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Features of Energy Saving Potential in Lithuanian Households

JEL Classification: *Q43; Q51; Q56; C92; D1*

Keywords: *energy saving potential; households; evaluation; behavior change*

Abstract: *Scientists from all over the world recognize that saving energy in households is currently a very relevant topic. Energy resources are a very important factor for each country's economic vitality. Not only the country's replenishment in energy resources is important, but also the reduction of energy consumption volume. The objective of the study: to assess the energy savings in households potential, applying the measures aimed at the behavior change of the population through energy-saving direction. Methodology: the impact of behavior change of the population measures is assessed according to the criteria of efficiency and effectiveness. In order to assess the potential for energy savings in households, the following methods, such as an experiment, the control group formation scenario, household questionnaire, were used. The questionnaire was designed to supplement the experiment, in order to gain deeper knowledge of the household, to obtain more detailed information about the nature of the behavior, to identify barriers to behavior change, and to select a control group of households to carry out the experiment. Data, results and main contribution of the paper: research shows that people's behavior related to energy saving is influenced by a number of mac-*

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ro-level and micro-level factors. In the article the assumptions of the changing behavior of population are analyzed and the assessment of the specific measures aimed at the behavior changes of the population and their implementation impact is conducted.

Introduction

Energy saving in households is recognized by various researchers as a very important and significant research subject. Currently, the bodies of research on behavioral economics for energy saving in households play an important role in the development of world's economic sciences. Energy saving in households can be realized in two directions: by changing the behavior and introducing product innovations (Steg, 2008, pp. 4449-4453; Gifford, 2011, pp. 290-302; Schiler *et al.*, 2008, pp. 1-15). Behavioural changes are primarily related to the implementation of the principles of sustainable consumption (Abrahams, 2011, pp. 1-11; Martinsson, 2011; pp. 5182-5191; Poortiga *et al.*, 2003, pp. 49-64; Godwy, 2007, p. 1-38; Girod *et al.*, 2009, pp. 5650-5661). Product innovation involve replacement of energy – inefficient appliances and old cars with the new ones, renovation of heating systems, using renewable energy sources for domestic use, etc. (Faiers & Neame, 2006, pp. 1797-1806; Zarnikau, 2003, pp. 1661-1672; Brownstone *et al.*, 2000, pp. 315-338; Ek, 2005, pp. 1677-1689; Nair *et al.*, 2010, pp. 2956-2963). Most of the studies and their authors, such as Abrahamse and Steg (2009, pp.711-720), Black *et al.* (1985, pp. 675-697), De Young (1993, pp. 485-505), Olson (1981, pp. 108-131), Stern (2000, pp. 408-424) focused on the social and psychological factors' influence on energy-saving behavior by examining the impact of cognitive variables, such as values, world views on energy preservation. Other authors have emphasized the importance of social processes (Homans, 1961, pp. 406; Garmendia & Stagl, 2010, pp. 1712-1722; Staats *et al.*, 2004, pp. 341-367) and the formation of sustainable behavior communities (Mckenzie-Mohr, 2000, pp. 543-554; 2001; Dulleck & Kaufman, 2004, pp. 1025-1032). A significant part of the studies was seeking to reveal the impact of information and different kind of feedback on energy-saving behavior (Darby, 2006; Iyer *et al.*, 2006, pp. 988-996; Faraqui *et al.*, 2009, pp. 1598-1608). Another important research unit includes the shaping of ethical, cultural and world-view as well as human capital dimensions of environmental behavior (Bamberg & Schmidt, 2003, pp. 264-285; Barnett & Serlet, 2008, pp. 210-224). Despite extensive research in this area, there is a lack of a unified methodology for evaluation based on the energy-saving potential in households which can be adapted to each particular country.

The individual behavioral studies in the fields of energy saving and sustainable consumption as well as sustainable lifestyle formation were hardly conducted in Lithuania, although Lithuania's dependence on imported fuels is high. Although some Lithuanian authors went deep into the energy saving in households (Balezentis, 2011, pp. 7322-7334, Cibinskiene & Navickas, 2011, pp. 144-151, Simanaviciene *et al.*, 2013, pp. 216-226, Streimikiene & Siksnielyte, 2014, pp. 891-904), the potential of household energy consumption and greenhouse gas emissions reduction by changing population's behavior is still not assessed in Lithuania, although this should be one of the most important goals for climate change mitigation policies aimed at the consumer side.

Theoretical Framework of Energy Consumption

In this section, the concepts of individual behavior, modeled from the perspective of energy consumption, are conveyed. The interface of individual behavior with energy consumption is revealed in the process. Attention in this paper is concentrated on the behavior which directly pertains to the needs for energy (electricity usage, fuel consumption), the assessment of such behavior as turning on the lights, the use of electrical appliances, cooking, washing, etc. (Streimikiene & Volochovič, 2011, pp. 4118-4124). It should be noted that the authors distinguish household energy saving behavior types into two main groups: productive behavior and energy consumption reducing behavior (Abrahamse & Steg, 2011, pp. 711-720). It is important to note that these types of behavior can be considered from an economic perspective – e.g. individual energy consumption behavior may be related to the monetary aspect, or, on the contrary, related to the valuable approach – e.g., the energy consumption behavior can be conditioned on the grounds of protecting the environment, which is of concern to individuals (Streimikiene *et al.*, 2012, pp. 3613-3620). The assessment at the macro-level, technological development, economic growth, demographic and institutional factors influence the development of our cultural behavior in the long run, while looking at the micro level and its incoming factors, such as motivation, skills and opportunities, adapts our behavior at the individual level (Abrahamse *et al.*, 2005, pp. 265-276). It should also be noted that the behavior of individuals is influenced by certain habits and some routine, which is carried out entirely without any thinking and spontaneously. It should be mentioned that the influencing factors can be grouped into internal (attitudes, norms, and beliefs) and external (institutions, rules, guidelines).

Other researchers add that in order to change the environmental behavior of individuals, it is necessary to take into account both the macro and the micro levels, in other words, both the internal and the external factors. How to make the best choice for behavior such as reducing energy consumption is a complex case. Nevertheless, empirical studies of energy consumption reveal a number of signs and evidence that the conditions laid down correctly have an impact on behavioral changes, and they can also be formed by public policies (Streimikiene *et al.*, 2012, pp. 3613-3620). Wilson and Dowlatabadi distinguish four perspectives of different nature examining the aspects of energy consumption by individuals. The first one, which is referred to neo-classical and behavioral economics, presents the traditional economic approach, distinguishing individual choices and behavioral aspects of the economy. Traditional economics identifies individuals as consumers seeking to gain the maximum benefit, where the benefit is defined as a measure of consumer choices.

The main idea of the behavioral economics which refers to consumer choice differs from the concept of benefits by various limitations, which were clarified by economic and psychological tests. Examining the pattern of benefit, attention is focused on the aspects of time inconsistency, system of approaches and limited rationality (Wilson & Dowlatabadi, 2007). Household savings potential studies evaluating the opportunity to save by increasing the efficiency and economy of use provide Dietz (Dietz *et al.*, 2009, pp. 18452-18456), Martinsson *et al.* (2011, pp. 5182-5191). The greatest potential for energy savings, according to the study conducted by Dietz and others, can be obtained by employing energy saving and efficiency measures that can save about 27% of the energy. Studies show that the consequences of the measures (feedback, awards) can increase the amount of energy savings. Therefore, the review of studies suggests that in order to maximize household energy saving it is important to apply certain packages of measures and to look at this issue holistically. Research shows that individual behavior with regard to energy consumption influence factors at macro and personal levels. The macro-level factors include technological progress, economic development level, demographic, institutional and cultural factors of the country, while the personal factors include individual human characteristics, attitudes, beliefs, norms, motivation, skills, knowledge and habits, routines. Energy consumption behavior of the population is mostly dependent on the habits and routine. This kind of behavior is difficult to change, because it is partly determined by the characteristics of the individual devices used, but it is more important that it is influenced by internal and external factors, such as beliefs, values, attitudes and behav-

ior of other individuals, cultural restrictions, as well as economic initiatives and restrictions.

An empirical study analysis (Noeren, 2007) showed that the measures aimed at the habits and routine procedure changes, such as information disclosure, goal setting and feedback of energy consumption and significant social influence enables to save energy consumption in households, but the most thoroughly examined studies faced numerous methodological shortcomings, e.g. there was only one type of measure used in the study, or there were several measures used, but the impact on energy savings of each measure was not distinguished. Studies have shown that obtaining regular and effective feedback on energy consumption behavior gives an opportunity for individuals to change their behavior, especially if their current behavior is not consistent with their values or beliefs. The feedback also provides many benefits, changing the attitudes of individuals, revealing bad habits and helping to avoid them.

Methodology to Assess Energy Savings in Households

As shown by the study conducted, which was a research for energy saving potential of households, changing the behavior has to cover both the macro and micro levels and to determine what the potential energy savings are, as well as greenhouse gas emission reduction in households after such behavior, with change measures as information disclosure, goal setting and energy consumption feedback realized afterwards. The essence of the assessment methodology contains impact assessment and recommendations of theoretical assumptions for the change of population's behavior, selection and implementation of specific policy measures aimed at population behavior's changes. In order to assess the potential for energy savings in households caused by behavioral changes, it is very important to determine the contribution of the household to energy consumption and its importance seeking goals of energy efficiency policy. Here the comparative analysis of energy consumption in household sector and correlation-regression analysis of main determinants of energy consumption trends play a very important role.

To assess the potential for energy savings in households and new energy-saving measures, it is important to examine the existing energy-saving measures in Lithuania, and to compare them with those for other countries, to determine whether Lithuania's energy saving policies to encourage households for energy saving are sufficient. Here the SWOT and PEST

analysis of the Lithuanian energy efficiency policies, targeted to households play an important role. As energy saving by households can be achieved both by changing behavior and introducing product innovations, it is important to distinguish these possible energy-saving options in households and to compare them according to the energy saving potential and costs. Seeking to support the selection of new energy-saving measures, it is important to compare the potential and cost of energy saving supported by these measures with policy measures, adopted in other sectors. Potential savings in households, introducing product innovations have been evaluated through the analysis and summary of studies carried out in Lithuania and results of the energy efficiency program. The most complex and longest stage of the research involves assessment of energy-saving potential in households. It consists of several key stages and includes a number of research organization and implementation techniques, such as scenario building, selection of measures aimed at formation of energy-saving behavior of households and implementation of these measures in control-households.

The effect of measures implementation should be assessed by determining the energy savings achieved in the households which participated in the control household groups. Another important aspect related to the assessment of energy-saving potential in households is registration and tracking of energy consumption. Therefore it is necessary to prepare docket and to train households to fill them in. The analysis of treatment group's social, demographic and psychological characteristics and their impact on behavior change is important. In order to prepare the experiment and to form a control group of households, it is necessary to carry out the questionnaire random household survey, based on more detailed information about the household. A questionnaire survey is designed to complement the experiment to examine in depth knowledge about household, to obtain more detailed information about the nature of the behavior, to identify barriers for behavior change and to select a control group of households to carry out the experiment. After the evaluation of the questionnaire survey results, the control group of households is formed. It is selected on the basis of the average Lithuanian demographic indicators and statistical characteristics of Lithuanian households, such as age, household size, education, income, living space. The experiment was carried out according to two scenarios: basic and energy saving. Under the basic and energy saving scenarios, the energy consumption in households was recorded. Registration was carried out according to the prepared docket, where the duration of all household activities related to energy consumption was recorded, in another docket the records of aggregate energy consumption per one month were regis-

tered. Under the proposed energy-saving scenario the measures were designed to change the behavior of the household:

- each household attended seminar about energy-saving opportunities;
- the goal for 20% energy saving was raised, identifying that a number of households will compete for energy saving achievement;
- specific energy-saving measures in three areas were proposed for households: energy saving, fuel saving in transport and changes of life-style.

A feedback was ensured: one month after the goal setting the energy consumption in household was checked. After the implementation of energy-saving scenario (goal setting and proposed measures for saving), the amount of saved energy by the energy-saving scenario was estimated, summarizing the results of all households which participated in the experiment. The data for estimation was collected from the records in dockets of energy consumption, summarized monthly. For better results, the study lasted for four months: two months in the summer and two months in the winter. Basing on the test results, recommendations for the promotion of new energy efficiency measures for implementation in households were formulated.

Research

The objective of the research was to assess the potential for energy saving in households by means of measures aimed at the change of individual behavior for energy-saving. As a household, we understand people living together in one house. The concepts of family and household are different, although sometimes interchangeable. Family – a group of two or more people related by marriage, blood ties or adoption and residing together. TV, computers, furniture, food are used not so individually as in households.

Under the basis of the average household characteristics, the experiment group of participating households was formed. From the selected volunteers, who replied to a questionnaire of a survey, the households were selected so that the demographic characteristics of the study group would meet the proportions of the Lithuanian population. The results of the questionnaire determined volunteers (40 households) who responded and completed the questionnaire, with the households selected so that the demographic characteristics of the research group would meet the population proportions. The tasks of the research were as follows:

- to evaluate the energy saving potential in households using measures influencing behavior,
- to disclose the essential barriers that disturb the change of behavior,
- to identify the key factors that determine the changes of behavior.

A half of the households selected for the research consist of a family with two people, more than a half of the members in surveyed households have a university education, monthly income does not exceed 260 euro in the majority of the surveyed households, average household size was 2,4. Working-age people (20-59 years.) accounted for about 67 per cent, up to 19 years aged people accounted for 12 percent. Since more than 80 percent of Lithuania's urban population lives in apartment buildings, they were chosen as the target group.

Research process:

- formation of the scenario,
- selection of the measures for behavior change regarding energy consumption,
- preparation of two types of docketts,
- the selection of experiment participants for the control group,
- presentation of information and training for experiment participants how to fill in the docketts,
- setting of a goal and anticipation of measures,
- feedback – determination of the results achieved,
- presentation of conclusions.

Assuming that household energy consumption in summer and winter time is different, the experiment was carried out both in the summer and winter seasons. The survey was designed for four months: two months during the summer season and two months during the winter season.

Two main scenarios were formed for the experiment:

- Basic scenario: every day during one summer and during one winter month until the goal setting the data about households activities related to energy consumption were recorded in the docket in order to be able to evaluate the energy consumption in households without any energy saving measures later.
- Energy-saving scenario: after the evaluation of primary situation, goal setting and introduction of certain energy saving measures, in the docket the data of activities related to energy consumption were recorded every day during one summer month and every day during one winter month, in order be able to evaluate the energy savings in households using energy-saving measures aimed at behavioral change later.

- Seeking to determine the amount of consumed energy data recorded on the characteristics of electric appliances, readings of electricity, gas and water meters were taken into account.

The data obtained for the experiment from each household was summarized in a consolidated docket. Basing on the recorded information summarized in the dockets from all participating households, the average amount of saved energy in Lithuanian households, implementing the measures aimed at the behavioral change was determined. Based on the survey results, the main factors (age, education, size of the family, income, attitude to environmental protection and energy consumption, etc.) determining the energy savings potential in households were identified. The survey identified the key barriers hindering the change of household behavior: lack of knowledge, distrust of information sources, inertia, values, etc.

It should be noted that consumption of heat in households was not assessed in the survey as the chosen households – apartment dwellers were unable to control the heat consumption. Total energy saving potential of households was assessed separately in groups of households, summarizing data, registered in the dockets. The resulting energy savings were converted into conditional fuel using the fuel calorie table.

For the energy-saving scenario, the following energy-saving measures in households were offered for residents:

- For reduction of electricity consumption: turning electric lights off when leaving the room, less time for the TV and the computer, washing by lower temperature, washing in "eco" mode, turning off the devices in standby mode, frequent defrosting of refrigerator.
- In the field of transport: the use of public transport, cooperation with others to travel to work, covering short-distances by cycling, "gentle" driving, speed reduction;
- In the field of lifestyle changes: consumption of local products, reducing the amount of meat in diet.

The feedback was ensured: one month after the goal setting the household energy consumption was checked. After the evaluation of average energy savings in examined households, we determined that one household during the summer month can save on average: 28.5 kWh of electricity, 0.9 m³ of natural gas, 20.9 l of gasoline or diesel fuel; respectively, in winter households can save on average: 21.5 kWh of electricity, 1 m³ of natural gas, 16.2 l of gasoline or diesel fuel. After application of the conversion coefficients, the energy saving potential was calculated in GJ or toe. After the conversion, it was determined that one household during the year, through the change of behavior and with no additional cost, can save 0.73 GJ (0,036 toe) of energy per month or 8.8 GJ (0.21 toe) of energy per year.

On the basis of the data about the number of households in Lithuania (1,425 million) obtained from the Statistics Lithuania, the energy-saving potential of changing population's behavior in households during the cold season is about 5.7 PJ, and during the warm season – 6.84 PJ. Total energy saving potential in households exceeds 12.5 PJ or 0.294 Mtoe / year.

Comparing the energy-saving potential of changing the behavior of households and applying innovations, it can be noticed that the energy saving potential of applying innovations is higher, but it requires large investments. Meanwhile, the energy saving potential in the sector of energy supply is less than in households. Comparing the cost of energy saving in households applying innovations with energy-saving costs in energy supply sector, the cost of energy-saving in energy supply sector is lower than the cost of energy-saving in energy consumption sector, but energy saving in households, changing people's behavior does not require any investment, yet enables to save.

Conclusions

A conducted research has showed that, comparing the energy saving potential by changing the behavior of households and applying innovations, it can be seen that the energy saving potential in innovations is higher, but it needs large investments. It is necessary to change the climate change mitigation policies and to redirect it to energy consumption sector in Lithuania. It is also proposed to pay more attention to climate change policy at the local and regional level: to set goals, to provide adequate support, knowledge and experience on how to combat climate change in daily life, as well as implement long-term projects. It is recommended to direct climate change mitigation policies from the expensive project financing in the energy supply side and to pay more attention to soft, society educating and behavior changing projects.

1. It is proposed to incorporate energy-saving measures aimed at changing the behavior of households to the National Energy Efficiency Program. It is important that these measures would include an integrated set of measures: targeted information, goal setting and feedback, because, for example, the mere awareness and educational campaigns are not sufficient to result in significant savings.

2. Transfer of the energy efficiency policy development and responsibility of its implementation and appropriate resources to relevant authorities (local government, community groups) would ensure the appropriateness of the measures in the region and enhance their acceptability.

3. Recommendations for implementation of energy efficiency policy in Lithuania:

- to raise the savings targets at the local level, to encourage the establishment of multi-saving programs in communities, to use the groups impact to saving goals;
- to install an online carbon feet calculator;
- to introduce the eco-labeling for all appliances used in household;
- to promote and finance housing audits and integrate feedback mechanisms;
- to apply informative bills for heating, hot water;
- to promote the use of bicycles, to improve infrastructure;
- to encourage the use of public transport, to prohibit entry by private cars to the city center and the old town;
- to organize car-free days;
- to promote the sharing of family cars and gentle driving;
- to pay more attention in the education sector to improve the knowledge of teachers and to raise pupils' awareness;
- to pay more attention to social advertising in the mass media; to disseminate the information on GHG emissions, and the effects of household consumption on GHG emissions;
- to support “behavioral change” leaders – include public figures in the process of behavior change. They should serve as an example

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