A MULTI-COUNTRY STUDY OF HOUSEHOLD ENERGY SAVING BEHAVIOUR

by

Ela Tabaku, B.Sc., University of Manitoba, 2009

A project paper

presented to Ryerson University

in partial fulfillment of the

requirements for the degree of

Master of Applied Science

in the Program of

Environmental Applied Science and Management

Toronto, Ontario, Canada, 2015

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this project paper. This is a true copy of the project paper, including any required final revisions.

I authorize Ryerson University to lend this project paper to other institutions or individuals for the purpose of scholarly research.

I further authorize Ryerson University to reproduce this project paper by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

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

A MULTI-COUNTRY STUDY OF HOUSEHOLD ENERGY SAVING BEHAVIOUR

Ela Tabaku, 2015

Master of Applied Science
Environmental Applied Science and Management
Ryerson University

ABSTRACT

Due to the increased worldwide demand for electricity, governments and policy makers are looking to identify tools to help reduce household energy consumption. This study examines the relationship between the empirical and attitudinal variables and the likelihood of implementation of household energy conservation measures and investments, using a wide data set involving household level characteristic from 10,252 respondents from ten different countries (Australia, Canada, Czech Republic, France, Italy, Korea, Mexico, Netherlands, Norway, and Sweden). Moreover, the effects of time varying electricity pricing on household energy saving measures and investments is evaluated. Using the multivariable probit model, this project makes comparison across the ten countries incorporating socio-demographic characteristics, and allows for the potential correlation between energy saving decisions (measures and investments).

ACKNOWLDEGEMENTS

First and foremost, I would like to thank my supervisor, Dr. Paul Missios, for the continued help and guidance throughout this work. His support is very much appreciated and I am grateful for the knowledge he has passed on.

I would also like to thank my parents who instilled in me the desire to learn and made many sacrifices so I would have access to a better education and future.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

ASEAN	The Association of Southeast Asian Nations
CIS	Commonwealth of Independent States
CPP	Critical Peak Pricing
DR	Demand Response
ED-CPP	Extreme Day CPP
EDP	Extreme Day Pricing
EEO	Energy Efficiency Opportunities
EIA	U.S. Energy Information Administration
EU	European Union
IBP	Incentive-Based Programs
IEA	The International Energy Agency
MtC	Millions of metric tons of carbon
NRCan	Natural Resources Canada
OECD	The Organisation for Economic Co-operation and Development
PBP	Price-Based Programs
RTP	Real Time Pricing
TOU	Time-of-Use

CHAPTER 1: INTRODUCTION

The continued increase in energy consumption, due to population and economic growth, represents a major concern to governments, policy makers, and the public, as it is linked to many environmental issues that are causing a toll on Earth's natural resources. More and more fossil fuels are burned at an increasing rate to sustain our way of life and advance the economies of developing countries. The increased energy demand has led to the unsustainable extraction of natural resources and has exposed the need for the reduction and eventual elimination of our dependence on non-renewable natural resources.

A growing cause of environmental damage in industrialized countries is household expenditure (Michaelis, 2003). Worldwide household energy consumption has increased by 20% from 1990 to 2006, accounting for 17% of World's energy consumption. On average the residential sector accounts 20% to 35% of a country's energy use (OECD, 2001), and in the United States it accounted for 39% of the country's CO_2 emission for year 2006 (EIA, 2008). The vast impact that household energy consumption has on the environment demonstrates the need for policy instruments meant to increase household energy saving and transform household into more sustainable ones. Household energy conservation activities have received a great deal of attention by governments, and different policies are being introduced to direct peoples' decisions towards more environmentally friendly ones. As noted in Michaelis (2003), surveys of public opinion show that there is an interest for action to address environmental problems, ranging from changes in lifestyle to technological progress. Many approaches are used by governments to target energy consumption behaviour, and they include taxation, tax incentives, education, communication campaigns, and a combination of different policy instruments (IEA, 2012). These policies can prove beneficial in altering behaviour; however, it is important to note

that altering behaviour is a complex matter, and the impact of socio-demographic, psychological, and external factors should be considered when selecting a policy instrument.

Socio-demographic factors such as income, age, gender, education, and employment have been found to impact the likelihood of a household adopting energy saving measures and investments. While age and gender do not seem to be good predictors of household energy consumption (Nair, *et al.*, 2010 & Gatersleben, *et al*., 2002), income and employment are among the strongest socio-demographic factors that influence residential energy use (Abrahamse & Steg, 2009). Moreover, residential consumers that are concerned about the environment are more willing to pay a higher fee for renewable energy (Bang *et al*., 2000; Kim & Choi, 2005). Studies have found that customers respond to changes in electricity price, but the magnitude of response varies greatly from study to study (Faruqui & Sergici, 2010). Policy instruments that address pricing, such as time-of-use (TOU) pricing, are beneficial to both the consumer and the producer, and have been shown to influence household energy usage behaviour (Faruqui, *et al*., 2013 & Yang, *et al*., 2013).

The differences in energy usage due to electricity pricing, socio-demographic factors, and psychological factors, suggest that policies should be selected in such a way that they are successful in changing the behaviour of the population they are targeting. To achieve the desired results it is necessary to understand the effects that the characteristics of a certain group, such as an income class or a particular country, have on the likelihood of adopting energy saving activities, and design policies that specifically target each group.

1.1 Project Objectives

The purpose of this research is to evaluate the relationship between the empirical and attitudinal variables and the likelihood of implementation of household energy conservation measures and investments. More specifically this paper will:

- assess the relationship between time-of-use (TOU) policy and households' energy saving measures and investments
- assess the relationship between environmental concern on the likelihood of households' purchasing renewable energy
- assess the relationship between different motivators and energy saving measures and investment

Many studies perform a direct relationship between the variables without accounting for the effect that the rest of the variables have on the results, which in turn can lead to skewed conclusions. For example, the OECD (2011) study shows that having metered electricity has an impact on energy-saving investments such as energy-efficient appliances or thermal insulation, but it does not take into account that these investments may not be a direct effect of the policy, rather than an effect of being from a certain country, age group, or income class. The purpose of this study is to provide insight on the effects of time-of-use pricing policy on energy saving activities, while controlling for the effects of background variables. These results can then be used as a lesson to indicate the importance of controlling for the influences of other variables when assessing the relationship between variable and outcome.

1.2 Project Questions

The research questions this project with seek to answer are:

- What is the relation between time-of-use (TOU) electricity pricing and households' energy saving measures and investments?
- Is individual's concern over environmental issues related to likelihood of households' purchasing renewable energy from electricity provider?
- What is the relationship between what people consider a motivator for energy saving and the households' energy saving measures and investment?

CHAPTER 2: LITERATURE REVIEW

2.1 Energy Outlook

The average electricity consumption per capita in both developed and developing countries has been steadily increasing and is expected to increase even more so in the future as world population continues to grow. As seen in Figure 2.1, there has been a drastic increase in household energy consumption per capita in all regions from 1980 to 2006 and this demand is expected to continue to increase. Such an increase in energy demand will place a strain on the environment and will likely lead to irreversible environmental damage through the release of greenhouse gasses and depletion of natural resources.

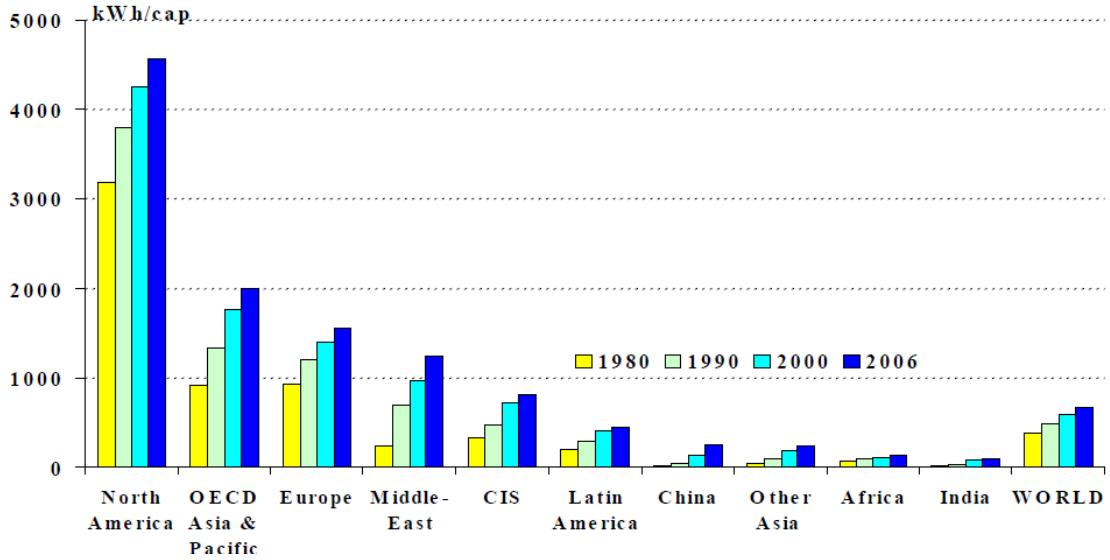

Figure 2.1. Household electricity consumption per capita (WEC, 2008). North America includes US and Canada; OECD Asia & Pacific includes Japan, Korea, Australia and New Zealand; Europe includes EU, Albania, Bosnia, Croatia, Iceland, Macedonia, Norway, Serbia, Switzerland, and Turkey; CIS (Commonwealth of Independent States) includes countries of the former Soviet Union excluding the Baltic States (i.e. Estonia, Latvia and Lithuania); Other Asia includes ASEAN and other South Asia.

In developing countries, the increase in energy demand is directly linked to the projected rise in population and the standards of living (EIA, 2013). On the other hand, in industrialized

countries, the fastest growing cause of increased energy expenditure and greenhouse gas emissions is lifestyle and consumption (Michaelis, 2003). Worldwide household energy consumption increased by 20% from 1990 to 2006, accounting for 20% of CO_2 emissions (OECD, 2011) and 17% of world energy expenditure, as shown in Figure 2.2. As noted by Kelly (2012), there are substantial variations in consumption between countries; for example, World Bank data for the energy consumption for year 2008 showed countries such as Norway, Canada and Sweden had a higher per capita consumption than Mexico, Italy and Czech Republic (World Bank, 2014). In Canada, heating accounted for 81% of residential energy use for year 2007, followed by appliances, lighting and cooling (Figure 2.3). Decreasing household energy usage is important both because of the current extensive use and because of the expected growth. Therefore, promoting household energy reduction and energy efficiency has the potential of significantly contributing to a decrease in the world's energy consumption and greenhouse gas emissions (Kallbekken, Saelen, & Hermansen, 2013).

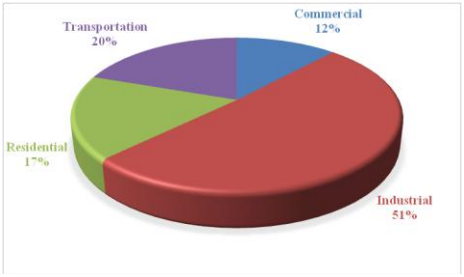

Figure 2.2: World energy consumption by sector for year 2011 (EIA, 2015)

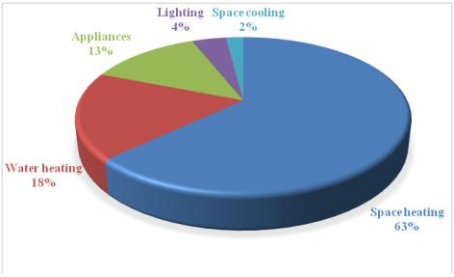

Figure 2.3. Residential energy use in Canada for year 2007 (NRCan, 2010)

Literature shows that strategies such as decreasing water heater temperature, switching electricity to standby, and installing energy efficient appliances lead to a decrease in energy use (Levine, M. *et al*., 2007). One study in particular calculates this possible reduction in terms of

reasonably achievable carbon emission reduction (RAER), noting that a decrease in RAER of 5.1% of the total household use or 32 MtC (millions of metric tons of carbon) can be attained by undertaking activities such as home insulation and upgrades of heating and cooling equipment (Dietz, *et al.*, 2009). Newsham and Donnelly (2013) have also found that replacing old space heating systems with new ones can lead to energy savings of about 2,000 kWh/year (Newsham & Donnelly, 2013). Moreover, partaking in activities such as changing water heaters and laundry temperature can lead to a decrease in RAER of 0.21% (or 1.2 MtC), and daily use behaviour, such as changing electricity to standby, decreasing thermostat temperature, and line drying can lead to a combined decrease in RAER of 1.58% (or 9.9 MtC) (Dietz, *et al.*, 2009). These findings make evident the significant impact that simple daily measures could have in decreasing energy consumption and greenhouse gas emissions.

2.2 Policy Objectives/Solutions

Governments around the world have implemented policy objectives meant to decrease energy consumption and promote renewable energy use. These policies tend to focus on buildings, appliances, lighting, transport, industries, and utilities, and usually address a combination of areas (IEA, 2011). Policy instruments vary widely and selection of an adequate instrument is a key factor in its success. The International Energy Agency (IEA) (2012) summarizes key developments in energy policies from the 28 IEA countries. As shown in Table 2.1, IEA group members have created policies that fall under six sections: general energy policy, energy efficiency, electricity, research and development, renewable, and oil and gas. Among the countries considered in this paper, more have engaged in energy efficiency and electricity policies. With regards to energy efficiency, Australia has created the Energy Efficiency

Opportunities (EEO) Program that aims to make industry more energy efficient and involves the analysis of energy data and a systematic process to identify opportunities for energy efficiency. Canada, on the other hand, continues to increase the standards for commercial building energy codes (IEA, 2012). Other programs implemented by the countries used in this study are presented in Table 2.1. Most policies introduced aim at increasing efficiency, reducing consumption and emissions, and increasing environmental protection. To achieve these policy objectives, many countries have implemented policy instruments aimed at swaying people's behaviour towards energy conservation. In order to select the most appropriate policy tool, it is important to consider the factors that influence energy usage behaviour.

2.3 Factors Influencing Energy Usage Behaviour

A wide range of strategies are proposed to decrease energy consumption. These include simple measures, such as switching the lights off when not in use or monitoring electricity expenditure, and more complex ones such as investing in energy efficient equipment and modifying behaviour (Levine, M. *et al*., 2007). While some of these measures are based on attitudinal factors, others, such as investing in energy efficient appliances, require significant monetary cost and are not likely to be implemented in households based on psychological or moral factors alone (Urban & Scansy, 2012). Identifying what motivates people to decrease energy consumption and increase energy saving behaviour is complex, and depends not only on socio-demographic factors, but also on peoples' attitudes, preferences, and electricity prices. A literature review of the impacts of some of the main socio-demographic, psychological, and external factors relevant to this study is tabulated in Table 2.2 and described in the following sections.

Table 2.1. Key Development in Energy Policy in IEA countries (IEA, 2012). The table marks (x) each country that has implemented a program on each of the six areas of energy policy, with short description of key programs in some of the relevant countries to this research paper. Continued in page 10.

Country	General Energy Policy	Energy Efficiency Policy	Electricity Policy	Energy Research and Development	Renewables	Oil and Gas
Australia		Energy Efficiency Opportunities (EEO) Program • systematic process to identify opportunities for energy efficiency	National Electricity Market (NEM) • improve energy market governance			
Austria			X		X	X
Belgium			X			
Canada	Responsible Resource Development (RRD) • more effective and efficient regulatory system • strengthening environmental protection	National Energy Code of Canada for Buildings 2011 • minimum requirements for the design and construction of energy efficient new commercial buildings				
Czech Republic	Czech State Energy Concept (SEC) • re-direct available coal into heating and highly effective co-generation systems and find alternative fuels					
Denmark		X			X	
Finland			X			
France				X		
Germany	X		X			
Greece			X			
Hungary			X			
Ireland		X				X
Italy		White Certificates (WhCs): • reduce GHG emissions • reduce energy import dependence • develop market for energy efficiency products and services.		X		X

Table 2.1. Key Development in Energy Policy in IEA countries (IEA, 2012). The table marks (x) each country that has implemented a program on each of the six areas of energy policy, with short description of key programs in some of the relevant countries to this research paper. Continued from page 9.

Country	General Energy Policy	Energy Efficiency Policy	Electricity Policy	Energy Research and Development	Renewables	Oil and Gas
Japan		Rational Use of Energy • improve the thermal insulation performance				X
Korea			The Drill • 20 min blackouts • voluntary emergency exercise in which all energy stakeholders were encouraged to participate to save electricity	X		
Luxemburg		X				
Netherlands	National Co-ordination Procedure • spatial decision-making is therefore done at the national level				X	
New Zealand		X	X			
Norway					X	X
Poland						X
Portugal		X				X
Slovak Republic		X				
Spain					X	
Sweden	Climate and Energy Policy Package • purchase of environment-friendly • vehicles • tax exemption on high-ratio blends of renewables into gasoline and diesel fuels • promote biofuels and development and deployment of clean vehicles				X	
Switzerland			X			
Turkey		X				
United Kingdom		X	X			
United States	X					

2.3.1 Socio-demographic Factors

I. Age

Age does not seem to be a good predictor of household energy use. Studies have shown that younger participants are more likely to invest in energy saving technology. Older homeowners, on the other hand, were are likely to adopt energy saving measures, which may be due to the lower income of the older participants, or the lack of knowledge about energy efficient measures and investments (Nair, *et al.*, 2010). Moreover, Gatersleben, *et al*. (2002) failed to find a relationship between age and energy consumption or saving. In contrast, Long (1993) found that homeowners older than 65 years made significant energy efficient investments, and Barr et al. (2005) reported that respondents with a mean age of 55 years are more likely to undertake both energy-efficient investments and measures than younger age groups.

II. Gender

As with age, the effects of gender on energy usage behaviour are inconsistent among studies. Kollmuss and Agyeman (2002) and Zelezny, et al., (2000) found that women have a higher environmental concern and are more willing to change. Other research has found that gender is not a good predictor of energy saving behaviour (Sardianou, 2007; Poortinga et al., 2003), and especially when other background factors, such as income and household characteristics, are accounted for (Clark, *et al.*, 2003).

III. Education

Participants with a lower education level are more likely to adopt behavioural measures (such as switching off the lights when not in use or line drying of laundry), but they are less

likely to participate in technical measures (i.e. energy-efficient heating system or house insulation) (Poortinga *et al*., 2003). More highly educated people are more likely to display environmental friendly behaviour, and have lower household energy use (Poortinga, *et al.*, 2004; Gatersleben, *et al*., 2002). Other studies have found that the education and income of the main wage earner of the family has no significant influence on the number of energy conservation actions taken by the household (Curtis, *et al*., 1984; Sardianou, 2007).

IV. Employment of occupants

Employment of household occupants (full-time, part-time, retired, etc.) directly impacts household income and therefore indirectly impacts energy consumption. Participants in full-time employment have more disposable income and therefore are more likely to invest in energy saving technology. Moreover, they spend less time at home which leads to a lower consumption level. As found by Powers, *et al*., (1992) full-time employment is related to household energy conserving investments.

V. *Household Income and Size*

Household income is one of the strongest socio-demographic factors to influence residential energy use behaviour. Research has shown that households with higher income and larger size tend to use more energy, suggesting that availability and need shape energy consumption rather than only psychological or altruistic factors such as protecting the environment (Abrahamse & Steg, 2009; OECD, 2008b; O'Neill & Chen, 2002). In addition Abrahamse and Steg (2009) demonstrate that direct energy use (gas, electricity and fuel) was related to household size (number of people in the household), while indirect energy use (from

production, consumption and disposal of goods) is related to both income and household size. These results are supported by the findings of Poortinga, *et al.* (2004) and Gatersleben, *et al*. (2002) showing that larger households and households with higher income have a higher energy use. While larger household have a higher energy use they have a lower per capita consumption. O'Neill and Chen (2002) found that a two-person household uses 17% less energy per person than a single-person household.

As discussed in Cayla, *et al*. (2011), households with lower income are less likely to invest in energy efficient equipment. However, this study also indicated that high income households are also not likely to invest in energy saving equipment (Cayla, Maizi, & Marchand, 2011). This observation does not agree with what would be expected, since it is believed that high income households have the necessary capital to invest in energy efficient technology. One possible explanation could be that the high income households do not perceive the benefits gained from investing in energy efficiency to outweigh the upfront investment. Perhaps this inconsistency can be overcome by raising electricity prices and therefore increasing the perceived benefit of energy efficient investments.

2.3.2 Psychological Factors

Understanding of environmental issues could be a powerful incentive that could lead homeowners to purchase a greater amount of renewable energy and increase energy savings. Abrahamse and Steg (2009) found that energy savings are influenced by psychological factors, and the more concerned people are about the environment, the more they are willing to pay for renewable energy (Bang et al., 2000; Kim & Choi, 2005). Other research supports these findings, showing that environmental knowledge and the belief that energy sources have consequences on

the environment is positively related to the likelihood of purchasing green energy (Rowlands, *et al*., 2003; Mostafa, 2007; Bang *et al*., 2000). Moreover, Abrahamse and Steg (2009) found that the more the respondents they surveyed thought they were capable of saving energy, the more they tended to save. On the other hand, there are studies that have not found the association between psychological factors and energy demand to be very strong (OECD, 2008b). Gatersleben, *et al.* (2002) and Axelrod and Lehman (1993) indicated that environmental concern is not a significant factor that influences energy consumption or that leads to environmental friendly behaviour.

2.3.3 External Factors – Demand Response

Demand Response (DR) programs are employed to provide users with incentives so that the energy load is shifted from peak to off-peak hours. Consumers can respond to the high electricity prices by reducing their electricity consumption during peak hours or by shifting their consumption from peak hours to off-peak hours (Albadi & El-Saadany, 2008). According to U.S. Department of Energy, Demand Response can be defined as "changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time" (DOE, 2005). DR programs have the potential to benefit the consumer who will enjoy a lower electricity bills. Moreover, these programs can lead to a decrease of the market electricity price because of the more efficient use of the infrastructure and can lower the risk of electricity outages (Albadi & El-Saadany, 2008).

DR programs can be Incentive-Based Programs (IBP) and Price-Based Programs (PBP). PBPs are based on consumers voluntarily reducing their demand in response to market prices and can be quite advantageous in reducing or shifting electricity consumption (Muratori, *et al*., 2014;

Albadi & El-Saadany, 2008). This program includes: Time of Use (TOU) rate, Critical Peak Pricing (CPP), Extreme Day Pricing (EDP), Extreme Day CPP (ED-CPP), and Real Time Pricing (RTP) (Muratori, *et al*., 2014; Albadi & El-Saadany, 2008). Yuan, *et al*. (2010) found that higher energy prices have the potential to decrease energy consumption in China in both the industrial and household sectors. Moreover, Reiss and White (2008) found that in year 2000, after the rapid increase in electricity prices in California, there was a decrease of 13% in the average household electricity over 60 days. This paper will look at time-of-use (TOU) electricity pricing, where households pay a lower electricity price during off-peak period and a higher price during peak period.

2.3.3.1 Time-of-Use Pricing (TOU)

The main purpose of time-of-use pricing (TOU) is to provide an incentive for users to reduce consumption during periods where supply is low and prices are high. On the other hand, flat electricity prices fail to provide pricing that reflects the marginal cost of providing power and gives no incentive to end-users to reduce or shift consumption. Households have been shown to respond to economic incentives (OECD, 2008b), and as such varying electricity prices were introduced to decrease consumption during peak hours. Many countries around the world, and especially the European Union (EU) member states, have implemented some legal framework for the installation of smart metering. As discussed in the European Smart Metering Landscape Report, countries such as France, Italy, Norway, and Sweden are among the countries with a strong path to the full implementation of smart metering (Renner, 2011).

An example of TOU pricing in Ontario is shown in Figure 2.4. During off-peak hours (from 7 pm to 7 am) the price for electricity is only 7.5 cents per kWh, which increases to 13.5 cents per kWh from 11 am to 5 pm when there is the most demand (OEB, 2014). While literature

suggests TOU pricing be mandatory, most of the current programs are voluntary. In Ontario, for example, TOU pricing is mandated only to regulated price plan (RPP) customers that have smart meters installed, and includes small volume consumers, such as households and small businesses (ECO, 2014). The results from the 2014 Annual Energy Conservation Progress Report show that TOU pricing has led to an estimated on-peak electricity reduction of between 2.6% to 5.7% during the summer months. More savings could be observed it the price ratio between off-peak and on-peak pricing is increased (ECO, 2014).

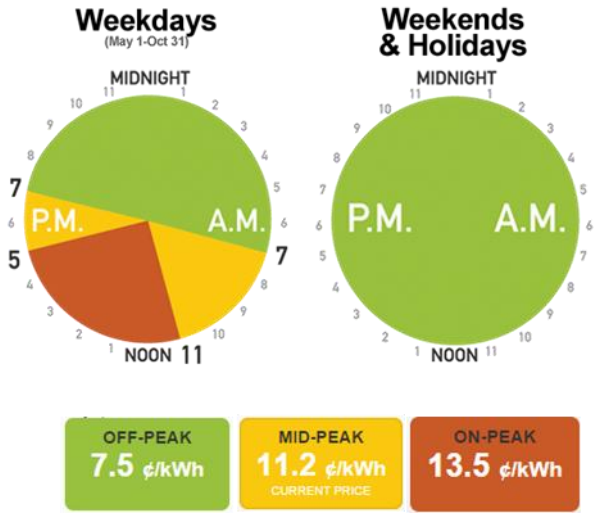

Figure 2.4. Ontario time-of-use electricity chart indicating the varying electricity prices charged depending on the time of use. During on-peak hours the price is almost double the price during off-peak hours. (OEB, 2014)

Chao (2010) provides a discussion about price-responsive management and the asymmetrical distribution of the social costs and benefits between off-peak and on-peak hours. As described in this paper, during on-peak hours both the consumer and producer incur net losses, while during off-peak hours both consumer and producer incur net benefits (Chao, 2010). Time varying rates were introduced to decrease consumption during peak hours and to better represent the marginal cost of electricity, which fluctuates depending on demand during the day,

and the cost associated with possible power outages (Baladi, *et al*., 1998; Cochell, Schwarz, & Taylor, 2012).

Other studies have shown that time varying rates are an improvement over flat rates and can be beneficial to both the producer and the consumer. Specifically, studies have revealed that households significantly altered their usage pattern under the TOU tariff (Faruqui & Sergici, 2010) and that a proper adaptation of this pricing scheme would be beneficial to both the producer and the consumer; the producer would increase profit, while the consumer would save electricity cost (Yang, *et al*., 2013). However, the effects of a TOU tariff may depend on region, so it is necessary to consider total energy use and pattern in order to adequately assess the impact of TOU rates and select an adequate pricing scheme (Cochell, *et al.,* 2012). Furthermore, high-end and low-end consumers behave differently in the face of time varying electricity pricing with high-end consumer being more likely to decrease consumption than low-end consumers (Herter, 2007).

Although the benefits of time based pricing are abundant, implementation of such a tariff faces many barriers, such as the cost of purchasing and installing smart meters and the change of the billing system (Borenstein, 2013). Moreover, time-based pricing can increase the electricity bill of low-income households that are already struggling financially and do not have the ability to avoid paying high peak electricity rates (Alexander, 2010). As described in Borenstein (2013) this can be addressed by introducing a voluntary dynamic pricing tariff for well-informed customers. As shown by Baladi, *et al*. (1998) both households that volunteered and were mandated to participate in time-based pricing behaved similarly and altered their usage pattern. This suggests that an opt-in (volunteer) program would be quite beneficial, as it would provide the same results but decrease resistance of the participants in this pricing scheme.

Table 2.2. Summary of key papers that consider the influence of socio-demographic variables in energy consumption and conservation. Continued in page 19.

	Factor	Authors (year)	Summary of Key Results
Socio-demographic Factors	**Age**	Nair, Gustavsson, & Mahapatra, (2010)	• Sweden. Younger respondents are more likely to adopt an investment measure than older homeowners
		Poortinga, Steg, Vlek, & Wiersma (2003)	• The Netherlands. Older participants (65 years and older) are less likely to invest in energy efficient technology
		Barr *et al*. (2005)	• United Kingdom. Higher age groups are more likely to be energy savers. Respondents with mean age of 55 years to partake in energy efficiency measures and investments than younger groups
		Gatersleben, B., Steg, L., & Vlek, C. (2002)	• The Netherlands. Age is not significantly related to household energy use
		Long, J. E. (1993)	• United States. Homeowners older than 65 years made significant energy efficient investments
	Gender	Kollmuss, & Agyeman, (2002)	• Women have less environmental knowledge than men but show more environmental concern and are more willing to change
		Zelezny, Chua, and Aldrich, (2000)	• Women show more pro-environmental behaviour than men
		Nair, Gustavsson, & Mahapatra, 2010	• Sweden. Gender does not influence homeowners' preference towards an energy efficiency measure
		Clark, Kotchen, & Moore (2003)	• United States. Gender is insignificant when the effect of other variables (such as income, and household characteristics) are accounted for.
		Sardianou, E. (2007)	• Greece. Gender is not found to be a good predictors of energy-conserving behaviour
		Poortinga, Steg, Vlek, & Wiersma (2003)	• The Netherlands. No relationship is found between gender and energy saving activities
		Schahn & Holzer, (1990)	• Germany. Men have higher knowledge of environmental issues than women
	Education	Nair, Gustavsson, & Mahapatra, (2010)	• Sweden. Respondents with higher educated are more likely to adopt an investment measure than homeowners with only a primary education • Homeowners with only a primary education were more likely to undertake only non-investment measures than investment measures compared to those with higher education. • Homeowners with secondary education are more likely to adopt other high investment energy efficiency measures compared to those with university education
		Kollmuss, & Agyeman, (2002)	• Higher education is not related to increased pro-environmental behavior
		Poortinga, Steg, & Vlek, (2004); Poortinga, Steg, Vlek, Wiersma (2003)	• United Kingdom. Higher education is related to lower home energy use • Participants with lower education are more likely to partake in non-investment measures compared to participants with higher education
		Sardianou, E. (2007)	• Education level of the consumers is not found to be a good predictors of energy-conserving behaviour
	Employment of Occupants	Powers, Swan, & Lee (1992)	• Full-time employment is related to household energy conserving investments.
	Household Income and Size	Nair, Gustavsson, & Mahapatra, 2010	• Sweden. The proportion of homeowners who adopted building envelope measures increases as annual household income increases.
		Poortinga, Steg, Vlek, Wiersma (2003); Poortinga, Steg, & Vlek, (2004) Gatersleben, Steg, & Vlek, (2002)	• The Netherlands. Investments are most acceptable for respondents with a high income. • Energy saving measures aimed at reducing direct energy are the least acceptable for high incomes • Higher income and size have a higher energy use • Energy saving measures are more acceptable for respondents with a low level of education than for respondents with an average or high level of education

Table 2.2. Summary of key papers that consider the influence of socio-demographic variables in energy consumption and conservation. Continued from page 18.

	Factor	Authors (year)	Summary of Key Results
Socio-demographic Factors	**Household Income and Size**	Cayla, Maizi, & Marchand (2011)	• France. Household with lower income are not likely to invest in energy efficient equipment • High income household are also not likely to invest in energy saving equipment
		Abrahamse & Steg (2009)	• The Netherlands. Households with higher incomes tend to use more energy.
		O'Neill & Chen (2002)	• United States. Larger households have a higher total energy consumption • Per capita consumption is lower in larger households
	Marital Status	Sardianou, E. (2007)	• Marital status of the consumers is not found to be a good predictor of energy-conserving behaviour
		Poortinga, Steg, Vlek, & Wiersma (2003)	• The Netherlands. Couples and families are more likely to partake in technical improvements (investments) than singles
Psychological Factors	**Environmental Knowledge, Values and Beliefs**	Abrahamse & Steg (2009)	• Psychological variables are not influential in energy use, but influential in household energy savings
		OECD (2008b)	• The association between psychological and attitudinal factors and energy demand is not very strong
		Mostafa (2007)	• Egypt. Environmental knowledge is positively correlated with green purchasing behavior
		Kim & Choi (2005) Kalafatis, Pollard, East & Tsogas, (1999)	• United States. Environmental concern is linked to likelihood of purchasing environmentally friendly products.
		Rowlands, Scott & Parker (2003)	• Canada. Peoples' willingness to pay higher premiums for green electricity is related to their belief that energy sources have consequences on the environment
		Gatersleben, Steg & Vlek, 2002	• The Netherlands. Environmental concern is not a significant factor that influences energy consumption or that leads to environmentally friendly behaviour
		Bang, Ellinger, Hadjimarcou, & Traichal (2000)	• Environmental concern is linked to willingness to pay for renewable energy. • Consumers report high levels of concern but low levels of knowledge about renewable energy • Renewable energy knowledge increases consumers' likelihood of paying more for sustainable energy sources
		Axelrod & Lehman (1993)	• Canada. Environmentally-concerned behavior does not appear to be motivated solely by the ideal of helping save the environment. Rather, both tangible and social outcome desires seem to impact upon one's motivation to act as well.
External Factors	**Electricity Prices**	Berkhout *et al*. (2004)	• The Netherlands. Household demand for electricity can be better modified through changes in prices
		John (2000)	• India, Indonesia, the Philippines, Thailand. Energy, income and prices are mutually causal in Thailand and the Philippines • Energy and income are neutral with respect to each other in Indonesia and India
		Nesbakken, R. (1999)	• Norway. High-income households are more sensitive to energy price changes than low-income households
	Social and Cultural Factors	Axelrod, & Lehman (1993)	• Canada. Environmentally-concerned behavior does not appear to be motivated only by the idea of helping save the environment. Social outcome desires have an impact on one's motivation to act.

CHAPTER 3: EMPIRICAL FRAMEWORK

In this Chapter the approach to study households' energy usage behaviour and the decision to adopt energy conserving measures and investments is described. This study employs a model that allows for the analysis of the impact on energy saving measures and investments while accounting for the interdependence among the various energy saving activities. Ten dependent variables are used in this analysis: (1) five indicators for the different energy saving measures; (2) four indicators for the different energy saving investments; (3) and one indicator for renewable energy technology investment. This study evaluates the relation between different factors and the likelihood of adopting energy saving measure and investments. Specifically, it looks at whether there is a relationship between implementation of time-of-use (TOU) electricity pricing and the likelihood of adopting energy saving activities, while controlling for the effect of background variables (socio-demographic variables). Considering the binary nature of the dependent variables, the model used allows for the estimation of the probability of participating in each of the energy saving activities using the multivariate probit model.

3.1 Data and Variables

The data set used in this project was gathered by Lightspeed Online Research Inc. for the OECD in February 2008 through an international web-based panel of 10,251 respondents from ten countries (Australia, Canada, Czech Republic, France, Italy, Korea, Mexico, Netherlands, Norway, and Sweden) (OECD, 2008a). All ten countries in the survey are OECD member countries and included countries of different development and income level. Lightspeed Online Research Inc. recruited respondents through websites in each country and used niche websites to select participants from different demographic groups. Selection of the participants was performed using an algorithm conducted by MARSC software to ensure the sample was

stratified by income, age, gender, and region in each of the ten countries (OECD, 2008a). The socio-demographic data collected were compared with official sources for each country to ensure that sample was representative and unbiased. In addition, participants that did not respond to the survey satisfactory were removed from the data set, and the sample was stratified by income, age, gender and region in each of the ten countries (OECD, 2008a). The explanatory variables presented in Table 3.3 include information on individual, household and attitudinal characteristics, energy efficient activities and policy instrument.

All variables representing individual characteristics, household characteristics, measures, investments, and policy instruments (presented in Table 3.3) are coded into binary variables. For example for variable (Canada), responses that selected *being from Canada* were given a value 1 and responses that selected *any other country* were given a value of 0. Measures and motivator variables take 4 possible values: *never, occasionally, often,* and *always* for measures and *not at all important*, *not important*, *fairly important,* and *very important* for motivators. For "measures" variables, *never* and *occasionally* were considered as a "negative" response and given the value of 0, while *often* and *always* were considered as a "positive" answer and given the value of 1. The same procedure was performed for "motivator" variables. Moreover, during this analysis the following were done:

1) Observations where participants selected "don't know" or "blank" responses for income, education, employment, occupation, and residence type were removed from the data set. A summary of the observations removed is presented in Table 3.1.
2) For outcome variables (measure and investments), motivators, and pricing policy (Policy_timeofuse), responses marked as "don't know" or "blank" were assumed to be a "negative" response, allowing for a larger data set. The total number of surveys used in this

analysis after the removal of “blank” and “don’t know” observations is tabulated in Table 3.2.

3) Additionally, the analysis was performed without considering the assumption in point 2 and all observations with “blank” and “don’t know” responses were removed from the data set. This alternative analysis is presented in Appendix D.

Table 3.1 Observations removed for the five different variables.

Variable	**Observations Removed**		
	Don’t know/ Other answer	Prefer not to say/ Blank answer	Total number of responses removed
Income	236	482	718
Education	0	99	99
Employment	0	419	419
Occupation	941	1807	2748
Residence type	202	0	202
Total observations removed			**4186**

Table 3.2. Number of surveys used in this analysis after the removal of “blank” and “don’t know” observations.

Country	**Total surveys administered**	**Number of surveys used in this analysis**
AUS	1,006	511
CAN	1,003	556
CZR	701	442
FRA	1,075	726
ITA	1,417	940
KOR	1,001	530
MEX	1,009	680
NLD	1,015	411
NOR	1,019	705
SWE	1,006	555
	10,252	6,056

Table 3.3. Definition and description of explanatory variables.

	Variable	Description		Variable	Description
Individual Characteristics	AUS	Australia indicator	Household Characteristics	type_house	House indicator
	CAN	Canada indicator		type_apartment	Apartment indicator
	CZR	Czech Republic indicator		area_rural	Rural location and isolated location indicator
	FRA	France indicator		area_urban	Urban and suburban location indicator
	ITA	Italy indicator	Measures	Measure_lights	Turn-off lights when leaving a room indicator
	KOR	Korea indicator		Measure_heating	Cut down heating/AC indicator
	MEX	Mexico indicator		Measure_load	Waiting for full load before using washing machine or dishwasher indicator
	NLD	Netherlands indicator			
	NOR	Norway indicator		Measure_applian	Turn-off appliances when not in use indicator
	SWE	Sweden indicator		Measure_standby	Switch off standby mode of appliances indicator
	gender_male	Male indicator	Investments	Efficient_appliances	Installed energy efficient appliances in the past 10 years
	Married	Married/living as a couple indicator		Efficient_bulbs	Installed low-energy light bulb in the past 10 years
	Income	Has annual combined income higher than $54,700		Efficient_insulation	Installed thermal insulation in the past 10 years
				Efficient_heating	Installed efficient heating boiler in the past 10 years
	age_class_1	Age 18 to 24 indicator		Renewable_energy	Installed renewable energy equipment (solar panel, wind turbines) in the past 10 years
	age_class_2	Age 25 to 34 indicator			
	age_class_3	Age 35 to 44 indicator	Motivators	Mtv_information	Information on energy conservation as motivator
	age_class_4	Age 45 to 54 indicator		Mtv_price	Higher energy prices as motivator
	age_class_5	Older than 54 years old indicator		Mtv_environment	Belief that environmental benefits are significant as motivator
	edu_1	No high school indicator		Mtv_energyefficient	Availability of energy efficient products as motivator
	edu_2	High school indicator		Mtv_labels	Easier identification of energy efficient labels as motivator
	edu_3	Some post-secondary education indicator		Mtv_cheapequipment	Less expensive energy efficient equipment as motivator
	edu_4	Bachelor degree indicator		policy_timeofuse	Time of use electricity billing indicator
	edu_5	Post_graduate degree indicator		BUYRNWL	Does your household take special measures to buy renewable energy?
	empl_fulltime	Full-time employment indicator	Concern/Belief	BETTRENV_LKRT	Belief that each individual/household can contribute to a better environment
	empl_leave	Employed but on leave indicator			
	empl_retired	Retired indicator		OVRSTATE_LKRT	Belief that environmental impacts are frequently overstated
	empl_homemaker	Homemaker indicator		FUTRGNRS_LKRT	Belief that environmental issues should be dealt with primarily by future generations
	empl_parttime	Part-time employment indicator			
	empl_unemployed	Student, volunteer, and unemployed indicator		TECHPROG_LKRT	Belief that environmental issues will be resolved primarily through technological progress
	occup_professional	Professional occupation indicator		NOTCOSTS_LKRT	Belief that environmental policies introduced by the government should not cost me extra money
	occup_executives	Executives occupation indicator			
	occup_selfemployed	Self-employed occupation indicator		CLCH_LKRT	Concern over climate change (global warming)
	occup_salaried	Salaried occupation indicator		NRSC_LKRT	Concern over natural resource depletion (forest, water, energy)
	occup_worker	Manual worker occupation indicator			

Individual characteristics presented are: gender (Gender_Male), marital status (Status_married), age (Age_class), education (Edu_class), employment status (Empl) and occupation (Occup). Figure 3.1 represents the number of participants in each group for each of the individual characteristic variables. Household characteristics used are: residence type (Restype) and the type of area where the residence is located (Area). Of the 6,056 participants, 3,543 live in a house and 2,513 in an apartment; 1,424 in a rural areas and 4,632 in an urban areas.

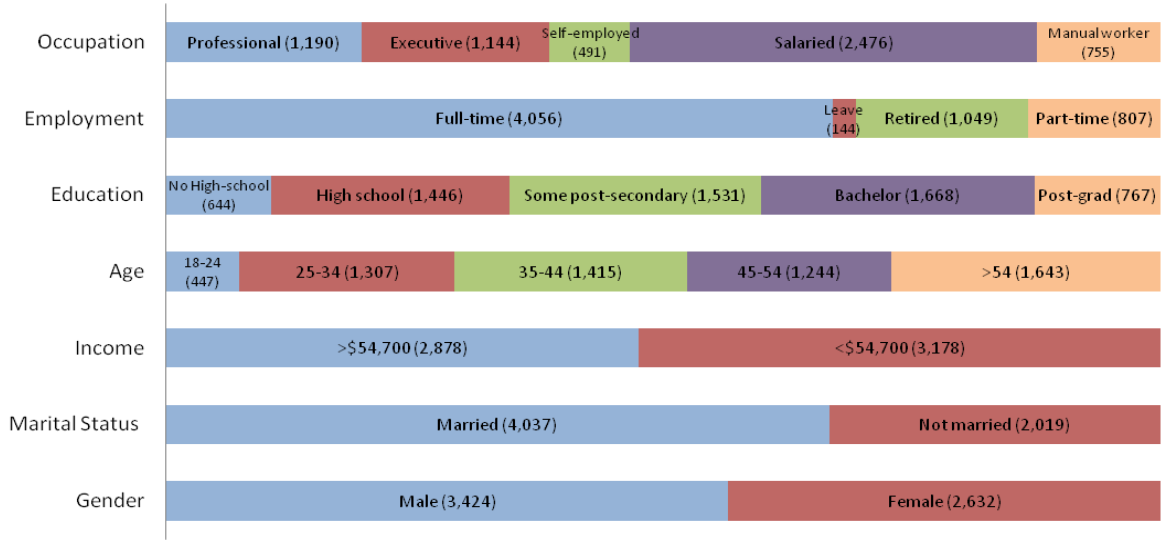

Figure 3.1. Number of respondents for each group of individual characteristic variables

Attitudinal characteristics are categorized into two groups: those that include simple behavioural measures (Measures) and those that require investment such as the implementation of energy efficient appliances or use of renewable energy (Investments). Specifically, the measures evaluated in this analysis are the likelihood of: (1) turning-off lights when not in use (Measure_lights); (2) cutting-down heating/AC temperature (Measure_heating); (3) waiting for full load before using washing machine or dishwasher (Measure_load); (4) turning-off appliances when not in use (Measure_applian); (5) switching appliances to standby mode

(Measure_standby). Household investments evaluated in this project are: (1) having installed energy efficient appliances in the past 10 years (Efficient_appliances); (2) having installed low-energy light bulb in the past 10 years (Efficient_bulbs); (3) having installed thermal insulation in the past 10 years (Efficient_insulation); (4) having installed efficient heating boiler in the past 10 years (Efficient_heating); (5) having installed renewable energy equipment (solar panel, wind turbines) in the past 10 years (Renewable_energy). The following figures provide some graphical representation of the participation in energy saving actives per each of the ten countries in this study. As seen in Figure 3.2 and 3.3, the participation in measures is much higher than that of investments; however, there are differences between the five different measures, between the five different investments, and between countries.

Another important factor to consider is what motivates people to partake in these energy efficient measures and investments, and the effect of time-of-use electricity rates (Policy_timeofuse). Of the 6,056 participants in this analysis, 2,435 reported having electricity pricing that depends on the time of day, while 3,621 reported they didn't have or they didn't know if they had this pricing scheme. The motivators considered are: (1) information on energy conservation (Mtv_information); (2) higher energy prices (Mtv_price); (3) belief that environmental benefits are significant (Mtv_environment); (4) availability of energy efficient products (Mtv_energyefficient); (5) easier identification of energy efficient labels (Mtv_labels); (6) less expensive energy efficient equipment (Mtv_cheapequipment). Lastly, the relation between personal belief on environmental concern on the likelihood of a household purchasing renewable energy from the supplier (BUYRNWL) will be evaluated. The factors considered are: (1) belief that each individual/household can contribute to a better environment (BETTRENV_LKRT); (2) belief that environmental impacts are frequently overstated

(OVRSTATE_LKRT); (3) belief that environmental issues should be dealt with primarily by future generations (FUTRGNRS_LKRT); (4) belief that environmental issues will be resolved primarily through technological progress (TECHPROG_LKRT); (5) belief that environmental policies introduced by the government to address environmental issues should not cost me extra money (NOTCOSTS_LKRT); (6) concern over climate change (global warming) (CLCH_LKRT); (7) concern over natural resource depletion (forest, water, energy) (NRSC_LKRT).

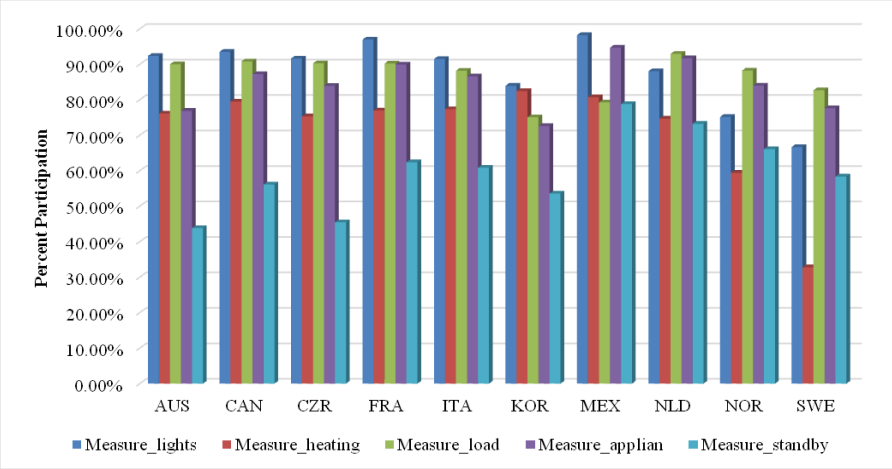

Figure 3.2. Percent participation of each country in energy efficient measures

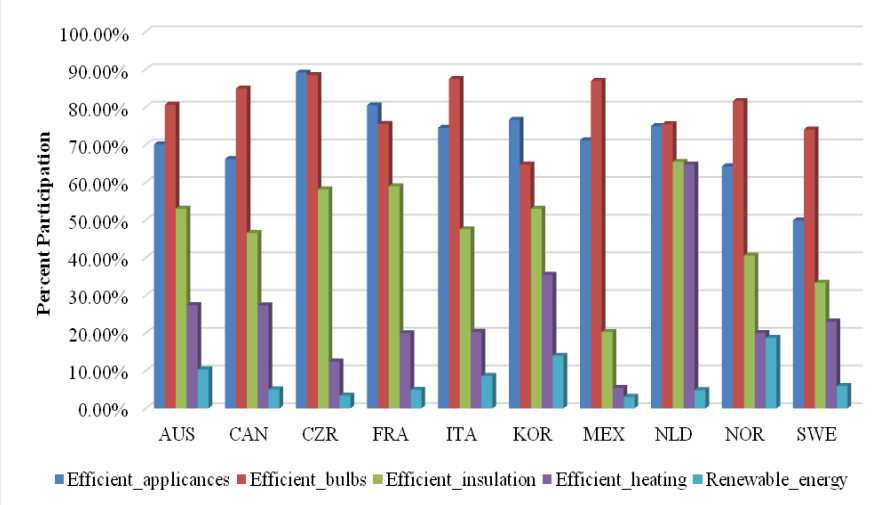

Figure 3.3. Percent participation of each country in energy efficient investments

Moreover summary statistics of variables for the entire sample set used in this study are provided in Table 3.4. In general, households partake in energy efficient measures more than energy efficient investments. Installation of efficient heating boiler and renewable energy equipment are the least common investments, while all motivators are believed to be important by most of the participants. Less than half of the participants have a household income higher than $54,700 a year and a higher number of participants have salaried occupations, full-time employment, and live in urban areas. The summary statistics indicate that the least common age group is between 18 and 24 years old, while the education is generally equally distributed, with having no high school education and having a post-graduate degree being the least common. The mean for time varying electricity pricing (policy_timeofuse) is 0.4021 demonstrating that less than 50% of the participants of the survey have this pricing scheme.

3.2 Methodology

3.2.1. Probit Model

Based on the analysis by Ferrara and Missios (2012) on the waste portion of the survey used for this paper, the probit model is selected to assess the impact of different factors on the likelihood of households employing energy efficiency technologies/appliances and renewable energy. Specifically, the decisions whether to adopt energy conservation practices and whether to purchase energy efficient and renewable energy technology is studied through univariate and multivariate probit. The description of the binary model presented below is based on the paper by Cappellari and Jenkins (2003). The probit model (or probit regression) is used to model binary outcome variables - outcomes that can take only two values, for example yes or no, or adopt or don't adopt. The probability of the response variable Y occurring is described in Equation 1. In

this model the vector of regressors (independent variables) X will influence the outcome of the response variable Y.

$$\Pr(Y = 1|X) = \phi\ (X\beta') \qquad \text{Equation 1}$$

where Pr denotes the probability, ϕ is the Cumulative Distribution Factor (CDF) of the normal distribution, and β are parameters estimated by maximum likelihood estimation (MLE). The probit model can also be written as a latent variable model as described in Equation 2. If M binary choices (measures and investments) that are mutually dependent (i.e. occurrence of one variable affects the probability of the other variable) are present, the M-equation multivariate probit can be written as:

$$y_{im}^{*} = \beta_{m}^{'} X_{im} + \ \varepsilon_{im}\ , \qquad \text{Equation 2}$$

where ε_{im} is the standard error and $m = 1, \dots, M$. The idea of the latent variable model is based on the effect of a set of observable or measurable variables (manifest variables) on the latent variable y^{*}, and the resulting measurement equation links the observed y with the latent y^{*} as described in Equation 3:

$$y_{im} = \begin{cases} 1\ if\ y_{im}^{*} > 0 \\ 0\ otherwise \end{cases}\ , \qquad \text{Equation 3}$$

where y_{im} represents outcomes for M different choices.

The output of the probit analysis provides coefficients, their standard errors, the z-statistic, associated p-values, and the 95% confidence interval of the coefficients. The probit regression coefficients give the change in the z-score for one unit change in the independent variable.

Table 3.4. Summary statistics for all variables.

Variable	Mean	Std. Dev.	Variable	Mean	Std. Dev.	Variable	Mean	Std. Dev.
AUS	0.0844	0.2780	edu_4	0.2754	0.4468	Measure_standby	0.6065	0.4886
CAN	0.0918	0.2888	edu_5	0.1267	0.3326	Efficient_appliances	0.7153	0.4513
CZR	0.0730	0.2601	empl_fulltime	0.6697	0.4703	Efficient_bulbs	0.8050	0.3962
FRA	0.1199	0.3248	empl_leave	0.1333	0.3399	Efficient_insulation	0.4658	0.4989
ITA	0.1552	0.3621	empl_retired	0.1732	0.3785	Efficient_heating	0.2383	0.4261
KOR	0.0875	0.2826	empl_homemaker	0.0000	0.0000	Renewable_energy	0.0814	0.2735
MEX	0.1123	0.3157	empl_parttime	0.0238	0.1524	Mtv_information	0.8035	0.3974
NLD	0.0679	0.2515	empl_unemployed	0.0000	0.0000	Mtv_price	0.6762	0.4680
NOR	0.1164	0.3207	occup_professional	0.1965	0.3974	Mtv_environment	0.8317	0.3741
SWE	0.0916	0.2885	occup_executives	0.1889	0.3915	Mtv_energyefficient	0.8998	0.3003
gender_male	0.5654	0.4957	occup_selfemployed	0.0811	0.2730	Mtv_labels	0.8266	0.3786
married	0.6666	0.4715	occup_salaried	0.4089	0.4917	Mtv_cheapequipment	0.9275	0.2593
income	0.4752	0.4994	occup_worker	0.1247	0.3304	policy_timeofuse	0.4021	0.4904
age_class_1	0.0738	0.2615	type_house	0.5850	0.4928	BUYRNWL	0.1328	0.3393
age_class_2	0.2158	0.4114	type_apartment	0.4150	0.4928	BETTRENV_LKRT	0.9569	0.2031
age_class_3	0.2337	0.4232	area_rural	0.2351	0.4241	OVRSTATE_LKRT	0.3293	0.4700
age_class_4	0.2054	0.4040	area_urban	0.7649	0.4241	FUTRGNRS_LKRT	0.2781	0.4481
age_class_5	0.2713	0.4447	Measure_lights	0.8811	0.3237	TECHPROG_LKRT	0.5418	0.4983
edu_1	0.1063	0.3083	Measure_heating	0.7173	0.4503	NOTCOSTS_LKRT	0.6255	0.4840
edu_2	0.2388	0.4264	Measure_load	0.8666	0.3401	CLCH_LKRT	0.7606	0.4268
edu_3	0.2528	0.4347	Measure_applian	0.8496	0.3575	NRSC_LKRT	0.8137	0.3894

3.2.2. Multivariate and Univariate Probit Analysis of the Effects of Individual Characteristics, Household Characteristics and Policy Variable on Measures and Investments

In this analysis 10 (M = 10) equations (measures and investments) are considered (tabulated in Table 3.1 and described in Section 3.1). The univariate probit allows for the study of the effect that the individual, household and policy variables have on outcomes variables. Specifically, it looks at the effect that an independent variable has on the outcome (measure and investment) assuming that the outcomes themselves (decisions) are independent of each other. On the other hand, the multivariate probit model allows for the study of the probability of engaging in a specific energy conservation activity being related to the decision of engaging in a different energy conservation activity, while controlling for background variables. This model assumes that one decision can depend on other decisions, but it may not. Figure 3.4 is a simple representation of the relationships evaluated in this section. The literature described in Section 2.3 indicates that background variables such as gender, marital status, and income impact the likelihood of a person adopting energy saving actions (OECD, 2011); as such, the background variables in Figure 3.4 are expected to have a direct impact or effect on the outcomes.

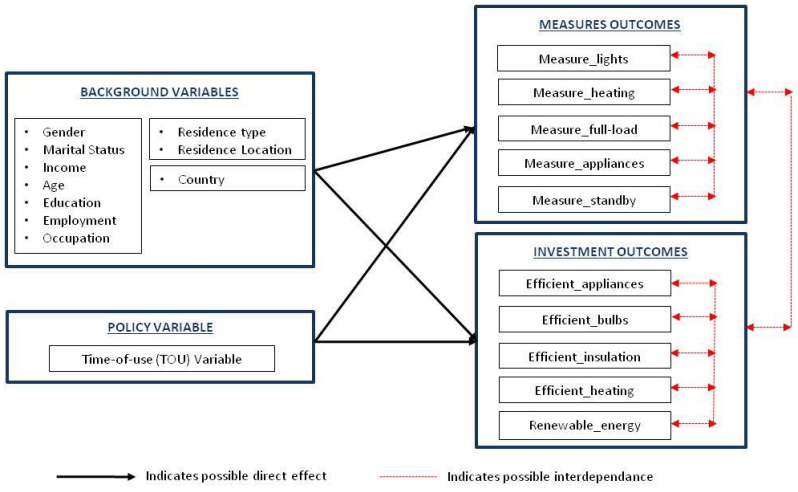

Figure 3.4: Model used in the study of the effect of policy and background variables on energy saving measures and investments through the multivariate probit regression.

As shown in Section 2.3.3.1, TOU pricing has been suggested to have an impact on the energy saving actions, and it is expected that this variable directly impacts the outcomes evaluated in this study. Moreover, it can be assumed that participants that partake in one energy saving outcome are more likely to partake in other energy saving outcomes. This model allows for the decision of a particular energy conservation activity to be related with the decision of a different energy conservation activity being implemented, while controlling for the background variables. For each background variable a reference group is selected creating a baseline. For example, Korea is selected as the country in the baseline and the effect of substituting each of the other 9 countries for Korea on the outcome variables is evaluated while maintaining all the other background variables constant.

3.2.3. Probit Analysis of the Effects of Environmental Concern on Renewable Energy Purchase

In this multivariate probit analysis, the outcome (dependent) variables is the purchase of renewable energy and the predictor variables are environmental concern (tabulated in Tables 3.5 and 3.6). The predictor variables take the values “strongly disagree”, “disagree”, “agree” and “strongly agree”. Since binary data are used in this analysis, strongly disagree and disagree were grouped together, and agree and strongly agree were grouped together as shown in Table 3.5. The same procedure is done for “not concerned”, “fairly concerned”, “concerned” and “very concerned” as shown in Table 3.6. The results of this analysis are presented in Section 4.2. As in the previous analysis, for continuous variables, a one unit increase in the independent variable, increases the z-score by the coefficient value.

Table 3.5. Description of the independent variables used in the analysis of the relationship between purchase of renewable energy and environmental concern.

Description	Variable name	Not Concerned, Fairly Concerned, and No Opinion (0)	Concerned and Very concerned (1)
Climate change (global warming)	CLCH_LKRT		
Natural resource depletion (forest, water, energy)	NRSC_LKRT		

Table 3.6. Description of the independent variables used in the analysis of the relationship between purchase of renewable energy and environmental concern.

Description	Variable name	Strongly Disagree, Disagree, and No Opinion (0)	Agree and Strongly Agree (1)
Each individual/household can contribute to a better environment	BETTRENV_LKRT		
Environmental impacts are frequently overstated	OVRSTATE_LKRT		
Environmental issues should be dealt with primarily by future generations	FUTRGNRS_LKRT		
Environmental issues will be resolved primarily through technological progress	TECHPROG_LKRT		
Environmental policies introduced by the government to address environmental issues should not cost me extra money	NOTCOSTS_LKRT		

3.2.4 Multivariate Probit Analysis of the Effects of Motivators on Measures and Investments

A multivariate probit model was used to assess the relation between the independent variables (motivators) and outcome variables (energy saving measures and investments) of the participants (variables tabulated in Table 3.1). The results of this analysis are presented in Section 4.3.

3.2.5. Empirical Analysis of Motivators

In this section, the participants were asked to rate factors that would encourage the household to reduce energy consumption (Motivators in Table 3.1). The participants had four options to choose from: “not at all important”; “not important”; “fairly important”; and “very important”. In the analysis, “fairly important” and “very important” were grouped together and converted to a percentage of the total number of participants per country. For example:

- Total number of participants for Canada = 556
- Number of participants that reported that having information on energy conservation (Mtv_information) is a fairly or very important motivator in reducing household energy consumption = 455
- Percent of responses considering the motivator fairly or very important = 455/556 x 100% = 81.83%

So, 81.83% of Canadian responders claimed that having information on energy conservation is a good motivator in reducing household energy consumption. The summary of these calculations is presented in Table 4.5, and the analysis of these results is presented Section 4.4.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Multivariate and Univariate Probit Analysis of the Effects of Individual, Household and Policy Variable on Measures and Investments

The results from the multivariate and univariate binary probit estimation are provided in Appendix B and Appendix C. Tables 4.1 and 4.2 shows the results with explanatory variables that are statistically significant in at least one of the equations (measures or investments) in which they are included. The variable for being employed but not currently working (Empl_leave) is excluded because it is statistically insignificant in all 10 equations and hence does not impact energy saving measures and investments. In addition, the variable for being a homemaker (Empl_homemaker) and being retired (Empl_retired) were removed due to colinearity of results. These variables are perfectly colinear with other independent variables in the data set and they do not impact the outcome of the analysis.

Before elaborating on the effects of individual and household characteristics, attitudinal factors, and policy variable on households' energy consumption, it should be noted that multivariate probit provides a good estimate for this model – there is evidence of dependence between the energy saving measures and energy saving investment activities considered in this paper. The hypothesis that the 45 off-diagonal coefficients of the variance-covariance matrix are equal to 0 is rejected, with chi2(45)=3455.87, at less than 1% (results found in Appendix B, Table B3). This explains the slight differences in the coefficients obtained from multivariate and univariate probit model; however, the effect of the variables on measures and investments are generally consistent, with the following discrepancies:

(a) Being married negatively impacts the likelihood of switching off appliances to standby mode when not in use (Measure_standby) when the multivariate probit model is used; however, a positive impact is observed when the univaraite probit model. Similar

inconsistencies are observed for the effects of having no high school (edu_1) on the likelihood of installing thermal insulation (Efficient_insulation), having some post-secondary education (edu_3) on the likelihood of turning off lights when leaving the room (Measure_lights), and being a professional (occup_professionals) on the likelihood of cutting down on heating/AC (Measure_heating). However, all these coefficients are insignificant and do not pose a concern for this analysis.

(b) Another dissimilarity observed between the multivariate probit and univariate probit results is the significance of results in one of the models, and insignificance of results in the other.

- Using the multivariate probit model, it is observed that households in the Netherlands (NLD) are less likely than households in Korea to install energy efficient appliances (Efficient_applinaces). On the other hand, the result is insignificant when using the univariate probit model. This indicates that being from the Netherlands has an impact on the decision to invest in efficient appliances when controlling for the effect of background variables. The same is observed for the impact of having some post secondary education (edu_3) on waiting for a full load before using the washing machine (Measure_load) and having a bachelor degree (edu_4), being a professional (occup_professionals) and having a salaried employment (occup_salaried) on the likelihood of installing efficient light bulbs (Efficient_bulbs).
- Being married has a positive impact on the likelihood of installing thermal insulation (Efficient_insulation) when using the multivariate probit model, but no impact when using the univariate probit model. This is also observed for the impact of working part-time (empl_parttime), being an executive (occup_executive), and being self-

employed (occup_selfemployed) on the likelihood of installing efficient light bulbs (Efficient_bulbs).

- Using the univariate probit model, it is observed that having a household income higher than $54,700 (income) a year negatively impacts the likelihood of cutting down on heating/AC (Measure_heating). On the other hand, the results are insignificant using the multivariate probit model, indicating that when controlling for the effects of background variables, income does not have an impact on this energy efficient measure. Additionally, this is observed for the impact of being between ages 25 and 34 (age_class_2) on the likelihood of purchasing renewable energy (Renewable_energy) and for the impacts of being from an urban or suburban area (area_urban) on the likelihood of cutting down on heating/AC (Measure_heating) and turning of appliances when not in use (Measure_applian).

The following Sections describe the effects of individual, household and altitudinal factors on energy saving measures and investments considering only statistically significant results.

4.1.1 Time of Use Policy (TOU)

The effects of varying electricity pricing (Policy_timeofuse) are statistically insignificant in three of the equations, and it can be deduced that TOU pricing does not impact the decisions of a household to wait for a full load before using washing machine or dishwasher (Measure_load), install energy efficient appliances (Efficient_appliances), and install energy efficient light bulbs (Efficient_bulbs). In the other seven (7) statistically significant equations, varying electricity prices encourage households to implement energy saving measures and investments (Figure 4.1). As reported by the OECD (2011) study participants that had time varying electricity rates, reported having invested in energy saving equipment more than

participants with flat electricity rates. This analysis confirms that having varying electricity pricing increases the likelihood of a household turning off lights when not in use (Measure_lights), cutting down heating/AC (Measure_heating), switching appliances to stand-by mode (Measure_standby), and turning-off appliances when not in use (Measure_applian). Moreover, this analysis demonstrates that TOU pricing has an impact on the likelihood of investing in energy saving activities, such as installing efficient thermal insulation (Efficient_insulation), efficient heating boiler (Efficient_heating), and renewable energy equipment (Renewable_energy). The high impact of TOU pricing on the decisions to install efficient thermal insulation and invest in renewable energy equipment could be due to the greater perceived long term savings as compared the initial financial investment. These results agree with the findings that varying electricity pricing are an improvement over flat electricity pricing and can lead to a decrease in energy consumption and increase in energy efficient investments, as described in Section 2.3.1.

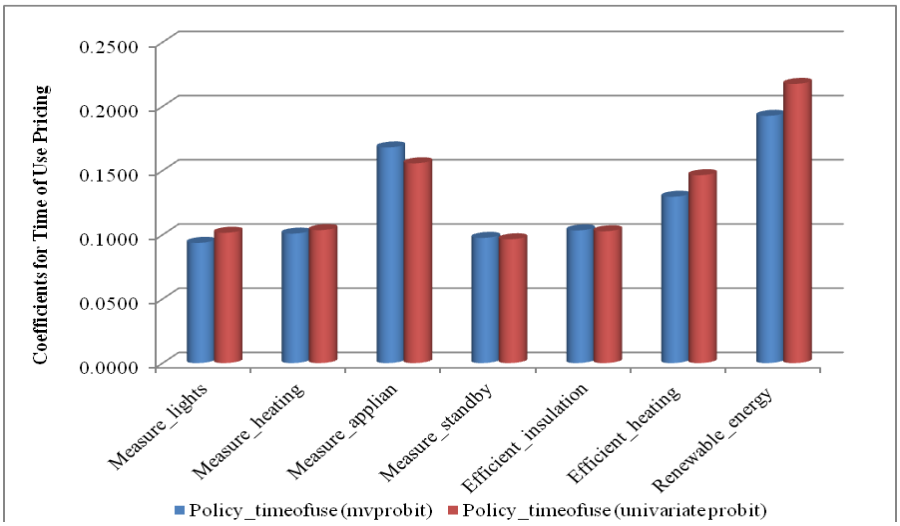

Figure 4.1. Effects of varying electricity pricing on energy saving measures and investments using the multivariate and univariate probit model.

4.1.2 Country Specific Characteristics

There exist significant differences across countries in the 10 equations (measures and investments), thus it can be concluded that country specific factors play an important role in household's decision to implement energy saving measures and investments. After controlling for individual and household characteristics, it is observed that households in Korea are more likely to turn the lights off when leaving the room (Measure_lights) more than households in Sweden and Norway, but less likely than in any other participating country. In addition, households in Korea are more likely to cut down on heating/AC (Measure_heating) as an energy saving measure, but less likely to wait for a full load before using the washer/dryer (Measure_load) and turn-off appliances when not in use (Measure_appliances) than any other participating country. Moreover, households in Korea are more likely to turn appliances to standby mode when not in use (Measure_standby) than households in Australia and Czech Republic, but less likely than households in the rest of the countries.

Country specific effects are also observed in the level of energy saving investments partaken by households (Table 4.2). Households in Czech Republic are more likely to invest in energy efficient appliances (Efficient_appliances) than households in Korea, while countries such as Australia, Canada, Mexico, Sweden, and Norway are less likely to do so. Furthermore, the use of energy efficient bulbs (Efficient_bulbs) is less likely to be employed in households in Korea than households in any other participating country, which is also supported by the analysis of the OECD (2011) study. Thermal insulation (Efficient_insulation) and installation of efficient heating boiler (Efficient_heating) are investments more likely to be implemented in households in Netherlands than in Korea and any other country; all other participating countries are less likely to partake in these investments than Korea. Moreover, installation of renewable energy

equipment (Renewable_energy) is more likely to occur in households in Korea. It is interesting to note that while all coefficient values are negative for the renewable energy variable, there are significant differences between countries. For example, Mexico (coefficient of -1.1554 and -1.1359) is less likely than all other countries to install renewable energy equipment. In summary, there is evidence suggesting that there are country specific factors that affect the level of households partaking in energy saving measures and investments. This could be due to many different factors such as cultural and educational factors, policy, energy prices, or weather conditions; however, the exact cause of these differences is difficult to determine without any additional information.

4.1.3 Individual and Household Characteristics

In this Section, the individual and household characteristics will be evaluated. It is worth noting that these are control variables that suggest tendencies and behaviours of households and are not the primary focus of this study. The following summary is based on statistically significant results only.

The results suggest that male participants are less likely than females to cut down on heating/AC (Measure_heating), wait for a full load before using the washer/dryer (Measure_load), and turn the appliances to standby when not in use (Measure_standby). However, being males are more likely than females to invest in renewable energy equipment (Renewable_energy). Generally, being married or living as a couple has a positive impact on the likelihood waiting for a full load before using the washer/dryer (Measure_load), invest in energy efficient appliances (Efficient_appliances), use of energy efficient bulbs (Efficient_bulbs) and installing thermal insulation (Efficient_insulation). As reported by Barr *et al*. (2005), older

respondents are more likely to participate in energy saving measures. This study showed that participants that are older than 54 years (age_class_5) are more likely to partake in energy conserving measures such as turning the lights off when leaving the room (Measure_lights), cut down heating/AC (Measure_heating), turn-off appliances when not in use (Measure_applian), and switch off appliances to standby mode (Measure_standby). Participants that are between 45 and 54 years old (age_class_4) are more likely to wait for a full load before using washing machine/dishwasher (Measure_load). When it comes to energy efficient investments, participants older than 54 are less likely to invest in energy efficient appliances (Efficient_appliances) and renewable energy equipment (Renewable_energy); however, they are more likely to invest in energy efficient light bulbs (Efficient_bulbs), thermal insulation (Efficient_insulation), and efficient heating boiler (Efficient_heating).

Having a household income higher than $54,700 negatively influences the likelihood of a household to partake in energy saving measures; however, a positive relation is observed on the likelihood of investing in energy efficient activities, such as installing energy efficient appliances, efficient thermal insulation, and efficient heating boiler. Looking at the coefficient, including the statistically insignificant ones, it is observed that generally higher incomes would allow people to invest on energy saving activities, agreeing with the results presented by Nair *et al*. (2010). The effects of occupation on the likelihood of adopting measures and investments concur with the effects of the income variable on the likelihood of adopting measures and investments. Participants that are executives, professionals, self-employed, and having a salaried position are less likely than manual workers to participate in energy saving measures, but more likely to invest in energy efficiency, such as investing in efficient appliances

(Efficient_appliances), installing thermal insulation (Efficient_insulation), installing efficient heating boiler (Efficient_heating) and renewable energy equipment.

Employment is generally insignificant across the equations. Being employed part-time has a negative impact on the likelihood of turning-off appliances when not in use (Measure_appliances) and installing efficient appliances (Efficient_applinces). Participants employed full-time and part-time are more likely than unemployed participants to invest in efficient heating boiler (Efficient_heating) and renewable energy respectively. These results do not exhibit a specific pattern making it difficult to infer behaviour. A higher education level is related to a higher likelihood in partaking in energy efficient measure, such as waiting for a full load before using the washing machine (Measure_load) or turning off appliances when not in use (Measure_applian), and energy efficient investments, such as installing energy efficient appliances (Efficient_appliances), or energy efficient light bulbs (Efficient_bulbs).

Living in a house as compared to living in an apartment positively impacts the likelihood of installing efficient appliances (Efficient_applinces), energy efficient light bulbs (Efficient_bulbs), thermal insulation (Efficient_insulation), efficient heating boiler (Efficient_heating) and renewable energy equipments. Moreover, it positively impacts the likelihood of cutting down heating/AC (Measure_heating) and waiting for a full load before using the washer/dryer (Measure_load). Households in an urban or suburban area are less likely than households in rural or isolated areas to invest in energy efficient equipments such as, energy efficient light bulbs (Efficient_bulbs), thermal insulation (Efficient_insulation), efficient heating boiler (Efficient_heating) and renewable energy equipments. Moreover, they are less likely to switch off equipment to stand by when not in use (Measure_standby).

Table 4.1. Comparison of coefficients from multivariate and univariate binary probit estimation results for energy efficient measures. Statistically insignificant results are marked in red.

	Measure_lights		Measure_heating		Measure_load		Measure_applian		Measure_standby	
	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)
AUS	0.3539	0.4132	-0.4230	-0.3699	0.4592	0.4987	0.0234	0.0581	-0.3316	-0.3223
CAN	0.4382	0.5105	-0.2395	-0.1989	0.5211	0.5420	0.4611	0.5019	0.0191	0.0052
CZR	0.2435	0.3549	-0.3341	-0.2753	0.5444	0.5913	0.2940	0.3471	-0.2566	-0.2524
FRA	0.8402	0.9020	-0.3051	-0.2649	0.5888	0.6030	0.5830	0.6112	0.1578	0.1434
ITA	0.3250	0.3266	-0.2557	-0.2109	0.5348	0.5129	0.4297	0.4531	0.1319	0.1416
MEX	1.0427	1.1550	-0.2157	-0.1528	0.0215	0.0600	0.9128	1.0001	0.6791	0.6798
NLD	0.0351	0.1099	-0.4616	-0.4001	0.6864	0.7355	0.6768	0.7178	0.4130	0.4138
NOR	-0.3835	-0.3194	-0.8635	-0.8278	0.3533	0.3706	0.3209	0.3234	0.2389	0.2297
SWE	-0.6526	-0.5871	-1.4788	-1.4497	0.1917	0.2016	0.1244	0.1305	0.0576	0.0493
gender_male	-0.0311	-0.0455	-0.0677	-0.0647	-0.2294	-0.2257	-0.0458	-0.0331	-0.1389	-0.1272
married	0.0557	0.0656	0.0090	0.0179	0.1249	0.1494	-0.0160	0.0072	-0.0094	0.0053
income	-0.1055	-0.1303	-0.0551	-0.0650	-0.0213	-0.0302	-0.0179	-0.0428	-0.1311	-0.1380
age_class_1	-0.2764	-0.2952	-0.5263	-0.5304	-0.2853	-0.3008	-0.3449	-0.3494	-0.1684	-0.1712
age_class_2	-0.1968	-0.2157	-0.2850	-0.2861	-0.1402	-0.1586	-0.3110	-0.3145	-0.2007	-0.2097
age_class_3	-0.0379	-0.0388	-0.1098	-0.1072	0.0941	0.0955	-0.1348	-0.1210	-0.0815	-0.0756
age_class_4	-0.0145	-0.0259	-0.0894	-0.0888	0.1570	0.1607	0.0233	0.0217	-0.0059	-0.0170
edu_1	-0.0672	-0.0841	-0.0725	-0.0828	-0.1938	-0.1695	-0.1279	-0.1292	-0.0309	-0.0617
edu_2	0.0907	0.0657	-0.0609	-0.0749	-0.2018	-0.1910	-0.1557	-0.1479	-0.0001	-0.0339
edu_3	0.0081	-0.0034	-0.0192	-0.0225	-0.1343	-0.1062	-0.1505	-0.1344	0.0340	0.0232
edu_4	0.0543	0.0442	0.0155	0.0145	-0.0274	-0.0004	-0.0747	-0.0531	0.0397	0.0328
empl_fulltime	0.0078	0.0051	0.0848	0.0867	-0.0215	-0.0216	-0.0046	-0.0041	0.0092	0.0149
empl_parttime	-0.0944	-0.1121	0.0588	0.0406	-0.1163	-0.1349	-0.1536	-0.1762	-0.0382	-0.0448
occup_executive	-0.1543	-0.1615	-0.0657	-0.0637	-0.3133	-0.3196	-0.1819	-0.1811	-0.0205	-0.0150
occup_professionals	-0.0553	-0.0823	0.0015	-0.0071	-0.1653	-0.1743	-0.0210	-0.0311	0.0048	0.0051
occup_salaried	0.0463	0.0668	-0.0285	-0.0143	-0.0857	-0.0600	0.0215	0.0431	-0.0275	-0.0071
occup_selfemployed	-0.0216	-0.0326	0.0198	0.0095	-0.0985	-0.0965	-0.1794	-0.1965	-0.1754	-0.1731
type_house	-0.0068	-0.0039	0.1371	0.1424	0.2293	0.2191	0.0022	0.0105	-0.0061	-0.0057
area_urban	-0.0239	-0.0191	-0.0678	-0.0784	-0.0438	-0.0524	-0.0829	-0.0955	-0.2038	-0.2120
policy_TOU	0.0936	0.1015	0.1009	0.1036	-0.0099	-0.0079	0.1680	0.1556	0.0975	0.0964
_cons	1.1723	1.1459	1.1674	1.1349	1.0072	0.9765	1.0211	0.9859	0.4984	0.5118

Notes:

1. empl_homemaker dropped because of collinearity
2. empl_retired dropped because of collinearity

Table 4.2. Comparison of coefficients from multivariate and univariate binary probit estimation results for energy efficient investments. Statistically insignificant results are marked in red.

	Efficient_appliances		**Efficient_bulbs**		**Efficient_insulation**		**Efficient_heating**		**Renewable_energy**	
	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)	Coefficient (Multivariate)	Coefficient (Univariate)
AUS	-0.3813	-0.3811	0.2818	0.2985	-0.3301	-0.3123	-0.4665	-0.4531	-0.4002	-0.3990
CAN	-0.4465	-0.4404	0.5226	0.5319	-0.3824	-0.3906	-0.3527	-0.3587	-0.6861	-0.6713
CZR	0.3832	0.4244	0.7444	0.7604	0.0172	0.0162	-0.7755	-0.8191	-0.7892	-0.8186
FRA	0.0311	0.0286	0.1543	0.1585	-0.1078	-0.1087	-0.6010	-0.5925	-0.7666	-0.7659
ITA	-0.0876	-0.0717	0.7385	0.7446	-0.1694	-0.1638	-0.3903	-0.4055	-0.1971	-0.2136
MEX	-0.3611	-0.3520	0.6328	0.6450	-1.1997	-1.2039	-1.5279	-1.5179	-1.1554	-1.1359
NLD	-0.1537	-0.1397	0.1904	0.1973	0.1600	0.1495	0.6875	0.6838	-0.6426	-0.7079
NOR	-0.5366	-0.5294	0.3203	0.3295	-0.6116	-0.6213	-0.6145	-0.6350	0.0392	0.0223
SWE	-0.7575	-0.7540	0.2484	0.2403	-0.5938	-0.5907	-0.3584	-0.3556	-0.5196	-0.4803
gender_male	-0.0176	-0.0114	-0.0278	-0.0243	0.0420	0.0403	0.0026	0.0022	0.1196	0.1049
married	0.2028	0.2029	0.1428	0.1487	0.1055	0.1053	-0.0069	-0.0144	-0.0205	-0.0176
income	0.0774	0.0723	0.0665	0.0612	0.1064	0.1032	0.1040	0.1011	0.0633	0.0617
age_class_1	-0.0805	-0.0899	-0.3716	-0.3773	-0.3184	-0.3285	0.0855	0.0833	0.3264	0.3723
age_class_2	0.1336	0.1266	-0.2651	-0.2726	-0.1633	-0.1682	-0.1061	-0.1038	0.1258	0.1770
age_class_3	0.0687	0.0639	-0.1690	-0.1672	-0.1141	-0.1129	-0.1028	-0.1026	-0.0144	0.0009
age_class_4	0.1522	0.1449	-0.0941	-0.0977	0.0262	0.0273	-0.0854	-0.0758	0.0781	0.0953
edu_1	-0.1585	-0.1502	-0.1207	-0.1160	0.0001	-0.0030	-0.0364	-0.0440	0.0528	0.0328
edu_2	-0.0208	-0.0103	-0.0756	-0.0702	-0.0308	-0.0342	-0.0700	-0.0689	-0.0469	-0.0435
edu_3	-0.1071	-0.0925	-0.1497	-0.1408	-0.1027	-0.0976	-0.0850	-0.0833	-0.1094	-0.1111
edu_4	-0.1203	-0.1093	-0.1181	-0.1053	-0.0587	-0.0603	-0.0530	-0.0506	-0.0122	-0.0141
empl_fulltime	-0.0727	-0.0758	0.0645	0.0585	-0.0441	-0.0479	0.1596	0.1661	0.1278	0.1149
empl_parttime	-0.1822	-0.1861	0.0876	0.0760	-0.0858	-0.0910	0.0864	0.1032	0.2112	0.2270
occup_executive	0.0458	0.0535	0.0704	0.0675	0.2513	0.2515	0.1486	0.1357	0.3689	0.3554
occup_professionals	0.0614	0.0650	-0.0045	-0.0087	0.1757	0.1750	0.1224	0.1208	0.2934	0.2830
occup_salaried	-0.0128	-0.0066	-0.0142	-0.0078	0.1117	0.1151	0.0598	0.0591	0.0836	0.0716
occup_selfemployed	0.1489	0.1458	0.0511	0.0546	0.1709	0.1672	0.1857	0.1827	0.1519	0.1523
type_house	0.3062	0.3104	0.2780	0.2757	0.4751	0.4725	0.4375	0.4200	0.4291	0.3812
area_urban	0.0063	0.0045	-0.1131	-0.1175	-0.1401	-0.1470	-0.0907	-0.0963	-0.2710	-0.2557
policy_TOU	0.0528	0.0519	0.0303	0.0287	0.1034	0.1027	0.1296	0.1464	0.1926	0.2175
_cons	0.5300	0.5143	0.4832	0.4789	-0.0848	-0.0672	-0.6888	-0.6746	-1.5691	-1.5476

Notes:

3. empl_homemaker dropped because of collinearity
4. empl_retired dropped because of collinearity

4.2 Probit Analysis of the Effects of Environmental Concern on Renewable Energy Purchase

The participants of the survey were asked to rate their concern on environmental issues and whether or not they agreed with certain statements relating to environmental issues. In addition, the participants were asked whether they take any special measures to purchase renewable energy from their electricity provider (BUYRNWL). In this analysis, the effect of environmental concern on renewable energy purchase was evaluated as described in Section 3.2.3. The results of this evaluation are tabulated in Table 4.3 and visual representation is provided in Figure 4.2.

Table 4.3: Results of multivariate probit evaluation of the relation between environmental concern and renewable energy purchase. Values in red represent statistically insignificant results.

Variable Name	Variable Description	Coefficient	Std. Err.	z	P>z
BETTRENV_LKRT	Each individual/household can contribute to a better environment	0.1651	0.1092	1.5100	0.1310
OVRSTATE_LKRT	Environmental impacts are frequently overstated	0.2082	0.0462	4.5100	0.0000
FUTRGNRS_LKRT	Environmental issues should be dealt with primarily by future generations	-0.0480	0.0472	-1.0200	0.3090
TECHPROG_LKRT	Environmental issues will be resolved primarily through technological progress	0.0460	0.0426	1.0800	0.2810
NOTCOSTS_LKRT	Environmental policies introduced by the government to address environmental issues should not cost me extra money	-0.1835	0.0431	-4.2600	0.0000
CLCH_LKRT	Concern over climate change (global warming)	0.0314	0.0565	0.5600	0.5780
NRSC_LKRT	Concern over natural resource depletion (forest, water, energy)	0.1386	0.0622	2.2300	0.0260
_cons (intercept)	N/A	-1.3838	0.1181	-11.7100	0.0000

As seen from Figure 4.2 most of the concerns are statistically insignificant and do not have an effect on the likelihood of a household purchasing renewable energy. Of the three equations that are statistically significant, two confirm with the expected outcome, while the other gives the opposite of what is expected. A strong and positive relation is observed between people agreeing with the statement that environmental impacts are frequently overstated (impacts_overstate) and purchase of renewable energy. Normally it is expected that people that believe that the environmental impacts are overstated would also believe that damage to the environment is not that significant and therefore opt to not purchase renewable energy. In this case people who have purchased renewable energy believe that environmental impacts are in fact overstated.

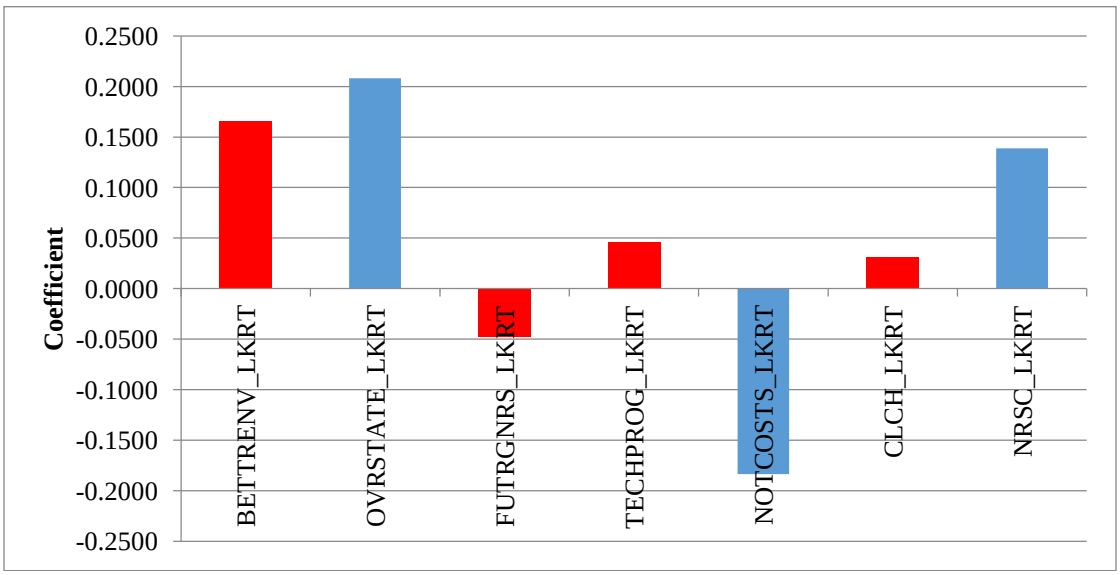

Figure 4.2: Results of probit model, evaluating the relationship between environmental concerns and purchase of renewable energy. The bars in red indicate statistically insignificant results.

Participants who believe that environmental policies introduced by the government to address environmental issues should not cost extra money are less likely to purchase renewable energy. This agrees with what would expect in this case: people who believe that addressing

environmental issues will be associated with an increase in cost are also more likely to purchase renewable energy. Moreover, being concerned about natural resource depletion is positively related to the likelihood of purchasing renewable energy.

4.3 Multivariate Probit Analysis of the Effects of Motivators on Measures and Investments

The results of the probit analysis are tabulated in Appendix A and a graphical representation is presented in Figure 4.3. Generally, from statistically significant results, people who consider the motivators important are more likely to partake in energy efficient measures and investments (Table 4.4). There are, however, variations in the effects that the same motivators have in different energy saving measure and investments. For example, having more information on energy conservation (Mtv_information) appears to have a positive effect on the likelihood of turning off lights when leaving the room (Measure_lights), and cutting down on heating/AC (Measure_heating), however a negative effect is observed on the likelihood of waiting for a full load before using washing machine or dishwasher (Measure_load). These results suggest that it is not only important to shape policies depending on the country to be implemented, but also on the outcomes that the policy is trying to achieve. Another interesting observation is that having higher electricity prices (Mtv_price) does not appear to impact most of the measures and investments, suggesting that simply an increase in prices may not be the preferred solution when trying to promote energy saving measures and investments. Moreover, labels have a positive impact among most measures and investments, demonstrating the importance of labeling in influencing energy saving behaviour.

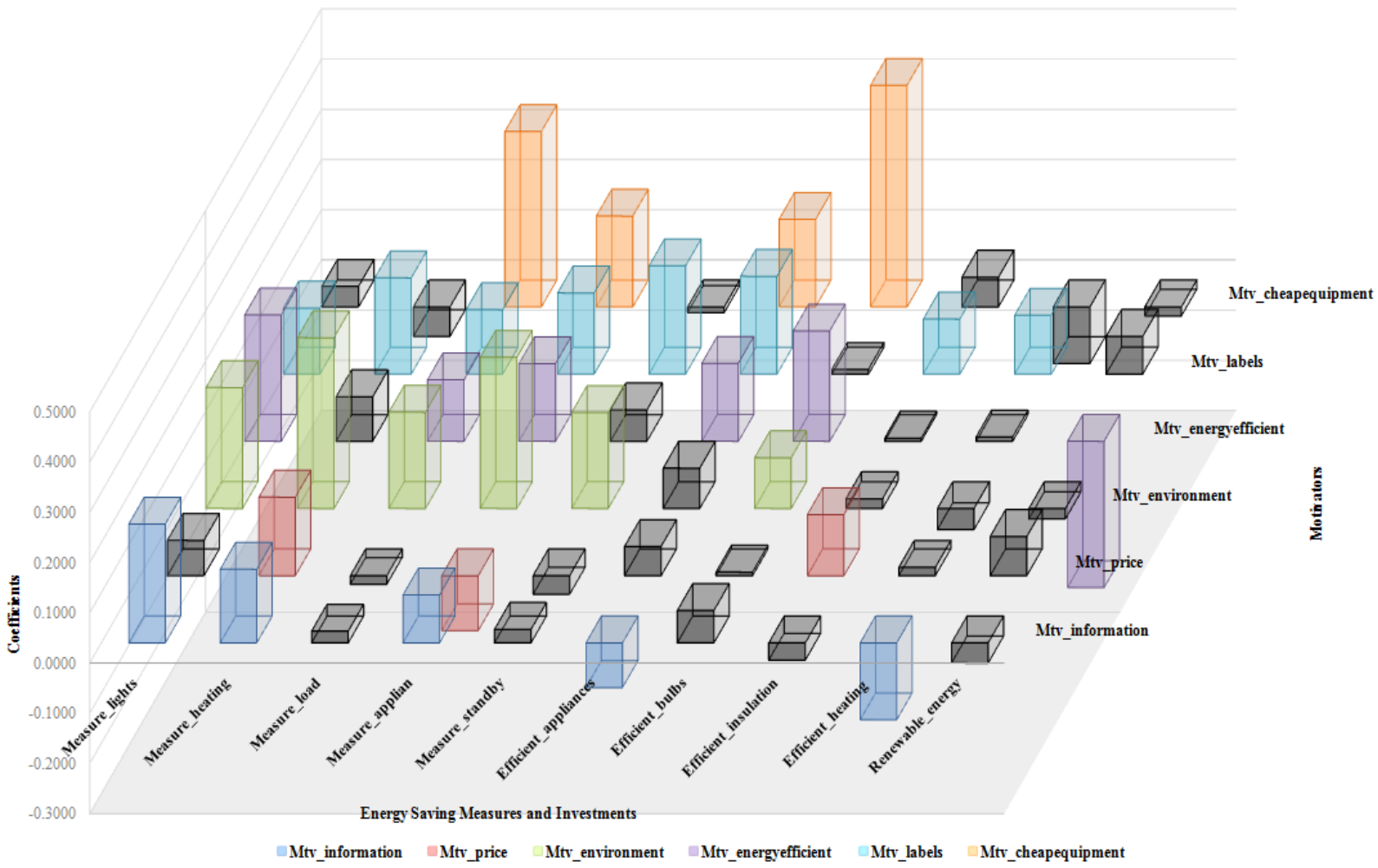

Figure 4.3. Multivariate probit analysis of the relationship of motivators and energy saving measures and investments. Positive coefficients indicates that households that consider the motivators important are more likely to partake in energy saving measures and investments. The greater the coefficient the stronger the relation. Bars in black color indicate statistically insignificant results.

Table 4.4. Summary of the relation between motivators and Measures and Investments. (+) indicates a positive effect; (-) indicates a negative effect; and (x) indicates an insignificant effect.

Actions taken	Motivators					
	Mtv_ information	Mtv_price	Mtv_ environment	Mtv_ energyefficient	Mtv_ labels	Mtv_ cheapequipment
Measure_lights	+	x	+	+	+	x
Measure_heating	+	+	+	x	+	x
Measure_load	x	x	+	x	+	+
Measure_applian	+	-	+	+	+	+
Measure_standby	x	x	+	x	+	x
Efficient_appliances	-	x	x	+	+	+
Efficient_bulbs	x	x	+	+	x	+
Efficient_insulation	x	+	x	x	+	x
Efficient_heating	-	x	x	x	+	x
Renewable_energy	x	x	x	-	x	x

To increase the probability of households installing efficient appliances (Efficient_applicances), a policy program that addresses the ease of identification of energy efficient labels (Mtv_labels) might be more successful than a program that addresses information on energy conservation (Mtv_information). Moreover, the results indicate that having more information on energy conservation (Mtv_information), belief on environmental benefits of actions (Mtv_environment), and availability of energy efficient products (Mtv_energyefficient), are strongly correlated with the probability of the household turning off lights when leaving the room (Measure_lights). Furthermore, belief on environmental benefits of the actions (Mtv_environment), easier identification of energy efficient labels (Mtv_labels), and less expensive energy efficient products (Mtv_cheapequipment) are positively correlated with the likelihood of a household turning off appliances when not in use (Measure_applian), and waiting for a full load before using the washing machine (Measure_load).

Generally the relation between motivators and energy efficient investments are not statistically significant. A strong relation is observed between the likelihood of a household

installing energy efficient appliances (Efficient_appliances) and greater availability of energy efficient product (Mtv_energyefficient), easier identification of energy efficient labels (Mtv_labels), and less expensive energy efficient equipment (Mtv_cheapequipment); whereas a households' probability of installing low-energy light bulbs (Efficient_bulbs) is related to less expensive energy efficient equipment (Mtv_cheapequipment) and belief that the environmental benefits of actions are significant (Mtv_environment).

4.4 Empirical Analysis of Motivators

What people consider to be a good motivator can be used to decide which policy instrument is more likely to give the desired results. This can also be used to differentiate between the policies that are better suited for a specific country or groups of people. For example, if price is believed to be a good motivator by the population of a country, then a policy instrument that addresses price will be more successful, while in a country that considers information more important, a policy instrument that addresses public education might result in the desired outcome. Because of the significance of understanding what people consider important, an empirical analysis of what the population of each of the participating countries of this study considers as a good motivator for household energy reduction is evaluated.

The description of the empirical analysis is presented in Section 3.2.5 and the results are presented in Figure 4.4. Availability of energy efficient products (Mtv_energyefficient) is a strong motivator in all ten participating countries. This agrees with the results from OECD (2011) study where the average importance of each scaled response (not at all important = 0, not important = 3.33, fairly important =6.66 and very important = 10) has been used. Moreover, the OECD study shows that availability of less expensive energy efficient products is the most

important factor in encouraging people to reduce energy consumption in all 10 participating countries (OECD, 2011).

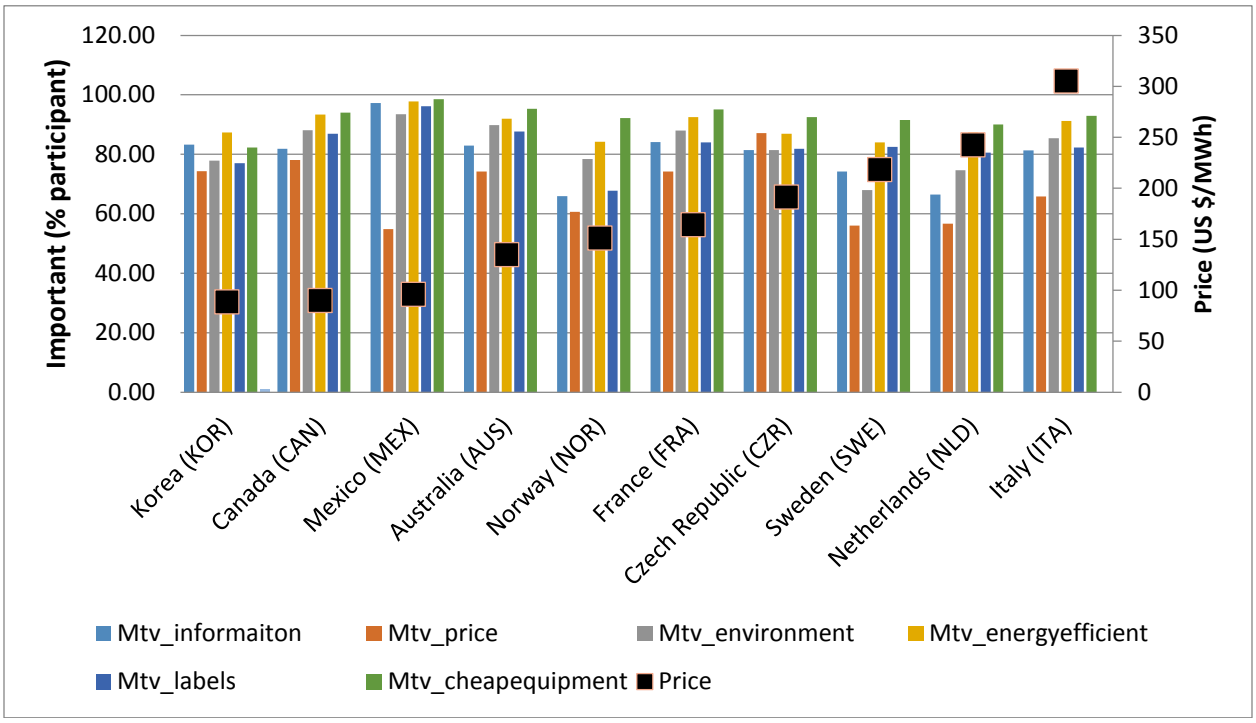

Figure 4.4: Importance of selected motivators as factor to reduce energy consumption. Prices obtained from IEA, 2012 and Simshauser, Nelson, & Doan, 2010 (Price for Australia is the average of Queensland (QLD) and New South Wales (NSW)).

Easier identification of energy efficient labels (Mtv_labels) is generally considered a slightly lower motivator as compared to availability of energy efficient products (Mtv_energyefficient) and this difference between the two motivators is more pronounced for Norway where there is a 16% difference between the two motivators (84.26% for Mtv_energyefficient and 67.80% for Mtv_labels). This is interesting as it is expected the two motivators to have comparable results, since if the need for more energy efficient products (Mtv_energyefficient) is important, than the need to have easily identifiable energy efficient

labels should be similarly important. These results would suggest that people generally believe that more energy efficient products need to be introduced in the market.

The results of this analysis suggest that information on energy conservation (Mtv_information) is quite important in Mexico, however less significant in other countries. This could have to do with the information that is currently available in the country. A lack of such information, for example in Mexico, could explain why the participants of the survey would consider this to be a very important factor. Mexico was followed by France, Korea, Australia, Italy, Canada and Czech Republic, with Norway, Sweden and Netherlands having the lowest percentage of participants considering this motivator as an important factor in reducing energy consumption. Belief that environmental benefits are significant as a motivator (Mtv_environment) is more pronounced in Mexico, Australia, France, Italy, and Canada agreeing with the results of the OECD study (OECD, 2011).

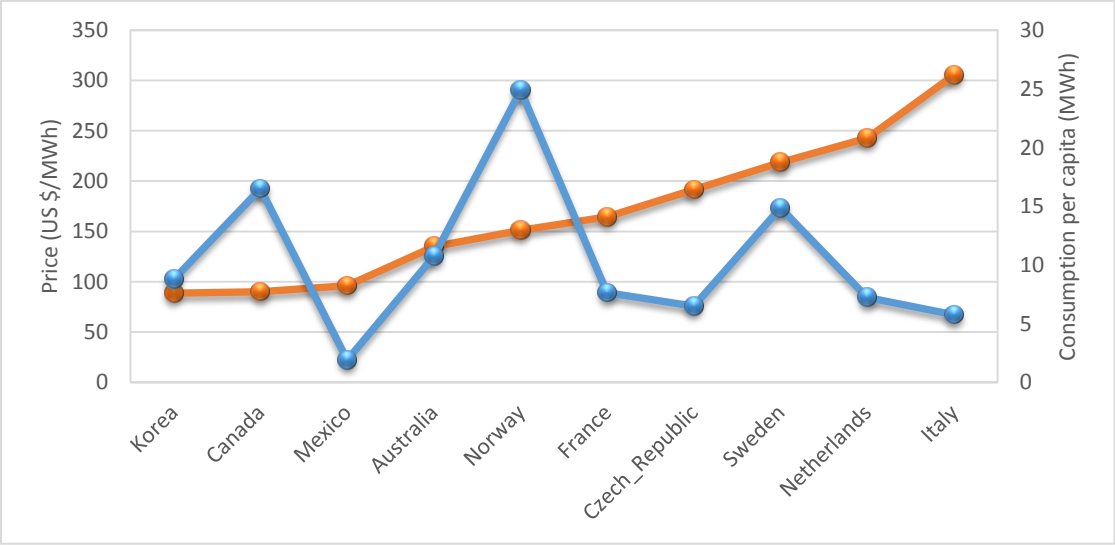

Figure 4.5. Energy consumption per capita (year 2008) and price of electricity (US $/MWh) for year 2008. Prices obtained from IEA, 2012 and Simshauser, Nelson, & Doan, 2010 (Price for Australia is the average of Queensland (QLD) and New South Wales (NSW)). Consumption data obtained from "World Bank, 2014".

A higher percentage of respondents in Czech Republic considers price to be an important motivator in reducing household energy consumption. Czech Republic is followed by Canada, Korea, Australia, and France. The country with the lowest percentage of people considering price as an important motivator was Mexico followed by the Netherlands, Italy, Sweden and Norway. Interestingly, as shown in Figure 4.5, Italy, that has the highest price per capita for electricity, considers price to be the least important motivator in decreasing household energy consumption. Comparing the price and consumption for each country, it can be seen that Italy has one of the lowest consumption levels per capita; since consumption is very low, an increase in price may not be perceived as an action that will have a major impact in household energy bill and therefore not a good motivator.

Table 4.5: Summary of results of empirical analysis of motivators. Number of participants for each motivator is the number of participants surveyed that claimed that the motivator was fairly and very important.

Country	Total participants	MOTIVATORS					
		Mtv_information		Mtv_price		Mtv_environment	
		No of participants that selected fairly and very important	Percentage (%)	No of participants that selected fairly and very important	Percentage (%)	No of participants that selected fairly and very important	Percentage (%)
Australia (AUS)	511	424	82.97%	379	74.17%	459	89.82%
Canada (CAN)	556	455	81.83%	434	78.06%	490	88.13%
Czech Republic (CZR)	442	360	81.45%	385	87.10%	360	81.45%
France (FRA)	726	611	84.16%	539	74.24%	639	88.02%
Italy (ITA)	940	764	81.28%	619	65.85%	803	85.43%
Korea (KOR)	530	441	83.21%	394	74.34%	413	77.92%
Mexico (MEX)	680	661	97.21%	373	54.85%	636	93.53%
Netherlands (NLD)	411	273	66.42%	233	56.69%	307	74.70%
Norway (NOR)	705	465	65.96%	428	60.71%	553	78.44%
Sweden (SWE)	555	412	74.23%	311	56.04%	377	67.93%

Country	Total participants	MOTIVATORS					
		Mtv_energyefficient		Mtv_labels		Mtv_cheapequipment	
		No of participants that selected fairly and very important	Percentage (%)	No of participants that selected fairly and very important	Percentage (%)	No of participants that selected fairly and very important	Percentage (%)
Australia (AUS)	511	470	91.98%	448	87.67%	487	95.30%
Canada (CAN)	556	519	93.35%	483	86.87%	523	94.06%
Czech Republic (CZR)	442	384	86.88%	362	81.90%	409	92.53%
France (FRA)	726	672	92.56%	610	84.02%	690	95.04%
Italy (ITA)	940	857	91.17%	774	82.34%	874	92.98%
Korea (KOR)	530	463	87.36%	408	76.98%	436	82.26%
Mexico (MEX)	680	665	97.79%	654	96.18%	670	98.53%
Netherlands (NLD)	411	359	87.35%	331	80.54%	370	90.02%
Norway (NOR)	705	594	84.26%	478	67.80%	650	92.20%
Sweden (SWE)	555	466	83.96%	458	82.52%	508	91.53%

CHAPTER 5: SUMMARY AND CONCLUSION

Addressing household energy consumption is important both because of the current consumption and its likely growth in the years to come. Policy instruments are an important tool used by governments to shape behaviour and promote change. As policy instruments vary greatly, selection of the appropriate instrument is a key factor in its success. This study examined households' energy usage practices based upon an analysis that accounts for the correlation between energy saving activities and a cross-country data set that allows for country specific effects. Significant differences are observed across the ten countries, indicating that country specific factors play an important role in household decision to implement energy saving measures and investments. It is observed that household in Czech Republic are more likely to invest in energy efficient appliances, while households in the Netherlands are more likely to install thermal insulation and efficient water heating boiler.

The effects of individual and household characteristics (control variables) on energy saving measures and behaviours were also evaluated, to provide an insight and the tendencies and behaviours of households. The results indicated that males are less likely than females to partake in energy saving measure and investments, while being married or living as a couple has a positive impact. Age was shown to have an impact on energy saving activities with older participants being more likely to partake in energy saving measure, but less likely to adopt energy efficient appliances (Efficient_appliances) and renewable energy equipment (Renewable_energy). Executives, professionals, self-employed and salaried individuals, along with higher income households are more likely to invest in energy efficient activities (investments) and renewable energy.

Moreover, this study allows for the evaluation of the impact of time-of-use pricing scheme in different countries. The effects of varying electricity pricing did not appear to impact decisions of a household to wait for a full load before using washing machine or dishwasher, install energy efficient appliances, and install energy efficient light bulbs. However, this pricing scheme encourages households to implement energy saving measures and investments, and is especially impactful in the likelihood of a household turning off appliances when not in use, installing efficient heating boiler, and renewable energy technology. Purchase of renewable energy from energy provider on the other hand is influenced by the concern about natural resource depletion. Lastly, this study showed that generally people who considered the motivators important were more likely to partake in energy efficient measures and investments. Specifically, strong relationships are observed between availability of less expensive efficient equipment and the likelihood of a household waiting for a full load before using the washing machine, turn off appliances when not in use, and install energy efficient appliances and thermal insulation. Moreover, strong positive relations are observed between all measures and belief that environmental benefits of actions are significant.

In summary, there are a few relevant conclusions that can be drawn from this analysis: First, there are complementary effects between the energy saving measures and investments that should be considered when assessing a policy instrument. Second, economic instruments, such as time varying rates, display desirable effect on energy saving behaviour across most measures and investments. Lastly, concern over environmental problems or natural resources is an important aspect that should be considered when selecting a policy instrument.

5.1 Study Limitations

The responses to the survey were self-reported and it is difficult to compare the results of one respondent with another. Moreover, time of use pricing scheme was a fairly new policy in 2008; however the analysis provides a good insight into the effect of such policy in participating countries.

5.2 Future Work

Future work to follow this study would be to undertake the same survey at a later time (in 2018 for example) and compare whether there are any changes in people's responses. The results of the same survey in the future could also be used to evaluate whether TOU policy has caused a decrease in energy consumption. It should be noted, however, that a much larger sample size is needed since an analysis as the one performed on this project decreases the sample size by removing the observations left blank or marked as "don't know".

APPENDICES

APPENDIX A: Results of multivariate probit analysis of motivators

Table A1. Results of multivariate probit analysis of motivators describing the relation of motivators and energy saving measures. Results of this analysis are discussed in Section 3.2.4. Coefficients in red are statistically insignificant.

	Measure_lights			Measure_heating			Measure_load			Measure_applian			Measure_standby		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
Mtv_information	0.2368	0.0562	4.2100	0.1466	0.0478	3.0700	0.0233	0.0570	0.4100	0.0956	0.0538	1.7800	0.0270	0.0460	0.5900
Mtv_price	0.0703	0.0460	1.5300	0.1565	0.0370	4.2300	-0.0171	0.0446	-0.3800	-0.1096	0.0436	-2.5100	-0.0370	0.0353	-1.0500
Mtv_environment	0.2409	0.0601	4.0100	0.3400	0.0508	6.6900	0.1917	0.0596	3.2200	0.3012	0.0570	5.2800	0.1913	0.0497	3.8500
Mtv_energyefficient	0.2518	0.0796	3.1600	0.0886	0.0697	1.2700	0.1227	0.0799	1.5400	0.1547	0.0761	2.0300	0.0626	0.0678	0.9200
Mtv_labels	0.1315	0.0652	2.0200	0.1916	0.0545	3.5200	0.1284	0.0642	2.0000	0.1615	0.0611	2.6400	0.2156	0.0527	4.0900
Mtv_cheapequipment	0.0409	0.0859	0.4800	-0.0590	0.0755	-0.7800	0.3494	0.0812	4.3000	0.1808	0.0806	2.2400	-0.0114	0.0727	-0.1600
_cons	0.4056	0.0759	5.3400	-0.1099	0.0692	-1.5900	0.4186	0.0730	5.7300	0.3599	0.0734	4.9100	-0.1172	0.0677	-1.7300

Table A2. Results of multivariate probit analysis of motivators describing the relation of motivators and energy saving investments. Results of this analysis are discussed in Section 3.2.4. Coefficients in red are statistically insignificant.

	Efficient_appliances			Efficient_bulbs			Efficient_insulation			Efficient_heating			Renewable_energy		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
Mtv_information	-0.0892	0.0493	-1.8100	0.0646	0.0519	1.2500	-0.0343	0.0459	-0.7500	-0.1532	0.0491	-3.1200	-0.0401	0.0649	-0.6200
Mtv_price	0.0579	0.0374	1.5500	0.0071	0.0406	0.1700	0.1217	0.0352	3.4600	0.0166	0.0384	0.4300	0.0781	0.0515	1.5200
Mtv_environment	0.0802	0.0525	1.5300	0.1011	0.0560	1.8100	0.0195	0.0499	0.3900	-0.0418	0.0540	-0.7700	-0.0204	0.0709	-0.2900
Mtv_energyefficient	0.1554	0.0707	2.2000	0.2197	0.0742	2.9600	0.0061	0.0686	0.0900	0.0087	0.0744	0.1200	-0.2912	0.0915	-3.1800
Mtv_labels	0.1948	0.0553	3.5200	0.0093	0.0603	0.1500	0.1097	0.0530	2.0700	0.1174	0.0581	2.0200	0.0752	0.0767	0.9800
Mtv_cheapequipment	0.1745	0.0747	2.3400	0.4413	0.0761	5.8000	0.0592	0.0729	0.8100	-0.1128	0.0777	-1.4500	-0.0183	0.0993	-0.1800
_cons	0.0752	0.0686	1.1000	0.1164	0.0691	1.6900	-0.3092	0.0681	-4.5400	-0.5645	0.0717	-7.8800	-1.1848	0.0885	-13.3900

APPENDIX B: Results of multivariate binary probit for energy efficient measures and investments

Table B1. Multivariate binary probit estimation results for energy efficient measures.

	Measure_lights			Measure_heating			Measure_load			Measure_applian			Measure_standby		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
AUS	0.3539	0.1121	0.0020	-0.4230	0.0937	0.0000	0.4592	0.1012	0.0000	0.0234	0.0906	0.7970	-0.3316	0.0819	0.0000
CAN	0.4382	0.1095	0.0000	-0.2395	0.0914	0.0090	0.5211	0.0977	0.0000	0.4611	0.0919	0.0000	0.0191	0.0780	0.8070
CZR	0.2435	0.1159	0.0360	-0.3341	0.0970	0.0010	0.5444	0.1077	0.0000	0.2940	0.0987	0.0030	-0.2566	0.0855	0.0030
FRA	0.8402	0.1229	0.0000	-0.3051	0.0894	0.0010	0.5888	0.0956	0.0000	0.5830	0.0933	0.0000	0.1578	0.0778	0.0430
ITA	0.3250	0.0947	0.0010	-0.2557	0.0829	0.0020	0.5348	0.0847	0.0000	0.4297	0.0819	0.0000	0.1319	0.0706	0.0620
MEX	1.0427	0.1383	0.0000	-0.2157	0.0906	0.0170	0.0215	0.0876	0.8070	0.9128	0.1023	0.0000	0.6791	0.0809	0.0000
NLD	0.0351	0.1082	0.7450	-0.4616	0.0960	0.0000	0.6864	0.1142	0.0000	0.6768	0.1075	0.0000	0.4130	0.0877	0.0000
NOR	-0.3835	0.0919	0.0000	-0.8635	0.0860	0.0000	0.3533	0.0911	0.0000	0.3209	0.0877	0.0000	0.2389	0.0773	0.0020
SWE	-0.6526	0.0912	0.0000	-1.4788	0.0888	0.0000	0.1917	0.0904	0.0340	0.1244	0.0869	0.1520	0.0576	0.0785	0.4630
gender_male	-0.0311	0.0483	0.5190	-0.0677	0.0381	0.0760	-0.2294	0.0452	0.0000	-0.0458	0.0431	0.2880	-0.1389	0.0354	0.0000
Married	0.0557	0.0501	0.2660	0.0090	0.0399	0.8210	0.1249	0.0460	0.0070	-0.0160	0.0450	0.7220	-0.0094	0.0370	0.8000
Income	-0.1055	0.0488	0.0310	-0.0551	0.0380	0.1480	-0.0213	0.0444	0.6310	-0.0179	0.0430	0.6770	-0.1311	0.0352	0.0000
age_class_1	-0.2764	0.1036	0.0080	-0.5263	0.0824	0.0000	-0.2853	0.0932	0.0020	-0.3449	0.0921	0.0000	-0.1684	0.0784	0.0320
age_class_2	-0.1968	0.0773	0.0110	-0.2850	0.0629	0.0000	-0.1402	0.0730	0.0550	-0.3110	0.0702	0.0000	-0.2007	0.0579	0.0010
age_class_3	-0.0379	0.0740	0.6090	-0.1098	0.0604	0.0690	0.0941	0.0720	0.1910	-0.1348	0.0674	0.0460	-0.0815	0.0551	0.1390
age_class_4	-0.0145	0.0736	0.8430	-0.0894	0.0595	0.1330	0.1570	0.0723	0.0300	0.0233	0.0684	0.7330	-0.0059	0.0547	0.9140
edu_1	-0.0672	0.1080	0.5340	-0.0725	0.0838	0.3870	-0.1938	0.1009	0.0550	-0.1279	0.0963	0.1840	-0.0309	0.0776	0.6910
edu_2	0.0907	0.0874	0.2990	-0.0609	0.0695	0.3810	-0.2018	0.0821	0.0140	-0.1557	0.0791	0.0490	-0.0001	0.0641	0.9990
edu_3	0.0081	0.0850	0.9240	-0.0192	0.0668	0.7740	-0.1343	0.0789	0.0890	-0.1505	0.0771	0.0510	0.0340	0.0618	0.5820
edu_4	0.0543	0.0776	0.4840	0.0155	0.0627	0.8050	-0.0274	0.0738	0.7100	-0.0747	0.0728	0.3050	0.0397	0.0581	0.4940
empl_fulltime	0.0078	0.0765	0.9190	0.0848	0.0614	0.1670	-0.0215	0.0741	0.7720	-0.0046	0.0703	0.9480	0.0092	0.0566	0.8700
empl_leave	-0.0914	0.1524	0.5490	0.0341	0.1273	0.7890	-0.0040	0.1625	0.9810	-0.0578	0.1426	0.6850	-0.1267	0.1180	0.2830
empl_parttime	-0.0944	0.0934	0.3120	0.0588	0.0751	0.4340	-0.1163	0.0897	0.1940	-0.1536	0.0841	0.0680	-0.0382	0.0693	0.5820
occup_executive	-0.1543	0.0877	0.0790	-0.0657	0.0718	0.3600	-0.3133	0.0846	0.0000	-0.1819	0.0791	0.0210	-0.0205	0.0669	0.7590
occup_professionals	-0.0553	0.0913	0.5440	0.0015	0.0746	0.9840	-0.1653	0.0883	0.0610	-0.0210	0.0829	0.8000	0.0048	0.0693	0.9440
occup_salaried	0.0463	0.0744	0.5340	-0.0285	0.0608	0.6400	-0.0857	0.0733	0.2420	0.0215	0.0670	0.7480	-0.0275	0.0565	0.6270
occup_selfemployed	-0.0216	0.1025	0.8330	0.0198	0.0830	0.8120	-0.0985	0.0978	0.3140	-0.1794	0.0884	0.0420	-0.1754	0.0756	0.0200
type_house	-0.0068	0.0524	0.8970	0.1371	0.0418	0.0010	0.2293	0.0482	0.0000	0.0022	0.0466	0.9630	-0.0061	0.0386	0.8750
area_urban	-0.0239	0.0564	0.6720	-0.0678	0.0456	0.1370	-0.0438	0.0561	0.4340	-0.0829	0.0517	0.1090	-0.2038	0.0425	0.0000
policy_TOU	0.0936	0.0526	0.0750	0.1009	0.0399	0.0110	-0.0099	0.0467	0.8320	0.1680	0.0454	0.0000	0.0975	0.0364	0.0070
_cons	1.1723	0.1569	0.0000	1.1674	0.1318	0.0000	1.0072	0.1495	0.0000	1.0211	0.1421	0.0000	0.4984	0.1187	0.0000

Notes:

1. empl_homemaker dropped because of collinearity
2. empl_retired dropped because of collinearity

Table B2. Multivariate binary probit estimation results for energy efficient investments.

	Efficient_applicances			Efficient_bulbs			Efficient_insulation			Efficient_heating			Renewable_energy		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
AUS	-0.3813	0.0891	0.0000	0.2818	0.0902	0.0020	-0.3301	0.0834	0.0000	-0.4665	0.0870	0.0000	-0.4002	0.1086	0.0000
CAN	-0.4465	0.0847	0.0000	0.5226	0.0883	0.0000	-0.3824	0.0799	0.0000	-0.3527	0.0830	0.0000	-0.6861	0.1181	0.0000
CZR	0.3832	0.1047	0.0000	0.7444	0.1024	0.0000	0.0172	0.0866	0.8420	-0.7755	0.1003	0.0000	-0.7892	0.1426	0.0000
FRA	0.0311	0.0875	0.7220	0.1543	0.0835	0.0650	-0.1078	0.0793	0.1740	-0.6010	0.0849	0.0000	-0.7666	0.1163	0.0000
ITA	-0.0876	0.0779	0.2610	0.7385	0.0799	0.0000	-0.1694	0.0711	0.0170	-0.3903	0.0755	0.0000	-0.1971	0.0942	0.0370
MEX	-0.3611	0.0850	0.0000	0.6328	0.0890	0.0000	-1.1997	0.0837	0.0000	-1.5279	0.1030	0.0000	-1.1554	0.1273	0.0000
NLD	-0.1537	0.0933	0.1000	0.1904	0.0910	0.0360	0.1600	0.0875	0.0670	0.6875	0.0880	0.0000	-0.6426	0.1267	0.0000
NOR	-0.5366	0.0824	0.0000	0.3203	0.0836	0.0000	-0.6116	0.0775	0.0000	-0.6145	0.0829	0.0000	0.0392	0.0958	0.6830
SWE	-0.7575	0.0843	0.0000	0.2484	0.0843	0.0030	-0.5938	0.0818	0.0000	-0.3584	0.0855	0.0000	-0.5196	0.1162	0.0000
gender_male	-0.0176	0.0379	0.6420	-0.0278	0.0409	0.4960	0.0420	0.0362	0.2460	0.0026	0.0403	0.9480	0.1196	0.0534	0.0250
married	0.2028	0.0390	0.0000	0.1428	0.0417	0.0010	0.1055	0.0380	0.0050	-0.0069	0.0423	0.8710	-0.0205	0.0563	0.7160
income	0.0774	0.0379	0.0410	0.0665	0.0412	0.1070	0.1064	0.0359	0.0030	0.1040	0.0400	0.0090	0.0633	0.0522	0.2260
age_class_1	-0.0805	0.0810	0.3210	-0.3716	0.0873	0.0000	-0.3184	0.0817	0.0000	0.0855	0.0872	0.3260	0.3264	0.1120	0.0040
age_class_2	0.1336	0.0619	0.0310	-0.2651	0.0680	0.0000	-0.1633	0.0590	0.0060	-0.1061	0.0648	0.1020	0.1258	0.0844	0.1360
age_class_3	0.0687	0.0587	0.2420	-0.1690	0.0657	0.0100	-0.1141	0.0559	0.0410	-0.1028	0.0610	0.0920	-0.0144	0.0807	0.8580
age_class_4	0.1522	0.0588	0.0100	-0.0941	0.0656	0.1510	0.0262	0.0552	0.6350	-0.0854	0.0608	0.1600	0.0781	0.0793	0.3250
edu_1	-0.1585	0.0856	0.0640	-0.1207	0.0913	0.1860	0.0001	0.0796	0.9990	-0.0364	0.0888	0.6820	0.0528	0.1162	0.6500
edu_2	-0.0208	0.0704	0.7670	-0.0756	0.0763	0.3220	-0.0308	0.0653	0.6380	-0.0700	0.0725	0.3350	-0.0469	0.0927	0.6130
edu_3	-0.1071	0.0670	0.1100	-0.1497	0.0727	0.0390	-0.1027	0.0630	0.1030	-0.0850	0.0697	0.2230	-0.1094	0.0898	0.2230
edu_4	-0.1203	0.0624	0.0540	-0.1181	0.0684	0.0840	-0.0587	0.0590	0.3200	-0.0530	0.0654	0.4170	-0.0122	0.0803	0.8800
empl_fulltime	-0.0727	0.0610	0.2330	0.0645	0.0676	0.3400	-0.0441	0.0575	0.4440	0.1596	0.0636	0.0120	0.1278	0.0862	0.1380
empl_leave	0.0285	0.1339	0.8310	-0.0112	0.1376	0.9350	0.1397	0.1219	0.2520	0.1807	0.1321	0.1710	0.1599	0.1769	0.3660
empl_parttime	-0.1822	0.0735	0.0130	0.0876	0.0817	0.2840	-0.0858	0.0707	0.2240	0.0864	0.0775	0.2650	0.2112	0.1028	0.0400
occup_executive	0.0458	0.0722	0.5260	0.0704	0.0778	0.3660	0.2513	0.0685	0.0000	0.1486	0.0755	0.0490	0.3689	0.1018	0.0000
occup_professionals	0.0614	0.0741	0.4070	-0.0045	0.0796	0.9550	0.1757	0.0711	0.0130	0.1224	0.0787	0.1200	0.2934	0.1049	0.0050
occup_salaried	-0.0128	0.0608	0.8330	-0.0142	0.0646	0.8260	0.1117	0.0582	0.0550	0.0598	0.0650	0.3580	0.0836	0.0912	0.3590
occup_selfemployed	0.1489	0.0830	0.0730	0.0511	0.0895	0.5680	0.1709	0.0781	0.0290	0.1857	0.0853	0.0290	0.1519	0.1161	0.1910
type_house	0.3062	0.0415	0.0000	0.2780	0.0439	0.0000	0.4751	0.0399	0.0000	0.4375	0.0442	0.0000	0.4291	0.0609	0.0000
area_urban	0.0063	0.0457	0.8900	-0.1131	0.0502	0.0240	-0.1401	0.0430	0.0010	-0.0907	0.0458	0.0480	-0.2710	0.0573	0.0000
policy_TOU	0.0528	0.0396	0.1830	0.0303	0.0424	0.4750	0.1034	0.0374	0.0060	0.1296	0.0410	0.0020	0.1926	0.0547	0.0000
_cons	0.5300	0.1291	0.0000	0.4832	0.1357	0.0000	-0.0848	0.1211	0.4840	-0.6888	0.1318	0.0000	-1.5691	0.1719	0.0000

Notes:

1. empl_homemaker dropped because of collinearity
2. empl_retired dropped because of collinearity

Table B3. rho values from multivariate binary probit model

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
rho21	0.4054	0.0223	18.1500	0.0000	0.3607	0.4482
rho31	0.3902	0.0253	15.4100	0.0000	0.3395	0.4387
rho41	0.4284	0.0236	18.1200	0.0000	0.3809	0.4735
rho51	0.3112	0.0230	13.5100	0.0000	0.2654	0.3556
rho61	0.1231	0.0241	5.1000	0.0000	0.0755	0.1701
rho71	0.1408	0.0261	5.3900	0.0000	0.0893	0.1916
rho81	0.0916	0.0238	3.8500	0.0000	0.0448	0.1380
rho91	0.0085	0.0259	0.3300	0.7430	-0.0422	0.0591
rho101	-0.0991	0.0334	-2.9700	0.0030	-0.1639	-0.0334
rho32	0.3893	0.0233	16.7000	0.0000	0.3427	0.4340
rho42	0.4006	0.0219	18.2900	0.0000	0.3568	0.4426
rho52	0.3245	0.0196	16.6000	0.0000	0.2857	0.3623
rho62	0.1140	0.0215	5.3100	0.0000	0.0717	0.1558
rho72	0.1614	0.0230	7.0300	0.0000	0.1161	0.2061
rho82	0.1179	0.0206	5.7100	0.0000	0.0773	0.1581
rho92	0.0475	0.0231	2.0500	0.0400	0.0020	0.0927
rho102	-0.0436	0.0299	-1.4600	0.1450	-0.1019	0.0151
rho43	0.4057	0.0236	17.1900	0.0000	0.3584	0.4509
rho53	0.2705	0.0222	12.1700	0.0000	0.2265	0.3135
rho63	0.1690	0.0231	7.3100	0.0000	0.1234	0.2140
rho73	0.1653	0.0248	6.6700	0.0000	0.1164	0.2135
rho83	0.1129	0.0229	4.9400	0.0000	0.0679	0.1575
rho93	0.0711	0.0257	2.7600	0.0060	0.0205	0.1213
rho103	-0.0543	0.0340	-1.6000	0.1100	-0.1206	0.0125
rho54	0.5715	0.0173	33.0400	0.0000	0.5367	0.6045
rho64	0.1455	0.0225	6.4600	0.0000	0.1011	0.1893
rho74	0.1444	0.0243	5.9500	0.0000	0.0965	0.1916
rho84	0.1002	0.0221	4.5300	0.0000	0.0567	0.1433
rho94	0.0472	0.0245	1.9200	0.0540	-0.0009	0.0951
rho104	-0.0275	0.0314	-0.8800	0.3810	-0.0888	0.0340
rho65	0.1061	0.0210	5.0500	0.0000	0.0648	0.1471
rho75	0.1482	0.0225	6.5900	0.0000	0.1039	0.1919
rho85	0.1018	0.0199	5.1100	0.0000	0.0626	0.1407
rho95	0.0962	0.0221	4.3600	0.0000	0.0528	0.1393
rho105	0.0822	0.0289	2.8400	0.0040	0.0253	0.1385
rho76	0.2453	0.0224	10.9300	0.0000	0.2009	0.2888
rho86	0.2937	0.0197	14.8800	0.0000	0.2545	0.3319
rho96	0.2592	0.0224	11.5600	0.0000	0.2148	0.3026
rho106	0.1349	0.0308	4.3800	0.0000	0.0740	0.1947
rho87	0.2363	0.0212	11.1600	0.0000	0.1944	0.2774
rho97	0.1659	0.0240	6.9100	0.0000	0.1185	0.2125
rho107	0.1117	0.0322	3.4700	0.0010	0.0483	0.1743
rho98	0.4067	0.0195	20.8200	0.0000	0.3677	0.4443
rho108	0.3633	0.0268	13.5300	0.0000	0.3096	0.4147
rho109	0.4437	0.0251	17.7100	0.0000	0.3933	0.4914

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho81 = rho91 = rho101 = rho32 = rho42 = rho52 = rho62 = rho72 = rho82 = rho92 = rho102 = rho43 = rho53 = rho63 = rho73 = rho83 = rho93 = rho103 = rho54 = rho64 = rho74 = rho84 = rho94 = rho104 = rho65 = rho75 = rho85 = rho95 = rho105 = rho76 = rho86 = rho96 = rho106 = rho87 = rho97 = rho107 = rho98 = rho108 = rho109 = 0: **chi2(45) = 3455.87 Prob > chi2 = 0.0000**

APPENDIX C: Results of univariate binary probit for energy efficient measures and investments

Table C1. Univariate binary probit estimation results for energy efficient measures.

	Measure_lights			Measure_heating			Measure_load			Measure_applian			Measure_standby		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coef.	Std. Err.	P>z
AUS	0.4132	0.1107	0.0000	-0.3699	0.0929	0.0000	0.4987	0.1023	0.0000	0.0581	0.0907	0.5220	-0.3223	0.0825	0.0000
CAN	0.5105	0.1089	0.0000	-0.1989	0.0907	0.0280	0.5420	0.0987	0.0000	0.5019	0.0929	0.0000	0.0052	0.0788	0.9470
CZR	0.3549	0.1159	0.0020	-0.2753	0.0971	0.0050	0.5913	0.1092	0.0000	0.3471	0.0999	0.0010	-0.2524	0.0866	0.0040
FRA	0.9020	0.1219	0.0000	-0.2649	0.0886	0.0030	0.6030	0.0964	0.0000	0.6112	0.0941	0.0000	0.1434	0.0785	0.0680
ITA	0.3266	0.0914	0.0000	-0.2109	0.0813	0.0100	0.5129	0.0836	0.0000	0.4531	0.0811	0.0000	0.1416	0.0709	0.0460
MEX	1.1550	0.1401	0.0000	-0.1528	0.0903	0.0900	0.0600	0.0885	0.4970	1.0001	0.1054	0.0000	0.6798	0.0821	0.0000
NLD	0.1099	0.1080	0.3090	-0.4001	0.0959	0.0000	0.7355	0.1160	0.0000	0.7178	0.1097	0.0000	0.4138	0.0887	0.0000
NOR	-0.3194	0.0899	0.0000	-0.8278	0.0848	0.0000	0.3706	0.0916	0.0000	0.3234	0.0871	0.0000	0.2297	0.0775	0.0030
SWE	-0.5871	0.0896	0.0000	-1.4497	0.0878	0.0000	0.2016	0.0907	0.0260	0.1305	0.0867	0.1320	0.0493	0.0791	0.5330
gender_male	-0.0455	0.0486	0.3490	-0.0647	0.0386	0.0930	-0.2257	0.0458	0.0000	-0.0331	0.0440	0.4510	-0.1272	0.0361	0.0000
married	0.0656	0.0503	0.1920	0.0179	0.0402	0.6570	0.1494	0.0465	0.0010	0.0072	0.0458	0.8750	0.0053	0.0377	0.8880
income	-0.1303	0.0490	0.0080	-0.0650	0.0384	0.0910	-0.0302	0.0450	0.5020	-0.0428	0.0439	0.3290	-0.1380	0.0360	0.0000
age_class_1	-0.2952	0.1040	0.0050	-0.5304	0.0831	0.0000	-0.3008	0.0938	0.0010	-0.3494	0.0938	0.0000	-0.1712	0.0797	0.0320
age_class_2	-0.2157	0.0769	0.0050	-0.2861	0.0632	0.0000	-0.1586	0.0733	0.0300	-0.3145	0.0708	0.0000	-0.2097	0.0589	0.0000
age_class_3	-0.0388	0.0741	0.6000	-0.1072	0.0608	0.0780	0.0955	0.0727	0.1890	-0.1210	0.0686	0.0780	-0.0756	0.0563	0.1790
age_class_4	-0.0259	0.0739	0.7260	-0.0888	0.0601	0.1390	0.1607	0.0733	0.0280	0.0217	0.0696	0.7550	-0.0170	0.0559	0.7610
edu_1	-0.0841	0.1096	0.4430	-0.0828	0.0850	0.3300	-0.1695	0.1025	0.0980	-0.1292	0.0989	0.1910	-0.0617	0.0793	0.4360
edu_2	0.0657	0.0872	0.4510	-0.0749	0.0699	0.2840	-0.1910	0.0823	0.0200	-0.1479	0.0802	0.0650	-0.0339	0.0652	0.6030
edu_3	-0.0034	0.0849	0.9680	-0.0225	0.0673	0.7380	-0.1062	0.0792	0.1800	-0.1344	0.0781	0.0850	0.0232	0.0630	0.7120
edu_4	0.0442	0.0773	0.5670	0.0145	0.0631	0.8180	-0.0004	0.0740	0.9960	-0.0531	0.0737	0.4710	0.0328	0.0591	0.5790
empl_fulltime	0.0051	0.0772	0.9470	0.0867	0.0620	0.1620	-0.0216	0.0753	0.7740	-0.0041	0.0717	0.9550	0.0149	0.0579	0.7970
empl_leave	-0.1135	0.1533	0.4590	0.0302	0.1285	0.8140	-0.0111	0.1653	0.9470	-0.0836	0.1440	0.5620	-0.1175	0.1208	0.3310
empl_parttime	-0.1121	0.0933	0.2300	0.0406	0.0755	0.5910	-0.1349	0.0905	0.1360	-0.1762	0.0852	0.0390	-0.0448	0.0705	0.5250
occup_executive	-0.1615	0.0882	0.0670	-0.0637	0.0722	0.3780	-0.3196	0.0857	0.0000	-0.1811	0.0811	0.0260	-0.0150	0.0680	0.8250
occup_professionals	-0.0823	0.0914	0.3680	-0.0071	0.0752	0.9250	-0.1743	0.0894	0.0510	-0.0311	0.0847	0.7130	0.0051	0.0704	0.9420
occup_salaried	0.0668	0.0752	0.3740	-0.0143	0.0614	0.8150	-0.0600	0.0746	0.4220	0.0431	0.0690	0.5320	-0.0071	0.0575	0.9010
occup_selfemployed	-0.0326	0.1027	0.7510	0.0095	0.0838	0.9100	-0.0965	0.0997	0.3330	-0.1965	0.0906	0.0300	-0.1731	0.0770	0.0250
type_house	-0.0039	0.0525	0.9410	0.1424	0.0422	0.0010	0.2191	0.0487	0.0000	0.0105	0.0474	0.8240	-0.0057	0.0393	0.8840
area_urban	-0.0191	0.0567	0.7360	-0.0784	0.0461	0.0890	-0.0524	0.0567	0.3550	-0.0955	0.0527	0.0700	-0.2120	0.0433	0.0000
policy_TOU	0.1015	0.0526	0.0540	0.1036	0.0403	0.0100	-0.0079	0.0471	0.8670	0.1556	0.0462	0.0010	0.0964	0.0372	0.0100
_cons	1.1459	0.1562	0.0000	1.1349	0.1318	0.0000	0.9765	0.1507	0.0000	0.9859	0.1443	0.0000	0.5118	0.1206	0.0000

Notes:

1. empl_homemaker dropped because of collinearity
2. empl_retired dropped because of collinearity

Table C2. Univariate binary probit estimation results for energy efficient investmetns.

	Efficient_appliances			**Efficient_bulbs**			**Efficient_insulation**			**Efficient_heating**			**Renewable_energy**		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coef.	Std. Err.	P>z
AUS	-0.3811	0.0889	0.0000	0.2985	0.0902	0.0010	-0.3123	0.0833	0.0000	-0.4531	0.0873	0.0000	-0.3990	0.1097	0.0000
CAN	-0.4404	0.0848	0.0000	0.5319	0.0889	0.0000	-0.3906	0.0800	0.0000	-0.3587	0.0832	0.0000	-0.6713	0.1183	0.0000
CZR	0.4244	0.1057	0.0000	0.7604	0.1028	0.0000	0.0162	0.0872	0.8530	-0.8191	0.1021	0.0000	-0.8186	0.1436	0.0000
FRA	0.0286	0.0873	0.7430	0.1585	0.0834	0.0580	-0.1087	0.0794	0.1710	-0.5925	0.0854	0.0000	-0.7659	0.1179	0.0000
ITA	-0.0717	0.0775	0.3550	0.7446	0.0796	0.0000	-0.1638	0.0711	0.0210	-0.4055	0.0758	0.0000	-0.2136	0.0945	0.0240
MEX	-0.3520	0.0851	0.0000	0.6450	0.0892	0.0000	-1.2039	0.0838	0.0000	-1.5179	0.1029	0.0000	-1.1359	0.1269	0.0000
NLD	-0.1397	0.0935	0.1350	0.1973	0.0914	0.0310	0.1495	0.0876	0.0880	0.6838	0.0889	0.0000	-0.7079	0.1321	0.0000
NOR	-0.5294	0.0823	0.0000	0.3295	0.0837	0.0000	-0.6213	0.0777	0.0000	-0.6350	0.0837	0.0000	0.0223	0.0971	0.8190
SWE	-0.7540	0.0839	0.0000	0.2403	0.0842	0.0040	-0.5907	0.0815	0.0000	-0.3556	0.0856	0.0000	-0.4803	0.1163	0.0000
gender_male	-0.0114	0.0379	0.7650	-0.0243	0.0411	0.5540	0.0403	0.0364	0.2680	0.0022	0.0407	0.9570	0.1049	0.0542	0.0530
married	0.2029	0.0391	0.0000	0.1487	0.0419	0.0000	0.1053	0.0381	0.0060	-0.0144	0.0427	0.7350	-0.0176	0.0570	0.7580
income	0.0723	0.0380	0.0570	0.0612	0.0414	0.1400	0.1032	0.0362	0.0040	0.1011	0.0405	0.0130	0.0617	0.0532	0.2460
age_class_1	-0.0899	0.0810	0.2670	-0.3773	0.0874	0.0000	-0.3285	0.0821	0.0000	0.0833	0.0877	0.3420	0.3723	0.1128	0.0010
age_class_2	0.1266	0.0619	0.0410	-0.2726	0.0681	0.0000	-0.1682	0.0592	0.0040	-0.1038	0.0654	0.1130	0.1770	0.0859	0.0390
age_class_3	0.0639	0.0587	0.2770	-0.1672	0.0660	0.0110	-0.1129	0.0562	0.0450	-0.1026	0.0618	0.0970	0.0009	0.0832	0.9910
age_class_4	0.1449	0.0589	0.0140	-0.0977	0.0659	0.1390	0.0273	0.0557	0.6240	-0.0758	0.0615	0.2180	0.0953	0.0815	0.2430
edu_1	-0.1502	0.0859	0.0800	-0.1160	0.0921	0.2080	-0.0030	0.0802	0.9700	-0.0440	0.0898	0.6240	0.0328	0.1189	0.7820
edu_2	-0.0103	0.0706	0.8840	-0.0702	0.0767	0.3600	-0.0342	0.0657	0.6030	-0.0689	0.0731	0.3460	-0.0435	0.0939	0.6430
edu_3	-0.0925	0.0670	0.1670	-0.1408	0.0731	0.0540	-0.0976	0.0634	0.1240	-0.0833	0.0705	0.2370	-0.1111	0.0915	0.2250
edu_4	-0.1093	0.0623	0.0800	-0.1053	0.0687	0.1250	-0.0603	0.0592	0.3080	-0.0506	0.0661	0.4440	-0.0141	0.0818	0.8630
empl_fulltime	-0.0758	0.0613	0.2160	0.0585	0.0681	0.3900	-0.0479	0.0580	0.4090	0.1661	0.0645	0.0100	0.1149	0.0886	0.1950
empl_leave	0.0257	0.1340	0.8480	-0.0137	0.1382	0.9210	0.1299	0.1229	0.2900	0.1840	0.1348	0.1720	0.1308	0.1842	0.4780
empl_parttime	-0.1861	0.0736	0.0110	0.0760	0.0821	0.3540	-0.0910	0.0711	0.2000	0.1032	0.0783	0.1880	0.2270	0.1051	0.0310
occup_executive	0.0535	0.0723	0.4600	0.0675	0.0779	0.3860	0.2515	0.0688	0.0000	0.1357	0.0762	0.0750	0.3554	0.1038	0.0010
occup_professionals	0.0650	0.0743	0.3820	-0.0087	0.0800	0.9140	0.1750	0.0714	0.0140	0.1208	0.0794	0.1280	0.2830	0.1067	0.0080
occup_salaried	-0.0066	0.0610	0.9140	-0.0078	0.0649	0.9040	0.1151	0.0585	0.0490	0.0591	0.0653	0.3650	0.0716	0.0926	0.4390
occup_selfemployed	0.1458	0.0833	0.0800	0.0546	0.0904	0.5450	0.1672	0.0787	0.0340	0.1827	0.0858	0.0330	0.1523	0.1178	0.1960
type_house	0.3104	0.0417	0.0000	0.2757	0.0441	0.0000	0.4725	0.0401	0.0000	0.4200	0.0444	0.0000	0.3812	0.0611	0.0000
area_urban	0.0045	0.0459	0.9220	-0.1175	0.0504	0.0200	-0.1470	0.0433	0.0010	-0.0963	0.0464	0.0380	-0.2557	0.0588	0.0000
policy_TOU	0.0519	0.0397	0.1910	0.0287	0.0426	0.5000	0.1027	0.0376	0.0060	0.1464	0.0413	0.0000	0.2175	0.0555	0.0000
_cons	0.5143	0.1288	0.0000	0.4789	0.1360	0.0000	-0.0672	0.1213	0.5790	-0.6746	0.1328	0.0000	-1.5476	0.1751	0.0000

Notes:

1. empl_homemaker dropped because of collinearity
2. empl_retired dropped because of collinearity

APPENDIX D: Alternative analysis

D.1. Multivariate and Univariate Probit Evaluation of the Effects of Individual, Household and Policy Variable on Measures and Investments

The results from the multivariate and univariate binary probit estimation are provided Table D1 to D5. The multivariate probit provides a good estimate for this model – there is evidence of relation between the measures and investments activities considered in this paper. The hypothesis that the 45 off-diagonal coefficients of the variance-covariance matrix are equal to 0 is rejected, with chi2(45)=1547.31, at less than 1% (Table D3). This explains the slight differences in the coefficients obtained from multivariate and univariate probit model; however, the effect of the variables on measures and investments is generally consistent, with the following discrepancies:

(a) A negative effect is observed for multivariate probit on the effect that being on leave (Empl_leave) has on the likelihood of turning the lights off when not in use (Measure_lights) and installing renewable energy equipment (Renewable_energy), whereas a positive effect is observed when using the univariate probit model. The same inconsistency is observed for the effect that being from country Mexico has on the likelihood of cutting down on heating or air conditioning (Measure_heating). On the other hand, being self-employed (Occup_selfemployed) is shown to have a positive effect on renewable energy using univariate probit and a negative effect using multivariate probit. A similar inconsistency is observed for the effects of working part-time (Empl_parttime) on the likelihood of turning appliances to standby when not in use (Measure_standby), and in the effects of being self-employed (Occup_selfemployed) on

the installation of renewable energy equipment (Renewable_energy). Nevertheless, all these coefficients are insignificant and do not pose a concern for this analysis.

(b) Another difference observed between the multivariate probit and univariate probit results, is the significance of results under one of the models and insignificance in the other. For example, the effect of being between 45 and 54 years old (Age_class_4) on the likelihood of turning appliances to standby when not in use (Measure_standby) is insignificant under the multivariate probit model, but significant under the univariate probit. This demonstrates that this variable alone does not impact the specific decision to partake in this measure. The same discrepancy is observed on the effect that being male (Gender_male) has on the likelihood of turning off appliances when not in use (Measure_appliances), and the effects of having income higher than $54,700 a year (Income) has on the likelihood of installing efficient heating boiler. Moreover, we observe that being self-employed (Occup_selfeployed) has a significant effect on the likelihood of installing efficient light bulbs (Efficient_bulbs) under the multivariate probit and an insignificant effect when using the univariate probit model. The same is observed for the effects of living in an urban area (Area_urban) on the likelihood of a household waiting for a full-load before using the washing machine (Measure_full_load).

Moreover, being a homemaker (Empl_homemaker), being on leave (Empl_leave), being a manual worker (Occup_manualworker) were dropped due to colinearity of results. The following sections describe the effects of individual, household and altitudinal factors on energy saving measures and investments and renewable energy implementation, considering only statistically significant results.

D.2. Country Specific Characteristics

Households in Korea are more likely to turn the lights off when leaving the room (Measure_lights) more than households in Sweden and Norway, but less likely than in any other participating country. In addition, households in Korea are more likely to cut down on heating/AC (Measure_heating) as an energy saving measure than are households in Sweden and Norway, but less likely to wait for a full load before using the washer/dryer (Measure_full_load) and turn-off appliances when not in use (Measure_appliances) than any other participating country. Turning the appliances to standby when not in use (Measure_standby) is a measure more likely to be implemented in Netherlands, Mexico, Italy and Norway.

Country specific effects are also observed in the level of energy saving investments. We observe that households in Czech Republic are more likely to invest in energy efficient appliances (Efficient_appliances) than households in Korea; countries such as Canada, Mexico, Sweden, Norway, and Australia are less likely to do so. Furthermore, the use of energy efficient bulbs (Efficient_bulbs) is less likely to be employed in households in Korea than households in any other participating country. These results are supported by the analysis of the OECD (2011) study. Thermal insulation (Efficient_insulation) and installation of efficient heating boiler (Efficient_heating) are investments more likely to be implemented in households in Netherlands than in Korea and any other country; all other participating countries are less likely to partake in these investments. Moreover, installation of renewable energy equipment (Renewable_energy) is more likely to occur in households in Korea. It is interesting to note that while all coefficient values are negative for the renewable energy variable, there are significant differences between countries. For example, Mexico (coefficient of -1.0811) is less likely than all other countries to install renewable energy equipment. To summarize, there is evidence suggesting that there are

country specific factors that affect the level of households partaking in energy saving measures and investments. This could be due to many different factors such as cultural and educational factors, policy, energy prices, or weather conditions; however the exact cause of these differences is difficult to determine without further evidence.

D.3. Individual and Household Characteristics

Male participants are less likely than females to turn off lights when leaving the room (Measure_lights), wait for a full load before using the washer/dryer (Measure_full_load), and turn the appliances to standby when not in use (Measure_standby). Generally, being married or living as a couple has a positive effect on the adaptation of energy conserving measures and investments. Participants that were married or living as a couple were more likely to turn the lights off when leaving the room (Measure_lights), cut down on heating/AC (Measure_heating), wait for a full load before using the washer/dryer (Measure_full_load), invest in energy efficient appliances (Efficient_appliances), use of energy efficient bulbs (Efficient_bulbs). We also observe participants between ages 45 and 54 (Age_class_4) are more likely to turn off appliances when not in use (Measure_appliances), wait for a full load before using washing machine/dishwasher (Measure_full_load), invest in energy efficient appliances (Efficient_appliances) and thermal insulation (Efficient_insulation).

Having a household income higher than $54,700 negatively influences the likelihood of a household to turn off lights when leaving the room (Measure_lights), and turning the appliances to standby when not in use (Measure_standby); however a positive effect is observed on installation of thermal insulation (Efficient_insulation). Looking at the coefficient, including the statistically insignificant ones, we observe that generally higher incomes would allow people to invest on energy saving measures, while low incomes would sway households towards more

simple energy saving measures. Employment (full-time, part-time, or on leave) is generally insignificant across the equations. We observe that being employed full-time has a negative effect on the likelihood of turning-off appliances when not in use (Measure_appliances), and investing in energy efficient appliances (Efficient_insulation). Being employed part-time has a negative effect on the likelihood of households turning-off lights when leaving the room (Measure_lights), investing in energy efficient appliances (Efficient_insulation) and positive on installation of renewable energy equipment (Renewable_energy). Moreover, being on leave has a positive effect on a household investing in energy efficient appliances (Efficient_appliances). As we can see these results do not exhibit a specific pattern making it difficult to infer behaviour. On the other hand, occupation, whether being a professional, executive or self-employed has a negative impact on energy saving measures and a positive effect on energy saving investments. Specifically, professionals are less likely to wait for a full load before using the washing machine or dishwasher (Measure_full_load) and more likely to invest in efficient appliances (Efficient_appliances), thermal insulation (Efficient_insulation), efficient heating (Efficient_heating), and renewable energy (Renewable_energy). Executives are less likely to turn-off lights when leaving the room (Measure_lights), waiting for a full load before using the washing machine or dishwasher (Measure_full_load), and turning-off appliances when not in use (Measure_appliances), but more likely to invest in efficient light bulbs (Efficient_bulbs), thermal insulation (Efficient_insulation), efficient heating (Efficient_heating), and renewable energy (Renewable_energy). Likewise, self-employed participants are less likely to turn-off appliances when not in use (Measure_appliances) and more likely to invest in thermal insulation (Efficient_insulation).

Residence and household location coefficients are mainly statistically insignificant and do not exhibit a specific pattern; nevertheless the findings of statistically significant effects are worth noting. Participants living in a house are more likely to wait for a full load before using the washer/dryer (Measure_full_load), and more likely to invest in all five investment types. Households in rural areas are more likely to turn-off appliances (Measure_appliances) and switch equipment to standby mode when not in use (Measure_standby); while households in urban areas are less likely to invest in renewable energy (Renewable_energy).

D.4. Time-of-Use Policy

The effects of varying electricity pricing (Policy_timeofuse) are statistically insignificant in five of the equations, and it can be inferred that TOU policy does not impact these decisions. In the statistically significant equations, varying electricity prices encourage energy saving measures and investments. This analysis shows that having varying electricity pricing increases the likelihood of a household investing in thermal insulation (Efficient_insulation), efficient heating boiler (Efficient_heating), and renewable energy (Renewable_energy). Moreover, we observe that TOU pricing has a positive impact on participants turning-off appliances (Measure_appliances) and switching equipment to standby mode when not in use (Measure_standby).

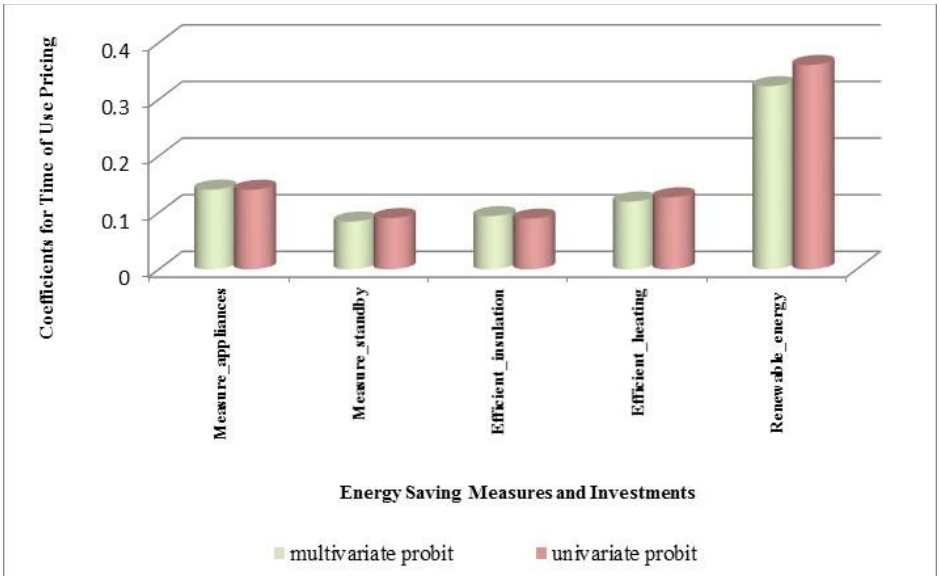

Figure D1. Effects of varying electricity pricing on energy saving measures and investments using the multivariate and univariate probit model.

Table D1. Multivariate binary probit estimation results for energy efficient measures for alternative analysis. Statistically insignificant results are marked in red.

	Measure_lights			Measure_heating			Measure_full_load			Measure_appliances			Measure_standby		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coef.	Std. Err.	P>z
Canada	0.5883	0.1808	0.0010	-0.0041	0.1466	0.9780	0.5251	0.1577	0.0010	0.7202	0.1580	0.0000	0.0329	0.1263	0.7940
Netherlands	0.1953	0.1562	0.2110	-0.2121	0.1390	0.1270	0.7712	0.1598	0.0000	0.7771	0.1528	0.0000	0.4819	0.1263	0.0000
France	0.9711	0.1884	0.0000	-0.0554	0.1387	0.6890	0.7293	0.1509	0.0000	0.5341	0.1422	0.0000	0.1646	0.1217	0.1760
Mexico	1.2150	0.2027	0.0000	-0.0528	0.1375	0.7010	0.0513	0.1342	0.7020	0.9500	0.1518	0.0000	0.7311	0.1244	0.0000
Italy	0.5542	0.1463	0.0000	0.0652	0.1278	0.6100	0.7705	0.1330	0.0000	0.5420	0.1254	0.0000	0.2396	0.1102	0.0300
Czech_Republic	0.3535	0.1812	0.0510	-0.0538	0.1516	0.7230	0.5942	0.1684	0.0000	0.3806	0.1548	0.0140	-0.1663	0.1333	0.2120
Sweden	-0.6116	0.1605	0.0000	-1.1606	0.1521	0.0000	0.1377	0.1624	0.3960	0.1895	0.1562	0.2250	0.1787	0.1407	0.2040
Norway	-0.3750	0.1488	0.0120	-0.5702	0.1366	0.0000	0.5467	0.1497	0.0000	0.3863	0.1404	0.0060	0.3236	0.1235	0.0090
Australia	0.6033	0.1695	0.0000	-0.1090	0.1402	0.4370	0.4965	0.1492	0.0010	0.1094	0.1360	0.4210	-0.2497	0.1223	0.0410
Gender_male	-0.0917	0.0744	0.2180	-0.0969	0.0550	0.0780	-0.3151	0.0696	0.0000	-0.0807	0.0635	0.2040	-0.1065	0.0504	0.0350
Status_married	0.1499	0.0770	0.0510	0.1311	0.0582	0.0240	0.1379	0.0691	0.0460	0.0629	0.0664	0.3440	0.0169	0.0539	0.7540
Income	-0.1469	0.0724	0.0420	-0.0688	0.0542	0.2040	0.0016	0.0656	0.9810	-0.0123	0.0623	0.8440	-0.1650	0.0500	0.0010
Age_class_2	-0.0197	0.1053	0.8520	-0.0650	0.0798	0.4150	-0.0902	0.0930	0.3320	-0.1973	0.0894	0.0270	-0.0659	0.0740	0.3730
Age_class_3	0.0289	0.0980	0.7680	0.0240	0.0760	0.7530	0.1132	0.0920	0.2180	0.0136	0.0862	0.8750	0.0566	0.0702	0.4200
Age_class_4	0.1304	0.1012	0.1970	0.1127	0.0766	0.1420	0.3003	0.0984	0.0020	0.2077	0.0915	0.0230	0.1076	0.0705	0.1270
Edu_class_2	0.0369	0.1391	0.7910	-0.0210	0.0972	0.8290	0.0783	0.1246	0.5300	-0.0764	0.1130	0.4990	-0.0315	0.0894	0.7250
Edu_class_3	-0.0361	0.1415	0.7990	0.0764	0.0996	0.4430	0.1426	0.1257	0.2570	-0.1128	0.1147	0.3250	-0.0002	0.0914	0.9980
Edu_class_4	0.0221	0.1465	0.8800	0.0706	0.1054	0.5030	0.1479	0.1317	0.2620	-0.0087	0.1219	0.9430	0.0522	0.0971	0.5910
Edu_class_5	0.0462	0.1626	0.7760	0.0042	0.1161	0.9710	0.1446	0.1428	0.3110	0.1338	0.1368	0.3280	-0.0443	0.1079	0.6820
Empl_fulltime	-0.1366	0.1104	0.2160	0.0517	0.0811	0.5240	-0.1252	0.1029	0.2240	-0.1686	0.0968	0.0810	-0.0705	0.0757	0.3510
Empl_parttime	-0.2328	0.1359	0.0870	0.0946	0.1031	0.3590	-0.1576	0.1273	0.2160	-0.1334	0.1200	0.2660	0.0151	0.0952	0.8740
Empl_retired	Dropped due to collinearity of results														
Empl_homemaker	Dropped due to collinearity of results														
Empl_leave	-0.0241	0.2679	0.9280	-0.1378	0.1825	0.4500	0.4979	0.3928	0.2050	-0.0606	0.2320	0.7940	-0.0370	0.1787	0.8360
Occup_professional	-0.0386	0.1040	0.7100	0.0408	0.0780	0.6010	-0.1830	0.0932	0.0500	-0.1081	0.0897	0.2280	0.0753	0.0721	0.2960
Occup_executive	-0.2186	0.0932	0.0190	-0.0235	0.0717	0.7430	-0.3099	0.0852	0.0000	-0.2061	0.0818	0.0120	0.0597	0.0666	0.3700
Occup_selfemployed	-0.0796	0.1272	0.5310	-0.0092	0.0956	0.9240	-0.0620	0.1171	0.5960	-0.3064	0.1014	0.0030	-0.1043	0.0870	0.2310
Occup_manualworker	Dropped due to collinearity of results														
Restype_house	-0.0658	0.0840	0.4340	0.0646	0.0634	0.3080	0.3070	0.0749	0.0000	0.0244	0.0714	0.7330	-0.0249	0.0581	0.6680
Area_rural	0.0705	0.0957	0.4610	0.0894	0.0729	0.2200	0.1144	0.0950	0.2280	0.1499	0.0857	0.0800	0.1933	0.0672	0.0040
Area_urban	-0.0868	0.0821	0.2910	0.0539	0.0619	0.3840	0.1322	0.0746	0.0770	0.0124	0.0706	0.8600	0.0186	0.0568	0.7430
Policy_timeofuse	-0.0923	0.0761	0.2250	0.0289	0.0562	0.6060	-0.1069	0.0691	0.1220	0.1407	0.0647	0.0300	0.0842	0.0512	0.1000
_cons	1.2983	0.2128	0.0000	0.6949	0.1691	0.0000	0.6583	0.1946	0.0010	0.7995	0.1819	0.0000	0.1768	0.1513	0.2430

Table D2. Multivariate binary probit estimation results for energy efficient investments for alternative analysis. Statistically insignificant results are marked in red.

	Efficient_applicances			**Efficient_bulbs**			**Efficient_insulation**			**Efficient_heating**			**Renewable_energy**		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
Canada	-0.2554	0.1414	0.0710	0.5979	0.1462	0.0000	-0.2413	0.1285	0.0600	-0.3880	0.1319	0.0030	-0.6839	0.1744	0.0000
Netherlands	-0.0464	0.1392	0.7390	0.2309	0.1326	0.0820	0.3434	0.1283	0.0070	0.8851	0.1283	0.0000	-0.8570	0.1803	0.0000
France	-0.0530	0.1379	0.7010	0.1886	0.1320	0.1530	0.0340	0.1248	0.7850	-0.6716	0.1295	0.0000	-0.7938	0.1685	0.0000
Mexico	-0.3753	0.1334	0.0050	0.6170	0.1347	0.0000	-1.0708	0.1243	0.0000	-1.3501	0.1441	0.0000	-1.0811	0.1728	0.0000
Italy	-0.0745	0.1242	0.5490	0.9012	0.1252	0.0000	-0.0869	0.1116	0.4360	-0.4259	0.1151	0.0000	-0.3149	0.1390	0.0230
Czech_Republic	0.4046	0.1670	0.0150	0.7038	0.1590	0.0000	-0.0244	0.1354	0.8570	-0.8655	0.1534	0.0000	-0.8400	0.2099	0.0000
Sweden	-0.7476	0.1511	0.0000	0.2225	0.1528	0.1450	-0.5809	0.1433	0.0000	-0.1021	0.1448	0.4810	-0.6986	0.2099	0.0010
Norway	-0.4791	0.1352	0.0000	0.4226	0.1370	0.0020	-0.5348	0.1237	0.0000	-0.6215	0.1297	0.0000	0.0731	0.1496	0.6250
Australia	-0.2387	0.1376	0.0830	0.3671	0.1361	0.0070	-0.1787	0.1251	0.1530	-0.3698	0.1274	0.0040	-0.4744	0.1544	0.0020
Gender_male	-0.0258	0.0551	0.6400	0.0239	0.0603	0.6920	-0.0665	0.0509	0.1910	-0.0752	0.0559	0.1790	0.0099	0.0730	0.8920
Status_married	0.1674	0.0578	0.0040	0.1809	0.0622	0.0040	0.0517	0.0545	0.3430	-0.0418	0.0600	0.4860	-0.1046	0.0775	0.1770
Income	0.0715	0.0545	0.1890	0.0553	0.0600	0.3570	0.1316	0.0504	0.0090	0.0882	0.0556	0.1130	0.0770	0.0717	0.2830
Age_class_2	0.1235	0.0806	0.1250	-0.2279	0.0876	0.0090	-0.0501	0.0749	0.5040	-0.0453	0.0824	0.5820	0.0836	0.1054	0.4280
Age_class_3	0.1235	0.0759	0.1040	-0.1353	0.0845	0.1090	0.0332	0.0705	0.6380	-0.0215	0.0767	0.7790	0.0083	0.0989	0.9330
Age_class_4	0.1559	0.0771	0.0430	-0.0222	0.0867	0.7980	0.1470	0.0710	0.0380	-0.0309	0.0775	0.6900	0.0875	0.0985	0.3740
Edu_class_2	0.0644	0.1020	0.5270	0.1094	0.1082	0.3120	-0.0497	0.0919	0.5890	0.0820	0.1029	0.4260	-0.0327	0.1402	0.8150
Edu_class_3	-0.0565	0.1017	0.5790	-0.0706	0.1073	0.5100	-0.1058	0.0940	0.2600	0.1026	0.1031	0.3200	-0.0281	0.1419	0.8430
Edu_class_4	-0.0440	0.1079	0.6840	0.0065	0.1152	0.9550	-0.0942	0.0996	0.3440	0.0301	0.1097	0.7840	0.0173	0.1463	0.9060
Edu_class_5	0.0492	0.1205	0.6830	0.1079	0.1300	0.4070	-0.0250	0.1101	0.8200	0.1729	0.1216	0.1550	0.0330	0.1600	0.8370
Empl_fulltime	-0.0115	0.0825	0.8890	0.0347	0.0928	0.7080	-0.2224	0.0773	0.0040	0.1089	0.0833	0.1910	0.0637	0.1098	0.5620
Empl_parttime	-0.0473	0.1021	0.6430	0.1183	0.1154	0.3050	-0.3270	0.0959	0.0010	0.0968	0.1030	0.3470	0.2326	0.1326	0.0790
Empl_retired	Dropped due to collinearity of results														
Empl_homemaker	Dropped due to collinearity of results														
Empl_leave	0.3833	0.2205	0.0820	0.1173	0.2179	0.5900	0.0233	0.1811	0.8980	0.1552	0.1894	0.4120	-0.0266	0.2666	0.9210
Occup_professional	0.1379	0.0787	0.0800	0.1056	0.0860	0.2190	0.1362	0.0727	0.0610	0.1570	0.0790	0.0470	0.1708	0.0991	0.0850
Occup_executive	-0.0107	0.0722	0.8830	0.1753	0.0806	0.0300	0.1554	0.0677	0.0220	0.1793	0.0727	0.0140	0.2752	0.0936	0.0030
Occup_selfemployed	0.0671	0.0958	0.4840	0.1182	0.1081	0.2740	0.1595	0.0884	0.0710	0.1038	0.0955	0.2770	0.0041	0.1282	0.9740
Occup_manualworker	Dropped due to collinearity of results														
Restype_house	0.2308	0.0640	0.0000	0.2877	0.0680	0.0000	0.2953	0.0595	0.0000	0.2664	0.0650	0.0000	0.3617	0.0874	0.0000
Area_rural	-0.0281	0.0741	0.7050	0.1016	0.0824	0.2170	0.1017	0.0686	0.1380	0.1084	0.0719	0.1320	-0.0063	0.0911	0.9450
Area_urban	-0.0188	0.0621	0.7620	-0.0089	0.0677	0.8950	0.0102	0.0574	0.8590	-0.0739	0.0630	0.2410	-0.1811	0.0840	0.0310
Policy_timeofuse	0.0184	0.0565	0.7450	-0.0557	0.0614	0.3640	0.0939	0.0520	0.0710	0.1196	0.0565	0.0340	0.3233	0.0766	0.0000
_cons	0.5170	0.1684	0.0020	0.1337	0.1728	0.4390	0.2127	0.1543	0.1680	-0.6540	0.1639	0.0000	-1.4028	0.2150	0.0000

Table D3. rho values from multivariate binary probit model for alternative analysis.

	Coefficient	Std. Err.	z	P>z	[95% Conf.	Interval]		Coefficient	Std. Err.	z	P>z	[95% Conf.	Interval]
rho21	0.4426	0.0327	13.5500	0.0000	0.3764	0.5043	**rho103**	0.0182	0.0482	0.3800	0.7060	-0.0762	0.1122
rho31	0.4210	0.0375	11.2200	0.0000	0.3448	0.4918	**rho54**	0.5259	0.0270	19.4600	0.0000	0.4709	0.5768
rho41	0.4227	0.0337	12.5600	0.0000	0.3546	0.4863	**rho64**	0.1720	0.0332	5.1800	0.0000	0.1062	0.2363
rho51	0.3331	0.0324	10.2900	0.0000	0.2682	0.3950	**rho74**	0.1579	0.0356	4.4300	0.0000	0.0873	0.2268
rho61	0.1598	0.0357	4.4700	0.0000	0.0891	0.2290	**rho84**	0.1325	0.0316	4.1900	0.0000	0.0701	0.1938
rho71	0.0534	0.0392	1.3600	0.1730	-0.0236	0.1298	**rho94**	-0.0083	0.0355	-0.2300	0.8150	-0.0778	0.0612
rho81	0.1027	0.0344	2.9900	0.0030	0.0350	0.1696	**rho104**	-0.0354	0.0450	-0.7900	0.4310	-0.1232	0.0529
rho91	-0.0102	0.0369	-0.2800	0.7820	-0.0823	0.0620	**rho65**	0.0846	0.0304	2.7800	0.0050	0.0247	0.1439
rho101	-0.0608	0.0461	-1.3200	0.1870	-0.1503	0.0297	**rho75**	0.1631	0.0331	4.9300	0.0000	0.0977	0.2271
rho32	0.4010	0.0341	11.7500	0.0000	0.3320	0.4657	**rho85**	0.1080	0.0280	3.8500	0.0000	0.0528	0.1626
rho42	0.4481	0.0311	14.4000	0.0000	0.3851	0.5070	**rho95**	0.0754	0.0310	2.4300	0.0150	0.0143	0.1358
rho52	0.3521	0.0275	12.8200	0.0000	0.2972	0.4047	**rho105**	0.0748	0.0403	1.8500	0.0640	-0.0046	0.1532
rho62	0.1317	0.0312	4.2300	0.0000	0.0702	0.1922	**rho76**	0.1779	0.0339	5.2500	0.0000	0.1108	0.2434
rho72	0.0788	0.0343	2.3000	0.0220	0.0113	0.1457	**rho86**	0.3050	0.0276	11.0400	0.0000	0.2499	0.3581
rho82	0.1509	0.0293	5.1500	0.0000	0.0930	0.2078	**rho96**	0.2658	0.0315	8.4300	0.0000	0.2030	0.3264
rho92	0.0556	0.0319	1.7400	0.0820	-0.0071	0.1179	**rho106**	0.1503	0.0434	3.4700	0.0010	0.0644	0.2339
rho102	-0.0086	0.0407	-0.2100	0.8340	-0.0882	0.0712	**rho87**	0.2489	0.0311	8.0000	0.0000	0.1870	0.3088
rho43	0.4184	0.0352	11.8900	0.0000	0.3471	0.4849	**rho97**	0.1683	0.0347	4.8500	0.0000	0.0996	0.2354
rho53	0.2513	0.0332	7.5700	0.0000	0.1852	0.3152	**rho107**	0.1421	0.0454	3.1300	0.0020	0.0523	0.2296
rho63	0.1552	0.0352	4.4100	0.0000	0.0856	0.2233	**rho98**	0.3591	0.0284	12.6600	0.0000	0.3023	0.4134
rho73	0.0783	0.0381	2.0500	0.0400	0.0033	0.1524	**rho108**	0.3126	0.0379	8.2500	0.0000	0.2365	0.3849
rho83	0.1637	0.0333	4.9100	0.0000	0.0977	0.2282	**rho109**	0.3756	0.0363	10.3500	0.0000	0.3024	0.4444
rho93	0.0558	0.0364	1.5300	0.1250	-0.0157	0.1268							

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho81 = rho91 = rho101 = rho32 = rho42 = rho52 = rho62 = rho72 = rho82 = rho92 = rho102 = rho43 = rho53 = rho63 = rho73 = rho83 = rho93 = rho103 = rho54 = rho64 = rho74 = rho84 = rho94 = rho104 = rho65 = rho75 = rho85 = rho95 = rho105 = rho76 = rho86 = rho96 = rho106 = rho87 = rho97 = rho107 = rho98 = rho108 = rho109 = 0: **chi2(45) = 1547.31 Prob > chi2 = 0.0000**

Table D4. Univariate binary probit estimation results for energy efficient measures for alternative analysis. Statistically insignificant results are marked in red.

	Measure_lights			Measure_heating			Measure_full_load			Measure_appliances			Measure_standby		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coef.	Std. Err.	P>z
Canada	0.6651	0.1793	0.0000	0.0444	0.1452	0.7600	0.5325	0.1593	0.0010	0.7603	0.1593	0.0000	0.0290	0.1271	0.8200
Netherlands	0.2592	0.1551	0.0950	-0.1905	0.1375	0.1660	0.7821	0.1627	0.0000	0.7866	0.1543	0.0000	0.4515	0.1270	0.0000
France	0.9910	0.1866	0.0000	-0.0224	0.1371	0.8700	0.7348	0.1533	0.0000	0.5380	0.1436	0.0000	0.1466	0.1223	0.2310
Mexico	1.3339	0.2061	0.0000	0.0187	0.1362	0.8910	0.0894	0.1355	0.5100	1.0292	0.1560	0.0000	0.7481	0.1257	0.0000
Italy	0.5816	0.1427	0.0000	0.0928	0.1252	0.4580	0.7507	0.1325	0.0000	0.5519	0.1252	0.0000	0.2249	0.1104	0.0420
Czech_Republic	0.4338	0.1817	0.0170	-0.0214	0.1509	0.8870	0.6214	0.1711	0.0000	0.3917	0.1568	0.0130	-0.1908	0.1341	0.1550
Sweden	-0.5598	0.1578	0.0000	-1.1188	0.1501	0.0000	0.1112	0.1617	0.4920	0.2045	0.1567	0.1920	0.1726	0.1410	0.2210
Norway	-0.3280	0.1452	0.0240	-0.5384	0.1338	0.0000	0.5087	0.1491	0.0010	0.3589	0.1393	0.0100	0.3065	0.1235	0.0130
Australia	0.6434	0.1666	0.0000	-0.0858	0.1379	0.5340	0.5032	0.1504	0.0010	0.1286	0.1367	0.3470	-0.2738	0.1231	0.0260
Gender_male	-0.1178	0.0752	0.1170	-0.1009	0.0558	0.0700	-0.3154	0.0708	0.0000	-0.1103	0.0652	0.0900	-0.1263	0.0515	0.0140
Status_married	0.1770	0.0771	0.0220	0.1482	0.0587	0.0120	0.1858	0.0698	0.0080	0.1066	0.0678	0.1160	0.0307	0.0550	0.5760
Income	-0.1674	0.0733	0.0220	-0.0846	0.0550	0.1240	-0.0122	0.0668	0.8560	-0.0296	0.0638	0.6430	-0.1758	0.0509	0.0010
Age_class_2	-0.0621	0.1045	0.5530	-0.0595	0.0805	0.4600	-0.0804	0.0940	0.3920	-0.1857	0.0908	0.0410	-0.0306	0.0754	0.6850
Age_class_3	0.0485	0.0992	0.6250	0.0326	0.0769	0.6720	0.1314	0.0936	0.1600	0.0145	0.0881	0.8690	0.0630	0.0715	0.3780
Age_class_4	0.1568	0.1029	0.1280	0.1332	0.0778	0.0870	0.3285	0.1006	0.0010	0.2204	0.0935	0.0180	0.1239	0.0718	0.0850
Edu_class_2	-0.0350	0.1452	0.8100	-0.0455	0.0998	0.6480	0.0169	0.1291	0.8960	-0.1191	0.1184	0.3140	-0.0519	0.0917	0.5720
Edu_class_3	-0.0887	0.1469	0.5460	0.0666	0.1018	0.5130	0.1045	0.1303	0.4220	-0.1518	0.1200	0.2060	-0.0081	0.0934	0.9310
Edu_class_4	-0.0156	0.1523	0.9180	0.0633	0.1080	0.5580	0.1190	0.1364	0.3830	-0.0349	0.1277	0.7850	0.0230	0.0994	0.8170
Edu_class_5	0.0162	0.1689	0.9240	-0.0105	0.1187	0.9300	0.1114	0.1478	0.4510	0.1186	0.1431	0.4070	-0.0492	0.1101	0.6550
Empl_fulltime	-0.1475	0.1118	0.1870	0.0391	0.0824	0.6350	-0.1346	0.1047	0.1980	-0.1897	0.0990	0.0550	-0.0928	0.0772	0.2290
Empl_parttime	-0.2770	0.1364	0.0420	0.0555	0.1040	0.5940	-0.1884	0.1289	0.1440	-0.1646	0.1224	0.1790	-0.0295	0.0965	0.7600
Empl_retired	Dropped due to collinearity of results														
Empl_homemaker	Dropped due to collinearity of results														
Empl_leave	0.0710	0.2806	0.8000	-0.1210	0.1866	0.5170	0.6175	0.4184	0.1400	-0.0413	0.2429	0.8650	-0.0431	0.1802	0.8110
Occup_professional	-0.0683	0.1057	0.5180	0.0327	0.0788	0.6780	-0.1873	0.0949	0.0480	-0.1071	0.0918	0.2440	0.0642	0.0736	0.3830
Occup_executive	-0.2590	0.0937	0.0060	-0.0386	0.0725	0.5950	-0.3441	0.0866	0.0000	-0.2291	0.0832	0.0060	0.0453	0.0676	0.5020
Occup_selfemployed	-0.1223	0.1265	0.3340	-0.0132	0.0968	0.8910	-0.0851	0.1196	0.4770	-0.3200	0.1043	0.0020	-0.0966	0.0881	0.2730
Occup_salaried	Dropped due to collinearity of results														
Restype_house	-0.0968	0.0842	0.2510	0.0544	0.0642	0.3970	0.3002	0.0759	0.0000	0.0261	0.0729	0.7200	-0.0114	0.0591	0.8470
Area_rural	0.0564	0.0971	0.5620	0.0994	0.0741	0.1800	0.1115	0.0966	0.2480	0.1477	0.0876	0.0920	0.1947	0.0687	0.0050
Area_urban	-0.1041	0.0824	0.2060	0.0505	0.0624	0.4180	0.1063	0.0756	0.1600	0.0003	0.0718	0.9970	0.0145	0.0577	0.8010
Policy_timeofuse	-0.0651	0.0762	0.3930	0.0361	0.0568	0.5250	-0.1031	0.0702	0.1420	0.1404	0.0661	0.0340	0.0904	0.0521	0.0830
_cons	1.3541	0.2157	0.0000	0.6922	0.1688	0.0000	0.7038	0.1980	0.0000	0.8486	0.1864	0.0000	0.2210	0.1530	0.1490

Table D5. Univariate binary probit estimation results for energy efficient investments for alternative analysis. Statistically insignificant results are marked in red.

	Efficient_appliances			Efficient_bulbs			Efficient_insulation			Efficient_heating			Renewable_energy		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
Canada	-0.2302	0.1415	0.1040	0.6150	0.1466	0.0000	-0.2502	0.1287	0.0520	-0.3911	0.1323	0.0030	-0.5982	0.1748	0.0010
Netherlands	-0.0434	0.1390	0.7550	0.2248	0.1324	0.0900	0.3206	0.1286	0.0130	0.8700	0.1292	0.0000	-0.8557	0.1847	0.0000
France	-0.0545	0.1374	0.6920	0.1830	0.1314	0.1640	0.0327	0.1249	0.7930	-0.6717	0.1305	0.0000	-0.7301	0.1704	0.0000
Mexico	-0.3541	0.1329	0.0080	0.6057	0.1343	0.0000	-1.0720	0.1244	0.0000	-1.3444	0.1434	0.0000	-1.0516	0.1742	0.0000
Italy	-0.0535	0.1234	0.6650	0.9064	0.1250	0.0000	-0.0995	0.1113	0.3720	-0.4537	0.1154	0.0000	-0.2743	0.1402	0.0500
Czech_Republic	0.4459	0.1686	0.0080	0.7034	0.1587	0.0000	-0.0337	0.1363	0.8050	-0.9240	0.1563	0.0000	-0.8224	0.2128	0.0000
Sweden	-0.7487	0.1500	0.0000	0.2068	0.1525	0.1750	-0.5893	0.1426	0.0000	-0.1176	0.1448	0.4170	-0.6349	0.2097	0.0020
Norway	-0.4774	0.1346	0.0000	0.4220	0.1368	0.0020	-0.5445	0.1237	0.0000	-0.6356	0.1305	0.0000	0.1224	0.1525	0.4220
Australia	-0.2475	0.1368	0.0700	0.3545	0.1356	0.0090	-0.1931	0.1249	0.1220	-0.3740	0.1276	0.0030	-0.4235	0.1561	0.0070
Gender_male	-0.0267	0.0552	0.6280	0.0159	0.0604	0.7930	-0.0676	0.0513	0.1870	-0.0719	0.0564	0.2020	0.0146	0.0738	0.8430
Status_married	0.1754	0.0579	0.0020	0.1849	0.0624	0.0030	0.0602	0.0547	0.2710	-0.0335	0.0604	0.5790	-0.0897	0.0781	0.2510
Income	0.0639	0.0546	0.2420	0.0623	0.0603	0.3010	0.1249	0.0508	0.0140	0.0980	0.0562	0.0810	0.0701	0.0724	0.3330
Age_class_2	0.1280	0.0806	0.1120	-0.2244	0.0875	0.0100	-0.0466	0.0752	0.5350	-0.0575	0.0827	0.4870	0.1250	0.1057	0.2370
Age_class_3	0.1183	0.0762	0.1200	-0.1309	0.0848	0.1230	0.0317	0.0711	0.6560	-0.0280	0.0775	0.7180	0.0114	0.1008	0.9100
Age_class_4	0.1587	0.0772	0.0400	-0.0219	0.0869	0.8010	0.1505	0.0715	0.0350	-0.0368	0.0783	0.6380	0.0897	0.1006	0.3720
Edu_class_2	0.0555	0.1032	0.5900	0.1129	0.1091	0.3000	-0.0427	0.0934	0.6480	0.1007	0.1052	0.3380	-0.0064	0.1424	0.9640
Edu_class_3	-0.0602	0.1023	0.5560	-0.0775	0.1077	0.4720	-0.1053	0.0952	0.2690	0.1128	0.1052	0.2840	-0.0188	0.1442	0.8960
Edu_class_4	-0.0581	0.1087	0.5930	0.0000	0.1157	1.0000	-0.0965	0.1009	0.3390	0.0480	0.1120	0.6680	0.0380	0.1484	0.7980
Edu_class_5	0.0406	0.1214	0.7380	0.1026	0.1307	0.4330	-0.0222	0.1115	0.8420	0.1941	0.1238	0.1170	0.0462	0.1621	0.7760
Empl_fulltime	-0.0209	0.0828	0.8000	0.0302	0.0931	0.7460	-0.2311	0.0778	0.0030	0.1341	0.0846	0.1130	0.0936	0.1128	0.4070
Empl_parttime	-0.0627	0.1023	0.5400	0.1046	0.1159	0.3670	-0.3510	0.0966	0.0000	0.1203	0.1042	0.2480	0.2719	0.1357	0.0450
Empl_retired	Dropped due to collinearity of results														
Empl_homemaker	Dropped due to collinearity of results														
Empl_leave	0.4023	0.2215	0.0690	0.1427	0.2196	0.5160	0.0439	0.1844	0.8120	0.2384	0.1916	0.2140	0.0392	0.2713	0.8850
Occup_professional	0.1311	0.0788	0.0960	0.1067	0.0865	0.2170	0.1465	0.0732	0.0450	0.1559	0.0798	0.0510	0.1596	0.1007	0.1130
Occup_executive	-0.0175	0.0722	0.8090	0.1645	0.0805	0.0410	0.1440	0.0680	0.0340	0.1638	0.0736	0.0260	0.2703	0.0950	0.0040
Occup_selfemployed	0.0722	0.0967	0.4550	0.1399	0.1090	0.1990	0.1737	0.0898	0.0530	0.1020	0.0970	0.2930	-0.0061	0.1304	0.9630
Occup_salaried	Dropped due to collinearity of results														
Restype_house	0.2421	0.0641	0.0000	0.2952	0.0682	0.0000	0.2995	0.0597	0.0000	0.2469	0.0652	0.0000	0.3201	0.0879	0.0000
Area_rural	-0.0179	0.0746	0.8110	0.0962	0.0826	0.2440	0.1017	0.0694	0.1430	0.1095	0.0728	0.1330	-0.0289	0.0934	0.7570
Area_urban	-0.0172	0.0621	0.7820	-0.0105	0.0679	0.8770	0.0094	0.0577	0.8710	-0.0706	0.0636	0.2680	-0.1498	0.0843	0.0760
Policy_timeofuse	0.0101	0.0567	0.8590	-0.0625	0.0615	0.3100	0.0894	0.0524	0.0880	0.1270	0.0570	0.0260	0.3608	0.0774	0.0000
_cons	0.5219	0.1686	0.0020	0.1431	0.1726	0.4070	0.2284	0.1549	0.1410	-0.6714	0.1663	0.0000	-1.5011	0.2189	0.0000

REFERENCES

Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *Journal of Economic Psychology*, *30*, 711-720.

Albadi, M. H., & El-Saadany, E. F. (2008). A summary of demand response in electricity markets. *Electric Power Systems Research, 78,* 1989-1996.

Alexander, B. R. (2010). Dynamic Pricing? Not So Fast! A Residential Consumer Perspective. *The Electricity Journal*, *23*(6), 39-49. doi:/10.1016/j.tej.2010.05.014

Axelrod, L. J. & Lehman, D. R. (1993). Responding to environmental concerns: What factors guide individual actions? *Journal of Environmental Psychology, 13,* 149-159.

Baladi, S. M., Herriges, J. A., & Sweeney, T. J. (1998). Residential response to voluntary time-of-use electricity rates. *Resource and Energy Economics, 20*, 255-244.

Bang, K.-H., Ellinger, E. A., Hadjimarcou, J., & Traichal, A. P. (2000). Consumer concern, knowledge, belief, and attitude towards renewable energy: An application of the reasoned action theory. *Psychology & Marketing*, *17*, 449–468.

Barr, S., Gilg, A.W., & Ford, N. (2005). The household energy gap: examining the divide between habitual-and purchase-related conservation behaviour. *Energy Policy, 33*, 1425–1444.

Berkhout, P. H. G., Ferrer-i-Carbonell, A., & Muskens, J. S. (2004), "The ex post impact of an energy tax on household energy demand", *Energy Economics*, *26*(3), pp. 297-317.

Borenstein, S. (2013). Effective and equitable adoption of opt-in residential dynamic electricity pricing. *Review of Industrial Organization, 42*, 127-160.

Cappellari, L., & Jenkins, S. P. (2003). Multivariate probit regression using simulated maximum likelihood. *The Stata Journal, 3*, 278-294.

Cayla, J. M., Maizi, N., & Marchand, C. (2011). The role of income in energy consumption behavior: Evidence from French households data. *Energy Policy, 39*, 7874-7883.

Chao, H. (2010). Price-responsive demand management for a smart grid world. *The Electricity Journal, 23*, 7-20. doi:/10.1016/j.tej.2009.12.007

Clark, C. F., Kotchen, M. J., & Moore, M. R. (2003). Internal and external influences on pro-environmental behavior: Participation in a green electricity program. *Journal of Environmental Psychology, 23*, 237–246.

Cochell, J. E., Schwarz, P. M., & Taylor, T. N. (2012). Using real-time electricity data to estimate response to time-of-use and flat rates: an application to emissions. *Journal of Regulatory Economics, 42*, 135-158.

Curtis, F. A., Simpson-Housley, P., & Drever, S. (1984). Communications on energy: Household energy conservation. *Energy Policy, 12*, 452–456.

Dietz, T., Gardner, G.T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings for the National Academy of Sciences, 106*(44), 18452-18456. doi: 10.1073/pnas.0908738106

Environmental Commissioner of Ontario (ECO). (2014). *2014 Annual Energy Conservation Progress Report. Planning to Conserve*. ECO Publishing. Retrieved February 8, 2015 from http://www.eco.on.ca/uploads/Reports-Energy-Conservation/2014/2014%20Energy%20Conservation%20Report%20Final.pdf

Faruqui, A., & Sergici, S. (2010). Household response to dynamic pricing of electricity: a survey of 15 experiments. *Journal of Regulatory Economics, 38,* 193-225.

Ferrara, I., & Missios, P. (2012). A Cross-Country Study of Household Waste Prevention and Recycling: Assessing the Effectiveness of Policy Instruments. *Land Economics, 88(4),* 710-744.

Gatersleben, B., Steg, L., & Vlek, C. (2002). Measurement and determinants of environmentally significant consumer behavior. *Environment and Behavior, 34,* 335-362.

Herter, K. (2007). Residential implementation of critical-peak pricing of electricity. *Energy Policy, 35,* 2121-2130.

International Energy Agency (IEA). (2011). *G-20 Clean Energy, and Energy Efficiency Deployment and Policy Progress.* Paris: IEA Publishing. Retrieved March 15, 2015 from http://www.iea.org/publications/freepublications/publication/G20_paper.pdf

International Energy Agency (IEA). (2012). *Electricity Information 2012*. Paris: IEA Publishing. Retrieved March 15, 2015 from http://www.iea.org/media/training/presentations/statisticsmarch/ElectricityInformation.pdf

John, A. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy Economics, 22,* 615–625.

Kalafatis, P. S., Pollard, M., East, R., & Tsogas, H. M. (1999). Green marketing and Ajzen's theory of planned behavior: A cross-market examination. J*ournal of Consumer Marketing, 16,* 441–460.

Kallbekken, S., Saelen, H., & Hermansen, E. A. T. (2013). Bridging the energy efficiency gap: A field experiment on lifetime energy costs and household appliances. *Journal of Consumer Policy, 36*, 1-16.

Kelly, G. (2012). Sustainability at home: Policy measures for energy-efficient appliances. *Renewable and Sustainable Energy Reviews, 16*, 6851-6860.

Kim, Y., & Choi, M. S. (2005). Antecedents of Green Purchase Behavior: An examination of collectivism, environmental concern and PCE. *Advances in Consumer Research*, *32*, 592–599.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*, 239–260.

Levine, M., Ürge-Vorsatz, D., Blok, K., Geng, L., Harvey, D., Lang, S., Levermore, G., Mongameli A. M., Mirasgedis, S., Novikova, A., Rilling, J., Yoshino, H. (2007). Residential and commercial buildings. In E. Jochem & H. Xu (Eds.), *Climate Change 2007: Working Group III: Mitigation of Climate Change*. Cambridge and New York: Cambridge University Press.

Long, J.E. (1993). An econometric analysis of residential expenditures on energy conservation and renewable energy sources. *Energy Economics*, *15*(4), pp 232–238.

Michaelis, L. (2003). Sustainable consumption and greenhouse gas mitigation. *Climate Policy*, 3S1, S135-S146.

Mostafa, M. M. (2007). A hierarchical analysis of the green consciousness of the Egyptian consumer. *Psychology & Marketing*, *24*, 445–473.

Muratori, M., Schuelke-Leech, B., & Rizzoni, G. (2014). Role of residential demand response in modern electricity markets. *Renewable and Sustainable Energy Reviews*, *33*, 546-553.

Nair, G., Gustavsson, L., & Mahapatra, K. (2010). Factors influencing energy efficiency investments in existing swedish residential buildings. *Energy Policy*, *38*, 2956–2963.

Natural Resources Canada (NRCan). (2010). *Energy Efficiency Trends in Canada 1990 to 2007*. Ottawa: NRCan Publishing. Retrieved February 7, 2015 from http://oee.nrcan.gc.ca/publications/statistics/trends09/pdf/trends.pdf

Nesbakken, R. (1999). Price sensitivity of residential energy consumption in Norway. *Energy Economics*, *21*, 493–515.

Newsham, G. R., & Donnelly, C. I. (2013). A model of residential energy end-use in Canada: Using conditional demand analysis to suggest policy options for community energy planners. *Energy Policy*, *59*, 133-142.

OECD/IEA. (2001). *An Initial View on Methodologies for Emission Baselines: Energy Efficiency Case Study*. Paris: OECD Environment Directorate. Retrieved March 15, 2015 from http://www.oecd.org/env/cc/2002529.pdf

OECD. (2008 a). (2008). *OECD Household Survey on Environmental Attitudes and Behaviour: Data Corroboration*. Retrieved December 16, 2014 from http://www.oecd.org/greengrowth/consumption-innovation/44101274.pdf

OECD. (2008 b). *Household Behaviour and the Environment: Reviewing the Evidence*. Paris: OECD Publishing. Retrieved March 15, 2015 from http://www.oecd.org/environment/consumption-innovation/42183878.pdf

OECD. (2011). *Greening Household Behaviour: The Role of Public Policy*. Paris: OECD Publishing. doi: 10.1787/9789264096875-en

Omer, A. M. (2008). Energy, environment and sustainable development. *Science Direct*, *12*, 2265-2300.

Ontario Energy Board (OEB). (2014). *Electricity Prices*. Retrieved October 6, 2014 from http://www.ontarioenergyboard.ca/OEB/Consumers/Electricity/Electricity+Prices

O'Neill, B. C., & Chen, B. S. (2002). Demographic determinants of household energy use in the United States. *Population and Development Review*, *28*, 53–88.

Poortinga, W., Steg, L, & Vlek, C. (2004). Values, Environmental Concern, and Environmental Behaviour. A study into household energy use. *Environment and Behaviour*, *36*, 70-93.

Poortinga, W.; Steg, L.; Vlek, C.; Wiersma, G. (2003). Household preferences for energy-saving measures: A conjoint analysis. *Journal of Economic Psychology*, *24*, 49–64.

Powers, T. L., Swan, J. E., & Lee, S. D. (1992). Identifying and understanding the energy conservation consumer: A macromarketing systems approach. *Journal of Macromarketing*, *12*, 5–15.

Renner, S., Albu, M., van Elburg, H., Heinemann, C., Lazicki, A., Penttinen, L., Puente, F., & Saele, H. (2011). *European Smart Metering Landscape Report.* Vienna: Österreichische Energieagentur – Austrian Energy Agency (AEA). Retrieved from http://www.piio.pl/dok/European_Smart_Metering_Landscape_Report.pdf

Reiss, P. C., & White, M. W. (2008). What changes energy consumption? Prices and public pressures. *The RAND Journal of Economics*, *39*, 636–663. doi: 10.1111/j.1756-2171.2008.00032.x

Rowlands, I. H., Scott, D., & Parker, P. (2003). Consumers and Green Electricity: Profiling Potential Purchasers. *Business Strategy and the Environment*, *12*, 36-48.

Sardianou, E. (2007). Estimating energy conservation patterns of Greek households. *Energy Policy*, *35*, 3778–3791.

Schahn, J., & Holzer, E. (1990). Studies of individual environmental concern: The role of knowledge, gender, and background variables. *Environment and Behavior, 22*, 767–786.

Simshauser, P., Nelson, T., & Doan, T. (2010). The Boomerang Paradox: how a nation's wealth is creating fuel poverty – and how to defuse the cycle (Working Paper No. 17). Retrieved from AGL Applied Economic & Policy Research website http://www.aglblog.com.au/wp-content/uploads/2010/10/No.17-Boomerang-Paradox-Final-Oct-20102.pdf

Smartmeters. (2014). *About smart meters*. Retrieved October 6, 2014, from http://www.smartmeters.vic.gov.au/about-smart-meters/reports-and-consultations/advanced-metering-infrastructure-cost-benefit-analysis/1.-introduction

Smart Metering Entity (SME). (n.d). *History*. Retrieved October 6, 2014 from http://www.smi-ieso.ca/history

Urban, J., & Scasny, M. (2012). Exploring domestic energy-saving: The role of the environmental concern and background variables. *Energy Policy*, *47*, 69-80.

U.S. Department of Energy (DOE). (2005). *Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them*. Retrieved March 15, 2015 from http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/DOE_Benefits_of_Demand_Response_in_Electricity_Markets_and_Recommendations_for_Achieving_Them_Report_to_Congress.pdf

U.S. Energy Information Administration (EIA). (2015). *How much energy is consumed in the world by each sector*? Retrieved February 7, 2015 from http://www.eia.gov/tools/faqs/faq.cfm?id=447&t=1

U.S. Energy Information Administration (EIA). (2013). *Annual Energy Outlook 2013 with Projections to 2040*. Retrieved February 7, 2014 from http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf

U.S. Energy Information Administration (EIA). (2008). *Emission of Greenhouse Gases in the United States 2007*. Retrieved February 9, 2015 from http://www.eia.gov/oiaf/1605/ggrpt/pdf/0573%282007%29.pdf

World Bank. (2014). *Electric Power Consumption*. Retrieved October 7, 2014 from http://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?page=1

World Energy Council (WEC). (2008). *Energy Efficiency Policies around the World: Review and Evaluation*. London: World Energy Council Publishing. Retrieved February 17, 2015 from http://www.worldenergy.org/wp-content/uploads/2012/10/PUB_Energy_Efficiency_-Policies_Around_the_World_Review_and_Evaluation_2008_WEC.pdf

Yang, L., Dong, C., Wan, C. L. J., & Ng, C. T. (2013). Electricity time-of-use tariff with consumer behaviour consideration. *International Journal of Production Economics*, 402-410.

Yuan, C., Liu, S., & Wu, J., (2010). The relationship among energy prices and energy consumption in China. *Energy Policy*, *38*, 197-207.

Zelezny, L.C.; Chua, P.-P.; Aldrich, C. (2000). Elaborating on gender differences in environmentalism. *Journal of Social Issues*, *56*, 443–457