"HOUSEHOLD ENERGY CONSERVATION PATTERNS: EVIDENCE FROM GREECE"

Eleni Sardianou

PhD Candidate

Department of Home Economics and Ecology

Graduate Program of Sustainable Development

Harokopio University

Abstract

This paper develops an empirical model to investigate the main determinants of household energy conservation patterns in Greece employing cross section data. In the empirical analysis household energy conserving choices models are employed, using a discrete and a latent trait variable respectively as a dependent variable. The results show that socio-economic variables such as consumers' income and family size are suitable to explain differences towards energy conservation preferences. In addition, the results suggest that electricity expenditures and age of the respondent are negatively associated with the number of energy conserving actions that a consumer is willing to adopt. Finally, other variables such as environmental information feedback and consciousness of energy problems are characteristics of the energy saver consumer. By evaluating consumer's decision-making process with regards to energy conservation measures, we are able to formulate and propose an effective energy conservation framework for Greece. An energy policy framework is among the main prerequisites not only for achieving sustainable development but also for maintaining consumers' quality of life.

Keywords: Energy conservation, household behaviour.

JEL: Q49; Q20

Acknowledgements: The author wishes to thank Professor George Hondroyiannis, supervisor of PhD dissertation entitled "Energy conservation models with regards to quality of life and sustainable development", for useful discussion and comments in a previous version of this paper and Tetti Tzamourani for her assistance with TWOMISS Program. The author wishes to acknowledge financial support from the Ministry of National Education and Religious Affairs, Program: Heraklitous - European Fellowships for Research.

Address for Correspondence: Eleni Sardianou, Harokopio University 70, El. Venizelou Av., 176 71 Athens – Greece, Tel: +30 210 - 9549219, Fax: +30 210 – 9577050 e-mail: esardianou@hua.gr

1. Introduction

Scientists agree that anthropogenic emissions of greenhouse gases upset the ecological balance. Overconsumption of natural resources is portrayed as a major threat to the sustainability. Environmental problems like greenhouse effect, ozone layer depletion, and acid rain effect are not any more problems of a specific region or country. They are major global problem, which cannot be tackled effectively without a global co-operation.

The Kyoto Protocol sets out certain commitments for the developed countries, in the United Nations Framework Convention on Climate Change (UNFCC) for the period 2008-2012. The overall target agreed is a reduction of the six most dangerous gases that contribute to the greenhouse effect by at least 5% below the 1990 levels for the period 2008-2012. These gases are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluroide (SF_6) and two groups of industrial gases: hydrofluocarbons (HFC_S) and perfluorocarbons (PFC_S).

Economic theory suggest that, in order to gain comfort and time households are becoming excessive energy users, neglecting the environmental impact of their choices. According to household production theory, households are treated as productive units organized to provide services for the occupants; energy is treated as input in the provision of a range of household services. Consumers' choices define the utility they can derive (Becker, 1965; Lancaster, 1966; Muth, 1966). The extent of service that we can derive from a given amount of energy depends not only on the efficiency of the technology but also the consumers' lifestyle. Several theoretical and empirical studies focused on households' energy conserving behaviour and its links with socio-economic parameters, which hint at lifestyle changes. Critical parameters, which were taken into consideration, are: (i) economic variables (ii) demographic variables of household unit and dwellings' characteristics and (iii), attitudinal variables.

The aim of the study is to compose the profile of energy saver consumer in Greece. Greeks could be more sustainable energy users if they adopt more conservation actions and one potential area is household sector. In particular, Greeks will have to restrict the average growth of the emissions of all six gases, for the period 2008-2012. This target is to be achieved through a number of interventions at national and European level that refer to all sectors of the economy and particularly to energy sector. During the 1970-1990 period Greece's energy demand was marked by a sharp increase close to 5% per year.

Transport was shown to be the most energy-consuming sector, accounting in 1990 for 39% of total national energy consumption, with the residential services sector responsible for 31% and the industrial sector for the 26% (Mirasgedis *et al*., 1996). Greek households use two main sources of energy, electricity and petroleum products for space heating (Donatos and Mergos, 1991). Residential energy consumption in Greece has increased by 5.4% annually within the period 1965 -2001. During this period the share of electricity in household energy consumption has increased steadily, by 2% annually. On the other hand the share of petroleum products seems to be declining by 0.6% per annum. (IEA- Energy balances in OECD countries various editions). The polluter that contributes the most to the greenhouse effect is carbon dioxide (CO_2), which is generated mainly from the combustion of energy inputs like lignite, brown and coal, for electricity generation and fuel oil.

Even for a medium-sized European country like Greece energy sector plays a major role in global warming. In 1990 electricity sector accounted for 50% of CO_2 emissions produced in Greece (Vassos and Vlachou, 1997). During the period 1990-1995, CO_2 emissions in Greece from the energy sector accounted for approximately 90% of total CO_2 emissions (Christodoulakis et al., 2000). The CO_2 emissions that are generated from households contribute to total emissions by approximately 8.6%. Total per capita CO_2 emissions have also increased in the period 1990-1998 by 13.6% (IEA, 2000).
The purpose of the paper is to develop an empirical model for explaining households' energy conservation patterns with regards to their lifestyle. By evaluating consumer's decision-making process with regards to energy conservation measures, for first time to our knowledge based on a cross section data for Greece, we are able to formulate and propose an effective energy conservation framework for Greece. An energy policy framework is among the main prerequisites not only for achieving sustainable development but also for maintaining consumers' quality of life.

The paper proceeds as follows: Section 2 presents the theoretical background on energy conservation. Section 3 deals with methodological issues and the data used in the empirical analysis while in Section 4 the empirical evidence are presented. Finally, in section 5, the conclusions of the analysis are summarized and the policy implications are discussed.

2. Theoretical Background on Energy Conservation Determinants

Several studies have investigated aspects of the lifestyle-energy interaction (Nader and Beckemnan, 1978; Schipper *et al*., 1989; Lutzenhiser, 1992; Lutzenhiser, 1993; Nakagami, 1996). In the context of residential energy use lifestyle should reflect the understanding that environmental responsibility and concern for energy sources go part and parcel with our daily energy based actions (Held, 1983). This demand –conscious lifestyle does not necessarily imply curtailment or sacrifices as far as the level of comfort or the quality of living are concerned. On the contrary, this approach is centered on an altered awareness of energy consumption in our daily lives (Stern and Gardner, 1981). As Coomer (1977) claimed a significant decrease in energy consumption may mean a perceived lifestyle change and should not be identified by means of reduced quality of life or social status, and as Leonard- Barton (1981) defined in a discretionary change of lifestyle, a low energy lifestyle is characterized by ecological awareness and attempts to become more self-sufficient users, known as voluntary simplicity lifestyle. Van Raaij and Verhallen (1983) and Weber and Perrels (2000) specified that lifestyle approach should take into consideration a broader socio-cultural concept. In this concept, lifestyle patterns are shaped as a consequence of enduring activities with regards to time, housing, family and income conditions that households face and partly as a way of self-expression and self-realization. Below are described several demographic, socio-economic, housing and attitudinal variables that hint at lifestyle differences and in turns define the effect of lifestyle on consumer's decision-making process with regards to residential energy conservation.

2.1: Income influences on energy conserving behaviour

Household income is a dominant predictor of energy use behaviours (Held, 1983). Ritchie *et al*. (1981) results confirmed that family income was positively related to in-home energy consumption. A recent analysis confirmed that households with higher incomes consume more energy sources (Brandon and Lewis, 1999). Although, the relationship between annual family income and acceptance of energy conservation strategies is characterized as very weak (Olsen, 1983), conservation actions are developed by people who have higher income and/ or invested money that can be used for that purpose (Dillman *et al*., 1983). In an econometric estimation of determinants of energy conservation expenditures Long (1993) proved that income level of the households was positively and statistically related to larger conservation investments. Kasulis *et al*. (1981) had argued that if a household belongs to a low income group, they are already very likely to be using low amounts of energy and thus would not have the ability to respond to requests for greater conservation activity. Stern and Gardner (1981) stressed that energy efficiency rather than curtailment measures are more preferable to higher income consumers. In a recent study, Poortinga *et al*. (2003) argued that technical improvements were most acceptable for respondents with a high income, with behavioural measures being the least acceptable for high incomes. This might be explained by the fact that technical measures often require an initial investment, which might be less problematic for the higher-income group. Bearing in mind the payback period of most conservation actions, low-income households may feel financially unstable and lack the capital to invest in residential energy efficiency improvements (Schipper and Hawk, 1991). Walsh (1989) econometric analysis confirmed that higher income households are better able than lower income families to purchase energy conservation. It is evident that higher incomes mean more rapid expansion of appliance ownership and more rapid replacement of existing inefficient models (Schipper and Hawk, 1991). A survey of 1200 households in Ireland conducted by Scott (1997) supported the assumption that restricted access to credit and transactions costs (such as time and effort) made residential conservation actions prohibitive. Finally, lower income respondents were more sensitive to energy problem (Samuelson and Biek, 1991).

2.2: Energy prices inflation influences on energy conserving behaviour

Many researchers have stressed the importance of energy prices on the energy saving behaviour of the households. In a state-wide survey on 478 residential electricity consumers in Massachusetts during the summer of 1980, Black *et al*. (1985) examined the interactive effects of energy prices on conservation actions which involved energy efficiency improvements or curtailment of the services energy provides. They support that both high household energy bills and rising heating fuel price were incentives to energy saving. Long (1993) tested the energy prices and energy-reducing investments interaction using an extended database of 6.346 households in western United States for the year 1981. He clarified that there was a statistically significant relationship between energy price changes and conservation measures that individual Americans are likely to adopt. In fact, for each percentage point rise in the cost of energy he estimated a 0.21 percentage point increase in conservation items. Increased expected energy prices appeared to have a positive relationship to total conservation expenditures. In another survey for 2.911 Californian households, Walsh (1989) confirmed that the probability of a conservation improvement decision was positively related to higher expected fuel prices. Pitts and Wittenbach (1981) substantiated the above-mentioned conclusion. But for the time trend of energy prices another important factor is the cost of conservation improvements. Although energy –efficient equipment may be more expensive at the time of purchase households tend to ignore that energy conserving appliances are less expensive in use due to the restrictive use of increased price electricity (Schipper and Hawk, 1991). Not surprisingly enough, energy price inflations do not always encourage conservation activities. In fact, as Dillman *et al*. (1983) revealed, by examining the behaviour of 8.392 households in the United States, a higher energy price encouraged wealthy households to make energy conservation investments, whereas poor households forced to take lifestyle cutbacks in all of their expenditure patterns as a response to increased energy prices. The potential socio-economic and equity impacts of energy prices increases are evident bearing in mind that this practice is a non-voluntary character energy conserving measure (Held, 1983).

2.3: Effects of tax credits and subsidizes on energy conserving behaviour

Incentives dealing with household energy conservation activity can be categorized as follows: (i) incentive initiatives, such as grants for purchase of insulation, tax credits for insulation of solar equipment and low interest loans for the purchase of heat pumps, (i) disincentive initiatives such as taxes and prices rates that penalize consumption during peak periods, and (iii) restriction initiatives such as efficiency standards, (McDougal *et al*., 1981). However, empirical research has centered on the impact of tax credits or subsidy schemes. The effects of tax credits or subsidies on energy savings are ambiguous. Some researchers hold the belief that specific tax credits or subsidies do not induce conservation activity. Pitts and Wittenbach (1981), who based on a survey of 146 homeowners, supported that no direct relationship existed between conservation improvements installed by local contractors and the existence of a federal tax credit. Similarly, Walsh (1989) examined the factors that are systematically associated with household energy efficiency improvements and took into consideration a state-level tax credit. The results provided evidence in support of hypothesis that energy tax credits have not stimulated energy conservation behaviour. Moreover, larger tax credits were not found to be positively associated with larger improvements and attribute the failure of tax credits to promote energy efficiency to: (i) the small discount rate implied by the credits, (ii) bureaucratic barriers that consumer face in order to claim the credit and (iii) consumers' lack of knowledge about the existence of credit or consumers' misunderstanding of the price reducing effect of this credit (Held, 1983). Although, tax credits may produce distributional impacts, there are also two studies for United States that provide evidence for a positive relationship between tax credits or subsidies and energy conservation activities. Using a sample of 1761 households, Cameron (1985) focused on energy conservation "retrofits" such as insulation and storm windows in the context of a discrete continuous model. Based on the assumption that all households were perfectly informed of the tax credit and all faced the same-tax prices her simulations indicated that a government subsidy equal to 15% of improvements costs would cause 3% of all households to make some conservation improvement. She found that for each percent of government subsidization, accounting by 15% of conservation costs, about 0.2% of households would be induced to take a residential conservation improvement. Accordingly, Long (1993) found that households were to spend more on energy conservation items when these investments were subsidized by government tax policies. However, as Cameron (1985) pinpointed a major problem with subsidies, is that it is uneasy to distinguish "induced" conservation activity from energy efficiency activity, which would have occurred without the subsidy.

2.4: Households' socio-demographic characteristics and energy conserving behaviour

2.4.1: Effects of household unit characteristic on energy conserving behaviour

Studies investigating the decision to make an energy conservation improvement took into consideration various characteristics of household units' and its occupants. A survey conducted by Olsen (1983) in the State of Washington in spring 1981 revealed that sex of the respondent is not statistically significantly related to acceptance of energy conservation strategies. Energy use and acceptance of energy conservation strategies are positively related to educational level of the respondent (Held, 1983; Olsen, 1983), while less educated respondents prefer behavioural energy conserving measures (Poortinga *et* *al*., 2003) and are more conscious of energy problems (Samuelson and Biek, 1991). However, education of the respondents has no significant influence neither on the number of household energy conservation actions (Curtis *et al*., 1984), or on the actual energy consumption (Ritchie *et al.*, 1981). Households' energy conservation expenditures were not statistically different between married couple households and other family types (Long, 1993), whereas, family size and composition, presence or absence of family members from home, have a direct effect on energy behaviour and use (Van Raaij and Verhallen, 1983). In fact, family size was positively related to in-home energy consumption with households comprised of two to four people took a greater number of actions than households of differing size (Curtis *et al.*, 1984). Employment is also related to energy use. Although Curtis *et al*., (1984), reported that occupation of the respondents had no significant influence on the number of households' energy conservation actions, Olsen (1983) claimed that persons with higher - status occupations are slightly more accepting of energy conservation strategies. Finally, households residing in large dwellings, as measured by the number of rooms and number of floors, are energy intensive consumers (Ritchie *et al.*, 1981). So, the older and larger the dwelling, the more likely that households will engage in an energy conservation improvement (Walsh, 1989).

2.4.2: Age as a predictor variable of energy conserving behaviour

Numerous empirical studies examined age of the respondent as a predictor variable for energy conservation actions. In his study for Canadian households Walsh (1989) argued that younger heads of households are more likely to make a conservation improvement. He added that conservation investments are less likely to be made by older persons because they expect a relatively lower rate of return from energy improvements than do other age cohorts. In an earlier study for Canadian and U.K. consumers, respectively, Ritchie *et al*. (1981) and Brandon and Lewis (1999) have proved that age of household head was positively related to in-home energy consumption levels, whereas Hirst and Goeltz (1982) clarified that age has a curvilinear relationship with conservation behaviour, as young and elderly households take fewer actions than those in their middle age. In general, the older the person is, the less likely she or he is to adopt energy conservation strategies because: (i) the housing of elderly is generally older with decayed insulation, (ii) elderly diminished physical ability for conservation improvements, (iii) elderly have fewer years of formal education and lack of energy know-how and (iv) elderly do not relate well conservation's "spend- now- to save- later" philosophy (Olsen, 1983; Berry and Brown, 1988; Brown and Rollinson, 1985; Tonn and Brown, 1988; Poortinga *et al*., 2003). Contrary to the previously mentioned, Long (1993) estimations on energy conservation expenditures of Americans in 1981 revealed a positive sign between the age of the respondent and the money spend for conservation improvements, result that researcher attribute to the older and subsequently less energy efficient houses that elderly resided in.

2.4.3: Homeownership as a predictor variable of energy conserving behaviour

Home ownership may be a critical determinant of energy efficiency responses. As Stern and Gardner (1981) argued home ownership prescribes the type of energy conservation behaviour that residents would adopt. More precisely, efficiency measures are more available to consumers and to homeowners, whereas curtailment may be the only option for renters. Curtis *et al*. (1984), based on a sample of 473 Canadians, examined the relationship between house tenure and the number of reported conservation actions, and concluded that although form of home tenure was not significantly associated with number of actions, those who owned their homes declared a slightly greater number of actions than renters. In addition, Black *et al*. (1985), based on answers of 478 residents of Massachusetts during the summer of 1980, argued that homeownership had the strongest direct effect on investments in energy efficiency. They observed that homeowners gain the personal benefits of investment, either in comfort energy savings, property values, or whatever, whereas renters are not likely to invest their money to improve the energy efficiency of their landlord's property. Brandon and Lewis (1999) substantiated the above-mentioned conclusion and added that people living in rented accommodation might not have the right, as tenants, to invest in energy efficiency improvements of their homes. Finally, as Walsh (1989) survey indicated conservation practices are less likely to be adopted by renters because their expectations as far as the rate of return on theirs investments are relatively low due to a shorter tenure in their dwellings.

2.5: Effects of information diffusion on energy conserving behaviour

A critical question for researchers of energy conserving determinants was why do households decisions toward energy use diverge not only from what it seems effective for an economic point of view but also from an environmental one. Information seeking was another path of investigation, which was assessed. Information diffusion tends to be a voluntary and communicative strategy for activating energy conserving behaviour (Held, 1983). There are various approaches of information diffusion that can alter residential behaviour toward energy use, such as pamphlets enclosed in utility bills, advertising campaigns and appliance energy-consumption labels McDougal *et al.* (1981). Their main purpose is to increase the recipients'- households' knowledge of energy conservation alternatives by communicating them emotional, persuasive or supportive messages, which can be a motive for taking those actions (Olsen, 1981). Another important factor is the source of information. In case of Canadian energy consumers, Curtis *et al.* (1984) indicated that the number of sources people utilize to gain information and energy conservation actions taken were positively related. Brandon and Lewis (1999) confirmed the energetic influence of feedback information on energy saving behaviour by interviewing 1.000 residents of Georgian properties in Bath (UK). As Scott (1997) stressed, in a survey of 1.200 households in Ireland, the households' sense of small potential economic savings from adoption of energy conserving actions is attribute to lack of information, whereas Schipper and Hawk (1991) reported that consumers not only may lack the information about costs and benefits of energy efficiency improvements but also may not understand how to use the available information. Every kind of information (feedback information, general information or specific information and behavioural advice) can be evaluated in the process of an energy conservation campaign (Van Raaij and Verhallen, 1983).

2.6: Effects of attitudinal variables on energy conserving behaviour

Motivation for household energy conservation actions may stem from a number of influences and sources. Many studies have focused on social or psychological factors related to energy-saving behaviour, by examining the influence of cognitive variables, such as values, beliefs or attitudes towards energy conservation (Gardner and Stern, 1996). A number of studies suggest that social factors could be an important determinant of energy conserving behaviour. A social norm is defined as an expectation shared by a group, which specifies behaviour that is considered appropriate for a given situation (Secord and Backman, 1974). Rogers and Shoemaker (1971) define norms as the established behaviour patterns for the members of a given social system. Attitudes develop as a result of cumulative experience and knowledge derived from past exposure to environmental stimulus. O'Riodan (1971) refers that attitudes are organized sets of feelings and beliefs about a subject or situation, which can influence an individual's behaviour. According to Becker and Seligman (1981) it is important to examine attitudes because "appropriate energy related attitudes and beliefs might constitute a necessary condition for appropriate energy related behaviours". Since new attitudes can be established, attitude-action association has important implications for energy education (Collins *et al*., 1979).

Some authors have begun to speculate on the above-mentioned factors, while others have begun to provide relevant evidence. Seligman *et al*. (1979) explained a high portion of electricity consumption using attitudinal variables. Based on two samples, 56 and 69 couples respectively from a New Jersey townhouse development, agreed to fill out a questionnaire about their attitudes toward energy use and their actual summer electric consumption. Using an econometric analysis, researchers have found that beliefs and behavioural intentions closely related to specific energy –using behaviour are predictive of these behaviours. Respondents perceived their use of energy according to their judgment of the effect of energy conservation on personal comfort and health, the effort required to conserve and the monetary payoff for doing so, the ability of the individual to have an impact on the energy problem and their belief that the crisis is legitimate. Contrary to Seligman *et al*. (1979) results, Ritchie *et al*. (1981) survey for 2.366 Canadian households proved that none of the attitudinal variables was significant in the final explanatory model of actual energy consumption. Another predictor variable is perceived seriousness of the national energy problem. Verhallen and van Raaij (1981) argued that people's perception of their own contribution to energy problems is predictive of household energy conservation. Presumably, the greater the perceived seriousness of the problem, the more likely one should be to support strategies for promoting energy conservation (Olsen, 1983). A strong attitude exists that human misuse rather than resources scarcity, is responsible for the current energy problem. Energy attitudes may affect behaviour via the belief that conservation brings direct personal benefits and, the development of social norms about saving energy. This finding is similar to Olsen's (1981) who reported that Americans also felt that there was a real and serious problem in the USA. The empirical analysis of Curtis *et al*. (1984) substantiated the above-mentioned conclusions. They found, based in a sample of 473 Canadian residents, that conservation decisions were influenced by two attitudinal factors: (i) the belief that individual energy conservation actions are important and (ii) the willingness to change their lifestyle in order to save energy. Using a survey of 1.000 Texas residents, which was carried during the period July-August 1987, Samuelson and Biek (1991) analysis replicated previous work by Seligman et *al*. (1979) by identifying the same four principal dimensions underlying energy use attitudes and beliefs: (i) comfort and health, (ii) high effort – low payoff, (iii) role of individual consumer and (iv) legitimacy of energy problem.

However, in Brandon and Lewis (1999) study, conducted in 1994, for 1.000 residents of Georgian properties in Bath (UK), there was evidence that while environmental attitudes and beliefs are important in this context on energy conservation actions, financial considerations were of equal or even greater importance. An analogous study by Poortinga *et al*. (2003), which was conducted during October and November 1999 and participated 455 households, showed related degree of respondents' environmental concern to acceptance of different types of energy saving measures. Results seemed counter-intuitive as, respondents with a high environmental concern found measures with small energy savings relatively more acceptable than measures with large energy savings, whereas the reverse applied to respondents with a low environmental concern. These results might be explained by using Stern (2000) distinction between environmentally significant behaviour that is defined by its impact and environmentally significant behaviour that is undertaken by the actor with the intention to improve the environment.

So, energy conscious attitudes do not always lead to energy conserving behaviour. Attitudes may lead to good intentions but social norms, lack of knowledge on the energy use of certain behaviours and on the energy conservation effects of behavioural change and institutional factors may block the intention to be realized in actual behaviour (Van Raaij and Verhallen, 1983). As Black *et al*. (1985) claimed, generalized concern about the national energy situation does not influence behaviour directly but exerts an indirect influence by affecting personal norms. In their model, based on 478 Massachusetts electricity consumers during the summer of 1980, researchers found that the sense of obligation to adopt energy efficiency measures in the home derives from the sort of factors that typically activate moral norms. Some of these are social in nature (concern about the energy problem, awareness of social norm for efficiency), but other factors are also influence the personal norm. An important one is the belief that personal benefits will result from energy efficiency home improvements. When people do take minor actions that save money, provide comfort, and so forth, a cognitive process involving a sense of personal obligation mediates the effect of perceived personal benefit. Norms are activated in order to produce energy altruistic behaviour. Another work based on the interaction of attitudes, beliefs, norms, intensions and behaviour with respect to energy conservation, was that of Midden and Ritsema (1983) for Netherlands. The survey sample of 1.076 Dutch residents was conducted in June 1981 and gave insights in the impact of social norms on intention to conserve energy, which was characterized as rather weak. Energy conserving behaviour will be normatively strengthened when others in the environment of the individual perceive the benefits of this behaviour. These benefits are necessary to motivate people to exert pressure on others.

3. Methodological Issues and Data

Following previous studies of residential energy conservation, four subsets of variables were used in this empirical analysis of Greek households: economic factors (private monthly income, electricity expenditures), demographic variables (age, sex and educational level of the respondent, marital status and family size), dwellings' characteristics (homeownership, house type, number of rooms and size in m^2), information diffusion, and attitudinal variable (individuals belief about their contribution to environmental problems). All the previously mentioned variables hint at lifestyle differences. Therefore, in the empirical study the following expanded specification for consumers' participation in energy conserving actions is employed:

$$\begin{aligned} CONSERVE_i = {} & \alpha_o+\alpha_1 AGE_i+\alpha_2 SEX_i+\alpha_3 UNIV_i+\alpha_4 MARRIED_i+\alpha_5 MEMBER_i+\alpha_6 LNINMON_i \\ & +\alpha_7 LNEL_i+\alpha_8 OWNH_i+\alpha_9 TYPEH_i+\alpha_{10} NOROOMS_i+\alpha_{11} TM2_i+\alpha_{12} INFOENV_i \\ & +\alpha_{13} CRESP_i+u_i \end{aligned} \quad (1)$$

where AGE is the age of the correspondent; SEX is the sex of the correspondent, accounting for 1 if the respondent is male; UNIV is a dummy variable indicating whether the respondent has completed undergraduate studies in a Greek university or not; MARRIED is a dummy variable indicating whether the respondent is married or not; MEMBER is the number of household members living in the same residence; LNINMON is the natural logarithm of monthly private income of the respondent measured in euro; LNEL is the natural logarithm of household's expenditures for electricity in euro as they recorded in the last electricity bill; OWNH is a dummy variable indicating whether the household owns his dwelling; TYPEH is a dummy variable indicating whether the household resides in a detached house or not; NOROOMS is the number of rooms of household's dwelling; TM2 is dwelling size in m^2; INFOENV is a dummy variable indicating whether the respondent is informed about the global environmental problems; CRESP is a dummy variable indicating whether the respondent recognize his contribution to environmental problems and u is an error term.

The dependent variable CONSERVE represents consumers' behaviour towards specific energy-conserving actions. In order to construct the dependent variable we followed Curtis *et al.* (1984) and Stern and Gardner (1981) approach. The differentiation of energy conservation actions according to Curtis *et al.* (1984) and Stern and Gardner (1981) were used as a criterion for the choice of the statements with regards to energy use decision-making process. Curtis *et al.* (1984) observed that energy-conserving actions are of two types: (*i*) practices (which are no- and low cost actions that require some change in household behaviour, no capital investment and can easily implemented) and (*ii*) measures (that involve technical changes in the house and capital investment costs). Stern and Gardner (1981) distinguished between efficiency energy conservation actions and curtailment conservation actions and supported the idea of demand shift. According to Stern and Gardner (1981) demand shift refers to encourage consumers to shift to an energy type that is more available than the one they currently use or to provide consumers with initiatives in order to shift the time of day when the energy is consumed. For this purpose seven questions are included in the questionnaire to capture consumers' willingness to participate in energy conserving actions. In particular,

(*i*) con_light: I take care of switching off the lights when their use is not necessary (YES=1, NO=0).

(*ii*) con_appliance: I switch off household appliances when I don't use them. (YES=1, NO=0).

(*iii*) rp_lamp_price: Energy saving lamps can be 5 times more efficient than the conventional ones, would you buy them regardless of their higher purchase cost? (YES=1, NO=0).

(*iv*) thermal_ins: I have my house thermal insulated. (YES=1, NO=0).

(*v*) night_lig_bill: I prefer to do energy intensive tasks during the off peak period of electricity use, when the cost is lower. (YES=1, NO=0).

(*vi*) save-en_en: I would like to use a natural gas system in my house in order to decrease my participation in environmental destruction from the excessive use of energy resources. (YES=1, NO=0).

(*vii*) res_h_env: I would like to live in a house that bases its operation to renewable energy resources in order to get rid the cost of energy bills. (YES=1, NO=0).

The frequency percentages of responses for each of the seven questions as well as their categorization are presented in the following table.

Table 1.
Categorization and frequencies of variables counting for energy conserving actions

n=500		YES (%)	NO (%)		Type of energy conservation action
con_light		77.6	22.4		Practice/ curtailment
con_appliance		84.8	15.2		Practice/ curtailment
rp_lamp_price		70.6	29.4		Measure/ efficiency/ demand shift
thermal_ins		33.8	66.2		Measure/ efficiency
night_lig_bill		44.2	55.8		Practice/ curtailment / demand shift
save-en_env		59.6	40.4		Measure/ efficiency/ demand shift
res_h_env		60.2	39.8		Measure/ efficiency/ demand shift

Bearing in mind that the above-described variables are dummies, we followed two different methodologies in order to create our dependent variable. The first methodology was based in the calculation of the total number of proposed energy conserving actions by adding the responses of all seven questions. In this case, our variable ranges from zero to seven. The average actions stated were 4.3, while 9.8% and 16.2% of the respondents gave a positive answer for 2 and 3 respectively of the seven conservation actions. However, only 5.6% of the consumers were positive to all of the actions proposed. The second methodology was based in the estimation of a latent trait model using Twomiss Program. The Program is designed for fitting latent trait models. The estimated conditional mean of the latent variable given the observed response patterns of the dummies variables was the result of this procedure. In both methodologies, the transformed variable was regressed upon the explanatory variables of equation (1) using OLS technique. The empirical results are presented in the section 4 of this work.

The present analysis is based on an extensive survey of 586 Greek households, which was carried out from the 1st of June to 31st of August 2003. The form of the survey was a questionnaire, which was administered using face-to-face interviews with one adult from each household in their home. As a prerequisite, the person answered the questionnaire was above 18 years old and income earner. The sampled households were located in five of the main and most representative regions of Athens, as far as the socio-economic characteristics of their residents are concerned. The sampled households at each region were chosen at random following the protocol of "right –hand turns"[1]. According to this method, every third house in the block in which the starting address was located was interviewed until the number of interviews stipulated for that cluster was completed. Selection of every third house as the sampling ensured that sparsely developed blocks would be adequately represented in the sample. For example we started from block number 1 and we interviewed the house number 3, next we omitted second block and we interviewed the sixth house in the block. When the rule of three was completed, we started from the beginning.

A total of 500 questionnaires were completed, one hundred of each region. Approximately 61% of the respondents were female and 39% male. Respondents' ages ranged from 19 to 76, while the average age of the sample was equal to 37 years old. Seventeen percent of the households' heads reported that he or she received primary education; 38% attended high school, while 29% of the respondents reported that they have completed undergraduate studies in a Greek university. Fifty one percent of the persons sampled were married. The average household consisted of three individuals, ranging normally from one to nine members. In particular, 53% of the households have no children, almost 14% have one, 28% have two, and 5% have three or more. The average annual household non-property income is equal to 22,500 euros, while the majority of respondents reported that their wages were ranging from 500 to 800 euros. Seventy five percent of the persons interviewed declared that their salary was not enough to cover their basic needs. That's probably explain, why almost 62% of persons questioned have zero savings. However, the average daily working time is equal to seven hours, 34% of the respondents stated an eight-hour daily working program, while 24% work above ten hours per day.

As far as the characteristics of the dwelling are concerned, 80% of the households sampled live in apartment buildings, while 20% live in detached houses. Seventy percent of respondents are homeowners. The average dwelling size is almost 94 m^2 with the majority of respondents, 38%, live in a three-room dwelling. Forty one percent of the dwellings are characterized as houses with high temperature during summer and low temperature during winter. The majority of households' members, who used central heating, admitted that they would limit their consumption for space heating in case of an increase of oil's price.

[1] We followed a similar approach to Kasulis et al. (1981).

The average consumption of heating oil per household was 1,355 litres, 31% consumed one tone, while approximately 13% consumed 1,500 litres. 28.6% of the respondents reported expenditures for electricity above 121 euros according to the mean electricity bill during winter, 30% spend approximately 61 to 90 euros, while 25% almost 100 euros. Finally, the majority of the respondents (~75%) referred that they were informed about the environmental problems while the same percentage occurred for consumers' belief that they contribute to environmental annihilation. Table A.1 presents the descriptive statistics of the variables used in the empirical estimation.

4. Empirical Results

Several interesting results were obtained by the empirical estimation of equation (1). Table 2 summarizes the empirical results of our models. All models are estimated using OLS and the estimated standard errors are corrected using White Heteroskedasticity. Models I and III are the initial estimated models using as a dependent variable the first and the second methodology, as described in section 3. Non-statistically significant variables were omitted from the models I and III and the final results are presented in the third and fifth columns of Table 2, models II and IV respectively. All the estimated coefficients of the explanatory variables presented in the final models have the expected sign and are statistically significant at the 5% or 1% level.

In particular, both consumer's private monthly income and electricity expenditures are statically significant variables of the number of energy conserving actions reported. This finding support previous studies (Dillman *et al.*, 1983; Walsh, 1989 Long, 1993; Scott, 1997) about the positive relationship of income variable and conservation altered behaviour. In both methodologies income express respondents' intention to adopt more energy conservation actions. This result indicates that as income increases, households tend to be more willing to conserve energy mainly because they can afford the credit of energy improvement investments. Moreover, the estimated coefficient of the variable household electricity expenditures is negative. This result indicates that households with a high level of dependency on electricity use do not intend to restrict their consumption by adopting specific energy conservation actions, probably because they lack information about the positive effects of energy investments to house comfort, or because they can afford high energy prices and energy efficiency investments are not an incentive for paying less for energy.

Both empirical methodologies support the theoretical background that respondents' sex, educational level and marital status do not affect their choice with regard to the number of actions, or the combination of energy conserving actions undertaken. The empirical results are consistent with those of Olsen (1983) and Curtis *et al*. (1984). Contrary, family size is positively related to household's decision-making process towards conservation practices or measures at 1% level of significance. In fact, as number of family members increases, household's actions toward residential energy consumption increases, too. This finding was replicated by model IV but at 5% level of significance and is consistent with results of Van Raaij and Verhallen (1983) and Curtis *et al.* (1984).

The estimated coefficient for home ownership has a positive sign and is suitable to explain the number of residential energy conserving actions. This finding is consistent with the results of Black *et al.* (1985), Walsh (1989) and Brandon and Lewis (1999), whereas homeownership was omitted from the last model as not being statistical significant in the case of the latent variable model. Furthermore, dwellings' characteristics such as the number of rooms and the fitted squared area not statistical significant determinants of consumers' energy conservation choices, whereas households residing in detached houses are more willing to engage in energy conservation activities than those living in apartment blocks. These results are significant in both final models (II and IV).

According to theory age is a dominant predictor variable of energy conservation decisions with a negative sign (Walsh, 1989; Hirst and Goeltz, 1982). This theoretical assumption is confirmed in the case of Greece. In particular, in both models II and IV, age is found a statistical significant variable of the number of actions that consumers' would intend to take part. As age of the respondent increases, the number of reported energy conserving actions decreases.

Diffusion of environmental information is found a strong predictor of energy conserving behaviour (1% level of significance), with a positive sign. This finding supports those of Olsen (1983), Held (1983) and Van Raaij and Verhallen (1983) about the importance of information to environmental behaviour and indicates that information based energy policies, could be effective for promoting sustainability through conservation activities. Finally, our intention to capture the impact of attitudes toward energy problems on energy conserving actions reveals that, indeed, consumers' belief with regards to their contribution to environmental problems is a strong predictor of the number of energy conserving actions stated. This finding indicates that well-established attitudes towards environmental parameters hint at energy conserving intention.

Table 2.

Estimated OLS models of energy conserving actions

	Model I	Model II	Model III	Model IV
Dependent	Discrete variable	Discrete variable	Latent variable	Latent variable
(Constant)	2.987*** (3.61)	2.966*** (3.71)	-0.318 (-0.75)	-0.157 (-0.39)
AGE	-0.0006 (-1.11)	-0.0008* (-1.61)	-0.0005* (-1.61)	-0.0006** (-2.29)
SEX	-0.123 (-0.91)		-0.007 (-1.08)	
UNIV	0.142 (0.89)		0.005 (0. 64)	
MARRIED	-0.0015 (-0.10)		-0.008 (-1.04)	
MEMBER	0.129** (2.39)	0.134*** (2.56)	0.006** (2.19)	0.005** (1.952)
LNINMON	0.245*** (2.47)	0.246*** (2.67)	0.159*** (3.15)	0.124*** (2.63)
LNEL	-0.373** (-2.39)	-0.342** (-2.26)	-0.205*** (-2.57)	-0.223*** (-2.92)
OWNH	0.317** (2.12)	0.329** (2.26)	0.115 (1.51)	
TYPEH	0.327** (1.86)	0.376** (2.28)	0.237*** (2.65)	0.204*** (2.48)
NOROOMS	-0.0007 (-0.10)		-0.003 (-0.98)	
TM2	0.0001 (0.72)		0.0001 (0.94)	
INFOENV	0.476*** (3.25)	0.481*** (3.32)	0.265*** (3.54)	0.255*** (3.43)
CRESP	0.588*** (3.98)	0.610*** (4.18)	0.197*** (2.61)	0.211*** (2.82)
$R(adj)^2$	0.095	0.100	0.106	0.095
F	5.04***	7.94***	4.44***	6.43***

Note: ***, **, *, represent level of significant at 1%, 5%, 10% respectively.
t-statistics are presented in the parentheses. Estimated standard errors are corrected using White Heteroskedasticity.

5. Concluding Remarks and Policy Implications

This study provides important evidence for the first time, for energy conservation patterns of Greek consumers. Utilizing cross-section data, we conclude that consumers' characteristics do specify energy conserving behaviours. Our empirical findings, as far as socio-economics parameters and household unit characteristics are concerned, are in line with other reported studies.

In particular, from the empirical analysis the profile of energy saver consumer can be drawn. Consumers who have higher private incomes, own their houses and are members of an extended family core are more likely to make a conservation improvement, whereas number of rooms and size of the dwelling do not explain differences with regards to the adoption of energy conserving actions. These findings support the idea that higher demand for residential energy amenities is familiar with higher demand for household comfort and qualitative services. In addition, larger electricity expenditures are negative associated with acceptance of energy conservation strategies, whereas, sex, educational level and marital status of the consumers are not predictors of energy conserving behaviour. However, elderly rather than younger consumers are energy intensive users. What is more important is that, well informed and conscious of energy problems consumers can be identified as energy savers, too.

Our estimations have important implication for Greece. An energy conservation plan for Greek households should take into consideration that acceptance of energy conserving actions is differentiated with regards to consumers' economic and socio-demographic characteristics. So, an energy saving campaign should face consumers as subgroups with different needs and different aspects of lifestyle. As it is shown, low consumer earnings are a restrictive parameter of the number of actions reported as possibly being adapted. Policy makers should address the environmental impacts of energy resources overconsumption by proposing a framework based on providing not only economic incentives for subsidizing conservation actions for the poor, but also accurate information as to how much money can be saved by taking specific energy conservation actions. This framework would be more effective if the diffusion of information with regards to energy saving measures begins from the primary education since attitudes, beliefs and norms of younger are more receptive to changes.

Given the increased need for sustainability and quality of life, Greek households may alter their energy behaviour to an environmental friendly one. While, the importance of information diffusion is established from this survey, it would be interesting to empirically investigate the "power" of information policies compared to other economic policies, such as the implementation of an energy tax. This is a question for further research of Greek's preferences towards energy conserving measures.

References

1. Becker, G. (1965), "A theory of allocation of time", *Economic Journal*, Vol. 75, pp. 493-517.
2. Becker, L. and C. Seligman (1981), "Welcome to the energy crisis", *Journal of Social Issues*, Vol. 37 (2), pp. 1-7.
3. Berry, L. and M. Brown (1988), "Participation of the elderly in residential conservation programmes", *Energy Policy*, Vol. 16 (2), pp. 152-163.
4. Black, J., P. Sterm and J. Elworth (1985), "Personal and contextual influencies on household energy adaptations", *Journal of Applied Psychology*, Vol. 70 (1), pp. 3 –21.
5. Brandon, G. and A. Lewis (1999), "Reducing household energy consumption: A qualitative and quantitative field study", *Journal of Environmental Psychology*, Vol. 19 (1), pp. 75-85.
6. Brown, M. and P. Rollinson (1985), "The residential energy consumption of low-income and elderly households: how "non discretionary" is it? ", *Energy Systems and Policy*, Vol. 9 (3), pp. 271-301.
7. Cameron, T. (1985), "A nested logit model of energy conservation activities by owners of existing single family dwellings", *Review of Economics and Statistics*, Vol. June (2), pp. 205-211.
8. Christodoulakis, N., S. Kalyvitis, D. Lalas and S. Pesmajoglou (2000), "Forecasting energy consumption and energy related CO_2 emissions in Greece", *Energy Economics*, Vol. 22 (4), pp. 395- 422.
9. Collins, T., C. Herbkersman, L. Phelps and G. Barret (1979), "Establishing positive attitudes toward energy conservation intermediate level children", *Journal of Environmental Education*, Vol.10 (2), pp.18-23.
10. Coomer, J. (1977), "Solving the energy dilemma", *The Futurist*, Vol. 11, pp. 228-230.
11. Curtis, F., P. Simpson-Housley and S. Drever (1984), "Household energy conservation", *Energy Policy*, Vol. 12 (4), pp.452-456.
12. Dillman, D., E. Rosa and J. Dillman (1983), "Lifestyle and home energy conservation in the United States: the poor accept lifestyle cutbacks while the wealthy invest in conservation", *Journal of Economic Psychology*, Vol. 3 (3-4), pp. 299 –315.
13. Donatos, G. and G. Mergos (1989), "Energy demand in Greece: the impact of two energy crisis", *Energy Economics*, Vol. 11 (2), pp. 147-152.

14. Held, M. (1983), "Social impacts of energy conservation", *Journal of Economic Psychology*, Vol. 3 (3-4), pp. 379-394.
15. Hirst, E. and R. Goeltz (1982), "Residential energy conservation actions: analysis of disaggregated data", *Energy Systems and Policy*, Vol. 6 (1), pp. 135-150.
16. IEA (2000), "CO_2 emissions from fuel combustion", OECD, Paris.
17. Kasulis, J., D. Huettener and N. Dikeman (1981), "The feasibility of changing electricity consumption patterns", *Journal of Consumer Research*, Vol. 8 (3), pp. 279-290.
18. Lancaster, K. (1966), "A new approach to consumer theory", *Journal of Political Economy*, Vol. 74, pp. 132-157.
19. Leonard-Barton, D. (1981), "Voluntary simplicity lifestyles and energy conservation", *Journal of Consumer Research*, Vol. 8(2), pp. 243 –252.
20. Long, J., (1993), "An econometric analysis of residential expenditures on energy conservation and renewable energy sources", *Energy Economics*, Vol. 15 (4), pp. 232 -238.
21. Lutzenhiser, L. (1992), "A cultural model of the household energy consumption", *Energy*, Vol. 17 (1), pp. 47-60.
22. Lutzenhiser, L. (1993), "Social and behavioral aspects of energy use", *Annual Review of Energy and Environment*, Vol. 18, pp. 247-289.
23. McDougal, G., J. Claxton, J. Ritchie and D. Anderson (1981), "Consumer energy research: a review", *Journal of Consumer Research*, Vol. 8 (2), pp. 343-354.
24. Midden, G. and B. Ritsema (1983), "The meaning of normative processes for energy conservation», *Journal of Economic Psychology*, Vol. 4 (1), pp. 37 –55.
25. Mirasgedis, S., D. Makatsoris, D. Assimakopoulos, L. Papagiannakis and A. Zervos (1996), "Energy conservation and CO_2- emission abatement potential in the Greek residential services sector", *Energy*, Vol. 21 (10), pp. 871-878.
26. Muth, R. (1966), "Household production and consumer demand functions", *Econometrica*¸ Vol.34, pp. 699-708.
27. Nader, L. and S. Beckemnan (1978), "Energy as it relates to the quality and style of life", *Annual Review of Energy*, Vol. 3 (1), pp. 1-28.
28. Nakagami, H. (1996), "Lifestyle change and energy use in Japan: household equipment and energy consumption", *Energy*, Vol. 21 (12), pp. 1157-1167.
29. Olsen, M. (1981), "Consumers attitudes toward energy conservation", *Journal of Social Issues*, Vol. 37 (2), pp. 108-131.

30. Olsen, M. (1983), "Public acceptance of consumer energy conservation strategies", *Journal of Economic Psychology*, Vol. 4 (1-2), pp. 183-196.
31. Pitts, R. and J. Wittenbach (1981), "Tax credits as a means of influencing consumer behavior", *Journal of Consumer Research*, Vol. 8, pp. 335-338.
32. Poortinga, W., L. Steg, C. Vleg and G. Wiesma (2003), "Household preferences for energy-saving measures: a conjoint analysis", *Journal of Economic Psychology*, Vol. 24 (1), pp. 49-64.
33. Ritchie, B., G. McDougall and J. Claxton (1981), "Complexities of household energy consumption and conservation", *Journal of Consumer Research*, Vol. 8, pp. 233-242.
34. Rogers, E. and F. Shoemaker (1971), "Communication of innovations", New York: Free Press.
35. Samuelson, C. and M. Biek (1991), "Attitudes toward energy conservation: a confirmatory factor analysis", *Journal of Applied Social Psychology*, Vol. 21 (7), pp. 549 –568.
36. Schipper, L. and D. Hawk (1991), "More efficient household electricity use", *Energy Policy*, Vol. 19 (3), pp. 244-265.
37. Schipper, L., S. Bartett, D. Hawk and E. Vine (1989), "Linking life-styles and energy use: a matter of time? ", *Annual Review of Energy*, Vol. 14, pp. 273-320.
38. Scott, S. (1997), "Household energy efficiency in Ireland: A replication study of owner of energy saving items», *Energy Economics*, Vol. 19 (2), pp. 187-208.
39. Secord, P. and C. Backman (1974), "*Social psychology*", New York: McGraw-Hill.
40. Seligman, C., M. Kriss, J. Darley, R. Fazio, L. Becker, J. Payor (1979), "Predicting summer energy conservation from homeowners' attitudes", *Journal of Applied Social Psychology*, Vol. 9 (1), pp. 70 –90.
41. Stern, P. (2000), "Towards coherent theory of environmental friendly behavior", *Journal of Social Issues*, Vol. 56(3), pp. 407-424.
42. Stern, P. and G. Gardner (1981), "Psychological research and energy policy", *American Psychologist*, Vol. 36 (4), pp. 329-342.
43. Tonn, B. and L. Berry (1986), "Determinants of participation in home energy audit/loan programs: discrete choice model results", *Energy*, Vol. 11 (8), pp. 785-795.
44. Van Raaij, F. and T. Verhallen (1983), "A behavioral model of residential energy use", *Journal of Economic Psychology*, Vol. 3 (1), pp. 39 –63.

45. Vassos, S. and A. Vlachou (1997), “Investigating strategies to reduce CO_2 emissions from the electricity sector: the case of Greece”, *Energy Policy*, Vol. 25 (3), pp. 327-336.
46. Verhallen, T. and F. Van Raaij (1981), “Household behavior and the use of natural gas for home heating”, *Journal of Consumer Research*, Vol.8 (3), pp. 253 –257.
47. Walsh, M. (1989), “Energy tax credits and housing improvement”, *Energy Economics*, Vol. 11 (4), pp. 275-284.
48. Weber, C. and A. Perrels (2000), “Modelling lifestyle effects on energy demand and related emissions”, *Energy Policy*, Vol. 28 (8), pp. 549-566.

Appendix

Table A.1

Descriptive statistics of variables included in the models

Variable	N	Mean	Minimum	Maximum
con_light	500	0.78	0	1
con_appliance	500	0.85	0	1
rp_lamp_price	500	0.71	0	1
thermal_ins	500	0.34	0	1
night_lig_bill	500	0.44	0	1
save-en_env	500	0.60	0	1
res_h_env	500	0.60	0	1
age	500	36.45	19	76
sex	500	0.39	0	1
univ	500	0.21	0	1
married	500	0.50	0	1
member	500	3.31	1	9
lninmon	500	6.44	5.52	8.06
lnel	500	4.38	3.40	5.11
ownh	500	0.70	0	1
typeh	500	0.19	0	1
norooms	500	3.51	1	8
tm2	500	94.27	20	350
infoenv	500	0.75	0	1
cresp	500	0.74	0	1