townhouse d) High rise apartment building (greater than 4 stories) e) Low rise apartment building (4 stories or less) f) Duplex or triplex g) Other (please specify) h) Don't know / Not sure
10	Q53	Do you own or rent your current dwelling? a) Own b) Rent c) Have some other living arrangement d) Prefer not to respond
11	Q54	To the best of your knowledge, approximately when was your home built? a) Before 1942 b) 1942 – 1974 c) 1975 – 1990 d) 1990 – 2013 e) 2014 or later f) No sure g) Prefer not to respond
12	Q61	In which city or township do you reside? a) Kitchener b) Waterloo c) Cambridge d) Wellesley e) Wilmot f) Woolwich g) North Dumfries h) Prefer not to respond
13	Q36	When you receive information about energy conservation and/or efficiency messaging in the mail, do you read it…? a) Always

<table>
<tr><td></td><td></td><td>b) Often
c) Sometimes
d) Rarely
e) Never
f) Do not recall receiving information about energy conservation and/ or efficiency in mail
g) Not sure</td></tr>
<tr><td>14</td><td>Q37</td><td>How likely are you to follow/listen to information about energy conservation and/or efficiency that you may see or receive?

a) Definitely would
b) Probably would
c) Might or might not
d) Probably would not
e) Definitely would not
f) Not sure</td></tr>
<tr><td>Group 3</td><td colspan="2">(Independent Variables - Psychological Variables)</td></tr>
<tr><td>15</td><td>Q5</td><td>Using a scale of 1 to 10, where 1 is not at all a priority and 10 is an essential priority, please rate how much of a priority energy conservation and energy efficiency are to you personally?

<table>
<tr><td></td><td>Not a priority at all</td><td>Low Priority</td><td>Priority</td><td>High Priority</td><td>Essential priority</td><td>Don’t know/unsure</td></tr>
<tr><td>Conservation</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Efficiency</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>16</td><td>Q6</td><td>Which of the following statements best describes your view of the environment?

a) The environment is in significant trouble, we need to do everything we can to help change it.
b) The environment is in significant trouble, we need to do our part to help change it (every little bit counts)
c) The environment is in significant trouble, but there isn’t much we can do to change it so why bother
d) The environment is in trouble, but it is not significant
e) The environment is fine
f) You don’t know anything about the environment
g) Not sure</td></tr>
<tr><td>17</td><td>Q7</td><td>Which of the following statements best describes your view of climate change?</td></tr>
</table>

<table>
<tr><td></td><td></td><td>a) climate change is a significant issue – very concerned about the future.
b) climate change is a significant issue – somewhat concerned about the future.
c) climate change is a significant issue – but not concerned about the future.
d) climate change is an issue – but you do not feel it is significant.
e) climate change is not an issue – not real.
f) Do not know anything about climate change</td></tr>
<tr><td>18</td><td>Q22</td><td>Do you feel you know how to effectively reduce your home’s energy usage?
a) Definitely
b) Somewhat
c) Not particularly
d) Not at all</td></tr>
<tr><td>19</td><td>Q30</td><td>Have you ever heard of the term “Net Zero Energy” as it relates to conserving energy?

a) Yes, aware of the term and have detailed understanding of what it means
b) Yes, aware of the term and have some understanding of what it means
c) Yes, but have only heard of the name, not aware of the meaning
d) No, have no awareness of the term
e) Not sure</td></tr>
<tr><td>20</td><td>Q21(items B & E)</td><td>On a scale of 1 to 10 where 1 means ‘strongly disagree’ and 10 means ‘strongly agree’, please indicate how much you agree or disagree with each of the following statements related to residential energy conservation.

<table>
<tr><th></th><th></th><th>Strongly agree</th><th>Agree</th><th>Neither agree nor disagree</th><th>Disagree</th><th>Strongly disagree</th><th>Don’t know/ unsure</th></tr>
<tr><td>b</td><td>You try to save energy because it saves you money</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

		e	Energy efficiency and conservation can help reduce your utility bills							
21	Q33	Would you be interested in knowing how your energy consumption compares to others in your neighborhood? a) Yes b) No c) Not sure								

Dependent Variables

I. Energy Conservation Behaviors

Which of the following behaviors, if any, do you regularly take in your home? (Conservation activities/ behaviors)

1) Turn off lights when not in the room
2) Wash your clothes in cold water
3) Hang your clothes out to dry rather than using a dryer
4) Turn off the water when brushing your teeth
5) Turn off the water when washing dishes / use a partially filled sink
6) Take short showers
7) Run your dishwasher at off-peak hours
8) Run your laundry at off-peak hours
9) Run your other appliances at off-peak hours
10) Reduce the number of times you flush your toilet
11) Adjust your thermostat to use less heating and/or air conditioning

12) Unplug any electronics like TVs or computers when they are not in use or hook them up to a power bar with a timer

13) Drive a hybrid or electric car

14) Drive a compact car rather than a full-size sedan, SUV or truck

15) Recycle as much as possible

16) Use a green bin or compost as much as possible

17) Use a rain barrel to collect rain water to be used outside to water the gardens in lieu of a hose

18) None of the above

II. Energy Efficiency Behaviors

Have you already made any of the following energy improvements to your home?

Sr. No.	Improvement	Have done already
1	Upgrade to programmable thermostats	
2	Install a high-efficiency furnace	
3	Install energy-efficient lighting controls	
4	Install a high-efficiency central air conditioning system	
5	Replace windows or doors to reduce drafts in home	
6	Install insulation in walls, attic and/or basement	
7	Install electric water heater blanket	
8	Install hot water pipe wrap	
9	Install power bars with integrated timer or auto shut-off	
10	Install home automation system (e.g. Automatic temperature and	
11	Install weather stripping around windows and doors	
12	Install low energy light bulbs	
13	Replaced old, working appliances with Energy Star appliances	

14	Purchase and use alternate sources of energy (i.e. solar panels, geo-	
15	Install Efficient Showerheads	
16	Install Efficient Kitchen and Bathroom Aerators	
17	Install energy star water heater	
18	Install Tankless Water Heaters	