

# THE IMPACT OF INTERVENTION MEASURES ON HOUSEHOLD ENERGY CONSERVATION AND GHG EMISSION REDUCTION IN LITHUANIA

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**Abstract.** Household energy conservation and GHG emission reduction have been a topic of interest within applied social and environmental psychological research for a number of decades. Especially with commitments made by Intergovernmental Panel on Climate Change (IPCC) to take more efforts to assess the impact of behavioural changes on GHG emission reduction in their Fifth Report this field of researcher is gaining a lot of attention recently.

The article deals with the effectiveness of interventions aiming to encourage households to conserve energy and provides comparison of results of intervention studies aimed at household energy conservation in other countries with the case study conducted in Lithuania. The pilot study conducted in Lithuania aimed at evaluation of energy saving and GHG emission reduction potential in households by applying intervention measures targeting household behavioural changes.

The study conducted in Lithuania revealed that energy saving potential makes 0.132 tne per year and GHG emission reduction potential in Lithuanian households makes 1.95MtCO<sub>2</sub>/year. In comparison to saving potential and measures used for encouraging households to save energy in other countries, climate change mitigation policies used for Lithuanian households are not sufficient for exploiting all GHG mitigation potential.

**JEL classification:** Q5.

**Key words:** energy conservation, climate change mitigation, GHG emissions, interventions, behavioural changes, households.

**Reikšminiai žodžiai:** energijos taupymas, klimato kaitos švelninimas, intervencinės priemonės, elgsenos pokyčiai, namų ūkiai.

## 1. Introduction

Climate change is considered as one of the most important environmental problems in the whole world, EU and Lithuania. The challenges of climate change can be overcome in two ways—decreasing the demand and increasing the part of the energy that is cre-

ated by new and renewable energy recourses. According to research made in this field, there is a great energy saving and GHG emission reduction potential in households. This means that more efficient energy consumption would lead to better implementation of climate change requirements as well as smaller households' energy bills and thus improvement of daily life of every person. The right choices for residential measures to save energy can significantly reduce GHG emissions in households and help country to achieve GHG emission reduction targets set by international commitments including UNFCCC Kyoto protocol and the following international climate change mitigation regimes after Kyoto. It is commonly understood that households must change their behaviour to reduce problems related increased energy consumption and climate change therefore in the search of cheap GHG emission reduction measures households are an important target group because they are responsible for more than 20% of total energy consumption in developed countries. In addition, waste management and responsible consumption of products is the key issue in GHG emission reduction.

Lithuania after the closure of Ignalina NPP faces the increase in GHG emissions however Lithuanian climate change mitigation policy is targeting mainly supply sector and the priorities for GHG emission reduction are set on production side—building a new nuclear power plant at Visaginas. However, also available are cheap energy saving and GHG emission reduction measures at demand side. Such measures as antecedent and consequence interventions are not popular in Lithuanian climate change mitigation policy. The aim of the paper is to estimate the possibilities of energy saving and GHG emission reduction in Lithuanian households while changing their behaviour and to compare findings with the results of studies conducted in other countries.

The main aims of the paper to achieve the target are:

- To review intervention measures targeting behaviour changes
- To review results of intervention studies targeting behavioural changes;
- To conduct case study in Lithuania
- To compare results of Lithuanian case study with other intervention studies conducted

## **2. Intervention measures**

Behaviours related to household energy conservation can be divided into two categories: efficiency and curtailment behaviours (Gardner & Stern, 2002). Efficiency behaviours are one-shot behaviours and entail the purchase of energy-efficient equipment, such as insulation. Curtailment behaviours involve repetitive efforts to reduce energy use, such as lowering thermostat settings. Most policies are aiming at both efficiency and/or curtailment behaviours, with the later seeming somewhat overrepresented. This is striking, because the energy-saving potential of efficiency behaviours is considered greater than that of curtailment behaviours (e.g. Gardner & Stern, 2002). For instance, households may save more energy by properly insulating their homes than by lowering thermostat settings. It should be noted however, that energy-efficient appliances do not

necessarily result in a reduction of overall energy consumption when people use these appliances more often (the so-called rebound effect). Here, the importance of the interplay between macro-level (e.g. technological innovations) and micro-level factors (e.g. knowledge of efficient use of technological innovations) becomes apparent.

Various social and environmental psychological studies have embarked on issues related to household energy use. One line of research focuses on testing the effectiveness of intervention strategies aiming to change energy-related behaviours. Another line of research is theory driven and aims to identify underlying determinants of energy use, such as attitudes (Becker, 1978) and socio-demographics. In some studies, both the effectiveness of an intervention as well as (changes in) underlying determinants of energy use are monitored simultaneously (Geller, 1981; Staats et al., 2004). Some studies give additional insight into reasons why interventions were successful or not, and as such, they are a starting point for the further enhancement of an intervention's effectiveness.

Various types of strategies can be implemented to encourage consumers to reduce energy use. Some energy conservation initiatives are aimed at maintaining the same behaviours with greater efficiency by means of technological innovations, while others intend to foster curtailment of these behaviours (Gardner & Stern, 2002). Two categories of interventions may be distinguished: (i) structural and (ii) psychological interventions (Steg, 2003; Portiga et al., 2004). Structural interventions aim to change the (social) context in which behavioural decisions take place. The general idea behind these types of interventions is that by altering the conditions in which behaviour takes place, behaviour will change accordingly. Generally, three structural strategies are distinguished (Steg, 2003): financial-economic measures, physical/technical alternatives and legal regulation. First, energy conservation may be encouraged by means of financial-economic measures, aimed to make energy-intensive behaviours relatively more expensive and environmentally-friendly alternatives relatively less expensive. To illustrate, increasing the costs of energy use by means of a tax on the use of gas and electricity may entice households to reduce their energy use (Streimikiene, Ciegis, 2010). Furthermore, increasing the prices of products that require much energy may encourage households to choose less energy-intensive alternatives. These kinds of measures are only effective to the extent that consumers take prices into account when making such choices. Second, physical/technical alternatives involve changes to already existing infrastructure and equipment; such as the introduction of energy-efficient appliances, or hydrogen fuel cell technology. It has been acknowledged that efficiency improvements are necessary for sustainable development (Steg, 2003; Abrahamse, 2007). However, technological innovations can only be partial solutions, as the effectiveness of technological measures hinges upon the adoption of new technology by consumers and the extent to which consumers know how to use these technologies efficiently. Possible rebound effects may occur, in that consumers may increase the use of efficient appliances, counterbalancing initial efficiency gains. Third, legal regulation entails the introduction of legislation by the government, such as speed limits for cars in order to reduce carbon dioxide emissions. Generally, behaviour that deviates from these regulations is met with some form of punishment. The assumption is that these rules and

regulations will eventually become internalized. Regulatory measures may be an effective strategy for behavioural change, provided the monitoring and enforcement system works properly. Psychological interventions are aimed at changing already existing perceptions, knowledge, attitudes, norms and values (i.e. individual-level variables). The underlying assumption here is that by changing these perceptions, behaviour will change accordingly. Typically, a distinction is made between antecedent interventions and consequence interventions (Geller, 2002). Antecedent interventions are focused on changing one or several determinants before behaviour takes place. Examples of antecedent interventions are commitment, goal setting, modeling and information. To illustrate, the provision of information about energy-saving measures at home is presumed to lead to an increase in household knowledge of energy conservation, which in turn should—ideally—result in the adoption of energy saving behaviours.

Consequence interventions are based on the assumption that when positive or negative consequences are attached to a certain behaviour, this will subsequently lead to an alteration of this behaviour. Feedback is an example of a consequence intervention. For instance, when households receive feedback about their efforts to reduce energy use, they may, as a result of the positive consequences attached to their behaviour, be motivated to conserve energy.

Structural and psychological interventions have been employed to encourage household energy conservation, with varying degrees of success. In determining the effectiveness of interventions aimed at behavioural changes, it is important to examine the extent to which the intervention results in energy savings, behavioural changes and changes in behavioural antecedents because these measures provide a suitable basis for the further development of effective intervention planning. Interventions targeting behavioural changes can be grouped into 3 categories (Table 1).

**Table 1.** Interventions targeting behavioural changes

<b>Interventions</b>	<b>Example</b>
Antecedent interventions to promote household energy conservation.	Commitment, goal setting, information and modelling.
Consequence interventions	Feedback, Rewards, Prompts
Social interactions	Commitments, groups

Environmentally relevant behaviour, such as household energy use and conservation, are related to a broad range of factors. As has been argued above, household energy use is related to structural variables, such as economic growth and to individual level variables, such as individual perceptions and knowledge.

### **3. Interventions aiming at curtailment behaviour**

The antecedent interventions are measures to promote household energy conservation. As mentioned earlier, antecedent interventions influence one or more determi-

nants *prior* to the performance of behaviour. That is, interventions (e.g. information) are aimed at influencing underlying behavioural determinants (e.g. knowledge), which in turn are believed to influence behaviour. The following interventions are considered antecedent interventions: commitment, goal setting, information, and modelling.

A commitment is an oral or written promise to change behaviour (e.g. to conserve energy or reduce GHG emissions). This commitment in some cases is linked to a specific goal, for instance, to reduce energy use by 5%. The commitment can also be made public, for instance, by means of an announcement in the local newspaper. Then, social norms and the public opinion may play a role as determinants of conservation behaviour. Some measures of the effect of commitment on electricity consumption, by means of the so-called foot-in-the-door technique were performed (Abrahamse et al, 2005). The assumption behind this technique is that compliance to a first (smaller) request will result in compliance to a subsequent (bigger) request. Usually in the case of commitment, households either received a (small) request to fill out a questionnaire, a (bigger) request to sign a commitment to conserve energy by 10%, or both requests. The commitment usually is accompanied by information about energy conservation (Abrahamse et al, 2005). A field experiment was conducted in the US to evaluate comparatively the effectiveness of two community interventions designed to reduce energy consumption. Building on prior research which discovered that energy conservation could be increased if residents perceived themselves to be publicly committed to conservation, the conducted research contrasted “mild” and “strong” forms of public commitment. The results suggested that the milder form of public commitment which simply associated volunteers in an energy conservation program to community conservation efforts was more effective than a strong commitment intervention (Shippee, Gregor, 1982).

A goal setting is the giving of a reference point for households, for instance to save 5% or 10% of energy. A goal can be set by the experimenters, or by the households themselves. This type of intervention is usually used in combination with other interventions, such as feedback or as commitment to conserve a specific amount of energy. The study conducted by Becker (1978) gave households either a relatively difficult goal (20%) or a relatively easy goal (2%) to reduce electricity use. The goal was either combined with feedback (three times a week), or not. All households participating in the study received information on which appliances used most electricity. Households who received a difficult goal and feedback conserved more than 15% of electricity consumed. The others who received just a goal without feedback were not able to achieve considerable energy savings. This indicates that in order for a goal to work, households need feedback on how they are performing in relation to the goal. An easy goal appears not to be effective at all; 2% may have been perceived as not being worth the effort to save energy.

Another study (McCalley, Midden, 2002) has applied goal setting in combination with feedback to one specific energy-related behaviour: doing laundry. A goal setting procedure was used, and immediate feedback was given about the average amount of energy (kWh) used per washing trial, displayed in a simulated control panel of a washing machine. Participants who had been given a goal as well as feedback saved more energy per washing trial than participants who had only received feedback (without a

goal). No significant difference emerged between participants who had been able to set a goal themselves and those with an assigned goal (Abrahamse et al, 2005; Becker, 1978; Bittle et al., 1979; Brandon, Lewis, 1999; Gerdes, 2009).

Information is a very often used strategy to promote energy conservation behaviours. This may be general information about energy or environment related problems, or specific information about various energy-saving measures households can adopt seeking to achieve significant energy savings or GHG emission reductions. Providing information serves to increase household awareness of energy and environmental problems and their knowledge about possibilities to reduce these problems. Information about energy conservation can be presented to households in several ways: workshops, mass media campaigns and tailored information.

The effectiveness of a workshop, in which information about energy-saving measures was given, was studied in (Geller, 2002). During this experiment each participant received a shower-flow restrictor and a booklet with information about possible measures on energy conservation. Home-visits revealed no differences between workshop participants and others in the number of adopted energy-saving measures. So, Geller (2002) concluded that although information did influence underlying determinants of energy use, it did not result in behavioural changes.

Another measure to disseminate information is energy saving campaigns in mass media. Studies (Luyben, 1982) evaluated the impact of information on thermostat settings and energy savings provided by TV in the US on energy savings in households. The study revealed that there was no difference in thermostat settings between those who had heard the information on TV and those who had not. Interestingly, self-reported thermostat settings appeared to be significantly lower than those observed by interviewers, pointing to a possible influence of social desirability.

Another study evaluated a mass media campaign of the Dutch government, aimed at communicating the nature and causes of global warming, and possible ways of dealing with it (Staats et al, 1996). A survey revealed a slight increase in knowledge, but levels of awareness of the problem remained unchanged. Preparedness to behave pro-environmentally increased, but only among those who had already been behaving pro-environmentally before the mass media campaign (Portiga et al., 2003).

Tailored information is highly personalized and specific information. An advantage of this approach is that participants receive relevant information only, rather than getting an overload of general information, which may not always apply to their household situation. Examples of tailoring are energy audits, i.e. a home visit by an auditor who gives households a range of energy-saving options based on their current situation. For instance, they may advise a household to apply insulation and lower thermostat settings and other measures related with curtailment behaviour (Abrahamse et al., 2007).

The studies conducted in this field showed that home energy audits (providing information on heating and air conditioning) is a very efficient intervention measure to increase energy savings at households (Abrahamse, 2003; 2007).

Modeling, based on Bandura's learning theory (Abrahamse, 2003) entails providing examples of recommended behaviours. It is assumed that these examples will be



followed when they are understandable, relevant, meaningful and rewarding or providing positive results to people. Before and after measures revealed a significant increase in knowledge for the experimental group, but not for the control group. A follow-up study one year later showed that the energy savings were not maintained.

Feedback is often applied to promote energy conservation. Feedback consists of giving households information about their energy consumption, or energy savings. It can influence behaviour, because households can associate certain outcomes (e.g. energy savings) with their behaviour. Ideally, feedback is given immediately after the behaviour occurs (Geller, 2002). There is a differential effect of feedback frequency (Abrahamse, 2003). More frequent feedback allows receiving more significant changes in energy savings. In addition the feedback about individual performance relative to performance of others may be helpful in reducing household energy use as well. By giving comparative feedback, a feeling of competition, social comparison, or social pressure may be evoked, which may be especially effective when important or relevant others are used as a reference group (Steg, 2008; Steg et al, 2006). Positive effects have for instance been found for continuous feedback (McClelland, Cook, 1980).

Monetary rewards may serve as an extrinsic motivator to conserve energy. Rewards can either be contingent on the amount of energy saved, or a fixed amount (e.g. when a certain percentage is attained). Overall, rewards seem to have a positive effect on energy savings: all studies reviewed here report significant differences between households who had received a reward and those who had not. Results of several studies (McClelland & Cook, 1980; Slavin et al. 1981) indicated that the effect of rewards is rather short-lived.

In the following chapter the results of studies targeting curtailment behaviour conducted in US, Netherlands, UK and Switzerland are presented.

#### 4. The review of studies conducted in the field

The review of results of behavioural changes studies conducted in UK, US, Netherlands and Switzerland are summarized in Table 2.

**Table 2.** Survey of energy conservation at households studies in UK, Netherlands, Switzerland and USA

Country	Authors	Interventions	Design	Target behaviour	Saving effect %
USA	Becker, 1978	Feedback; Goal setting; Information	1) 20% goal, feedback 3 × per week; 2) 2% goal feedback 3 × per week; 3) 20% goal 4) 2 % goal; 5) Control	Electricity use	1) 20% goal, feedback 3 × per week—15,1% 2) 2% goal, feedback 3 × per week—5,7% 3) 20% goal—4,5% 4) 2 % goal—0.6%

Country	Authors	Interventions	Design	Target behaviour	Saving effect %
	Bittle et al, 1979	Feedback	1) Daily feedback (costs); 2) Control	Electricity use	4%
	Slavin et al, 1981	Rewards Feedback Information Prompts	Combination of measures	Electricity use	6,2% (from 1.7% to 11.2%)
	McMakin, et al, 2002	Information tailoring	Information	Gas and electricity use related to heating	10% saved energy during year 2 % saved energy during 4 months
	Gardner, Stern, 2009	Information: on measures to increase energy use efficiency	Information	Energy consumption, transport	27%
<b>UK</b>	Brandon, Lewis, 1999	Feedback	1) Comparative feedback; 2) Individual feedback; 3) Cost feedback	Electricity use	1) Comparative feedback—4,6% 2) Individual feedback—1.5% 3) Cost feedback—4,8%
	Fisher, Irvine, 2010	Information; Feedback Social interactions; Consultations	1) Information 2) individual and comparative feedback	Water, gas and electricity use, waste	Total CO <sub>2</sub> : 17% Electricity: 7% Gas: 21% Water: 15% Waste: 20%
<b>Netherlands</b>	Staats, et al, 1996	Information in mass media			After media campaign increase in willingness to show pro-environmental behaviour has increased among those already acted pro environmentally
	Vollink, Meertens, 1999	Feedback; Goal setting; Information	1) Information, goal setting, feedback 2) Control	Water gas and electricity use	water: 18% Gas: 23% Electricity: 15%
	McCalley, Midden, 2002	Feedback; Goal setting	1) Feedback; 2) Feedback, with self-goal setting; 3) Feedback with assigned goal 4) Control	Laundry	Feedback with individual goal setting was more efficient comparing with Feedback alone. Feedback with self goal setting 21,9%; Feedback with assigned goal—19.5%



Country	Authors	Interventions	Design	Target behaviour	Saving effect %
	Staats et al, 2004	Information Individual feedback, Comparative feedback	1) Information, individual and comparative feedback 2) Control	Water, gas and electricity use, waste and transport	Gas—20,5% Electricity—4,6% Water—2,8% Waste—32,1%
	Fisher, Irvine, 2010	Information; Feedback, Social interactions; Consultations	Information individual and comparative feedback	Water, gas and electricity use, waste	Electricity—7% Gas—23% Water—5% Waste—30%
<b>Switzerland</b>	Noeren, 2007	Education	Capacity building of consultants	Water, gas and electricity use	10%

(Abrahamse et al, 2005; Fisher, Irvine, 2010; Gardner, Stern, 2009)

As one can see from the research results generalized in Table 2 the information provision is not enough to change behaviour of energy consumers. With the inclusion of feedback in intervention measures the energy saving increased in all cases analysed. Also the increase in energy saving can be achieved by implementing the goal setting with the feedback. Especially important in this case is the social interaction as the individual keen to save more energy than his achievements are being compared with others and some competition elements are involved in energy saving behaviour.

The biggest energy saving achievements were obtained by research conducted in the UK. G. T. Gardner and P. C Stern (2009) showed that households can achieve the energy savings of 27% of all energy consumed by households due to energy saving measures and behavioral changes. Nevertheless conducted studies indicated that consequence interventions (feedback and rewards) can increase energy saving considerable. Therefore it is necessary to apply a holistic approach and introduce several packages of interventions seeking to obtain considerable increase in energy savings by households behavioral changes.

### 5. Lithuanian case study

The energy saving study conducted in Lithuania in 2010 was aiming to evaluate the impact of several intervention measures on energy savings and GHG emission reductions in Lithuania achieved due to behavioral changes (curtailment behavior). The interventions applied: the goal setting and provision of information on energy saving measures in households. The feedback was applied for control group seeking to evaluate results achieved. The control group was selected based on households survey. The 6 households living in multi-flat buildings in the capital of Lithuania were selected. The main characteristics of the control group are presented in Table 3.

**Table 3.** Households in the control group

No.	The number of inhabitants	Age group	Children	Education	Income, Lt
<b>1<sup>st</sup> household</b>	2	18-25	-	Higher	3001-4000
<b>2<sup>nd</sup> household</b>	3	26-35	1	Higher	2001-3000
<b>3<sup>rd</sup> household</b>	4	26-35	2	Secondary	3001-4000
<b>4<sup>th</sup> household</b>	4	36-45	2	Higher	4001-5000
<b>5<sup>th</sup> household</b>	2	46-55	-	Higher	2001-3000
<b>6<sup>th</sup> household</b>	2	36-45	-	Higher	More than 5000

As one can see from information provided in Table 3 half of households consist of 2 members and almost all households, except the third household, have higher education. 66% of households in the control group have a monthly income of up to 4000 lt.

The experiment was conducted during 4 months as energy consumption patterns differ during summer and winter seasons. Therefore the experiment lasted 2 months in summer and 2 months in winter. The experiment was conducted by applying 2 scenarios—baseline scenario: the energy consumption in households was registered in special journals according doing nothing or basic scenario without any behavioural changes and energy saving measures. The registration was performed during 2 months (June and January);

Energy saving scenario: after evaluation of results of basic scenario the goal was set for energy savings and tailored information was provided for households based on analysis of their energy consumption patterns registered during doing nothing scenario. The households were required to fill in energy journals during two months (July and February).

The GHG emissions were evaluated based on energy consumption records for baseline and energy saving scenarios. The carbon footprint developed by UK was applied for conversion of energy to GHG emissions Carbon Footprint Calculator (2011).

The survey conducted before experiment allowed selection of households willing to participate in the experiments and to evaluate their environmental cautions and alertness in environmental pollution and climate change.

The conducted survey of households (100 households were surveyed) in Lithuania revealed that households neither have information about GHG emission reduction nor energy saving goals set in Lithuanian policy documents. The biggest share of respondents (66%) indicated that for GHG emission reduction responsibility should be taken by the Government of Lithuania. Just 16% of respondents thought that for GHG emission reduction the main responsibility lay on individuals. Therefore the biggest share of households surveyed in Lithuania does not take responsibility for GHG emission reduction. Such results indicate low environmental awareness and cautions in Lithuania. 83% of respondents stated that they lack information on energy saving measures and climate change mitigation policies in Lithuania. 66% respondents consider that en-

environmental situation and policy in Lithuania are not favourable for energy savings. Among the main energy saving measures applied by households in Lithuania are: energy saving bulbs (66%) and use of shower instead of bath (33%).

After evaluation of survey results the following interventions targeting curtailment behaviour were selected:

- The workshop was conducted for 6 households (control group) selected as willing to participate in experiment. During this workshop the climate change problem and climate change mitigation policies and measures were introduced to workshop participants. The impact of energy savings on GHG emission reduction was emphasized and the measures to save energy and reduce GHG emission at households were presented;
- Energy saving target was set for households—reduction of monthly energy consumption by 20% by announcing that 6 households will compete seeking to implement the same target;
- Several measures were proposed for energy savings in households related with curtailment behaviour:
  - Reduction of energy consumption by switching of electricity then leaving the room, shortening the time for watching TV set, using PC, washing at lower temperatures and using eco regimes or replacing automatic washing by hand washing; limiting the time of use of shower; switching of appliances from standby regime; the use of refrigerator, ovens and other appliances according to instructions;
  - Reduction of fuel consumption by car: the use of public transport, use of bicycle instead of car, walking instead of using car or public transport, ecological driving and keeping relevant speed during drive, use of one car for few families;
  - The behavioral changes in consumption patterns: use of local products, the reduction of meat consumption, the sorting of waste and use of such measures as
- The feedback was ensured by evaluating the results in achieving the set goal.

It is necessary to remind that heat savings were not included in evaluations as households in multi-flat buildings do not have the ability to regulate heat consumption in apartments.

Energy saving potential was evaluated by analysing registration journals filled in by 6 households during 4 months. Table 4 generalizes result of energy savings by households obtained during one month in winter and summer.

As one can see from information provided in Table 4, the average energy savings during a month obtained by the 6 households makes about 16.75 kWh of electricity, 0.17 m<sup>3</sup> of natural gas and about 13.47 l of fuels. These energy savings can be converted into tne by applying calorific values for energy carriers. Therefore one household in Lithuania can save on average about 0.011 tne of energy per month or about 0.132 tne per year. Based on data of Department of Statistics (2010) there are 1.39 million households in Lithuania and the total energy saving potential in households make about 0.18 Mtne in Lithuania.

**Table 4.** Energy savings in winter and summer seasons by comparing energy consumption according baseline and energy saving scenarios

Households	Motor fuel consumption, l		Natural gas savings, m3		Electricity savings, kWh	
	Winter	Summer	Winter	Summer	Winter	Summer
1 <sup>st</sup> household	44	38,1			6	5
2 <sup>nd</sup> household	0,6	11			31	20
3 <sup>rd</sup> household	3	2,5			20	9
4 <sup>th</sup> household	10	15			11	10
5 <sup>th</sup> household	4	3,5	1	1	22	30
6 <sup>th</sup> household	16	14			30	11

The saved energy was evaluated in GHG emission reductions by applying the carbon footprint. The achieved energy saving during experiments conducted in Lithuanian indicated significant GHG emission reduction potential in households due to curtailment behavior. Monthly GHG emission reductions in winter and summer are presented in Tables 5-6.

**Table 5.** GHG emissions during according baseline and energy saving scenarios in summer

Households	Monthly GHG emissions according baseline scenario, t	Monthly GHG emissions according energy saving scenario, t	GHG emission reductions %
1 <sup>st</sup> household	0.75	0.60	20%
2 <sup>nd</sup> household	0.46	0.39	15%
3 <sup>rd</sup> household	0.44	0.38	14%
4 <sup>th</sup> household	0.96	0.85	11%
5 <sup>th</sup> household	0.50	0.45	10%
6 <sup>th</sup> household	0.70	0.56	20%

**Table 6.** GHG emissions during according baseline and energy saving scenarios in winter

Households	Monthly GHG emissions according baseline scenario, t	Monthly GHG emissions according energy saving scenario, t	GHG emission reductions %
1 <sup>st</sup> household	0.92	0.72	22%
2 <sup>nd</sup> household	0.65	0.50	23%
3 <sup>rd</sup> household	0.40	0.34	15%
4 <sup>th</sup> household	0.92	0.78	15%
5 <sup>th</sup> household	0.52	0.45	13%
6 <sup>th</sup> household	0.82	0.64	22%

The average monthly GHG emission reduction achieved by household during summer makes 14.8% and 18.4% during winter. Therefore the average GHG emission reduction potential at households due to behavioural change makes about 16.6%.

The average monthly GHG emission reduction potential by household makes 0.115 t CO<sub>2</sub> or 1.38t CO<sub>2</sub> per year. As according Department of Statistics (2010) there are 1.39 million Households in Lithuania the total GHG emission reduction potential in households due to behavioural changes make 1.96 Mt CO<sub>2</sub> per year.

According to Lithuanian policy documents (Ministry of Environment of Republic of Lithuania, 2010) GHG emission reduction potential in Lithuania in 2010 was evaluated as 20.2 Mt CO<sub>2</sub>/year. Therefore GHG emission reduction potential in Lithuanian households would make about 9% of total GHG emission reduction potential. In addition it is necessary to emphasize that this potential can be achieved at no costs. Just costs of information dissemination and other interventions aiming at behavioral changes needs to be taken into account however these measures are very cheap comparing with expensive GHG emission reduction measures at supply side such as building new nuclear power plant or new capacities based on renewables etc.

Comparing the result of this pilot study conducted in Lithuania one can notice that evaluated GHG emission reduction potential in Lithuania (16.6%) is similar to results obtained in Netherland, UK and other countries. In Netherlands according study conducted (Nonhebel, Moll, 2001) GHG emission reduction potential due to behavioral changes of households makes about 27%; in UK according (Fisher, Irvine, 2010) GHG emission reduction potential due to behavioral changes at households makes 17%.

Comparing energy saving potential at households due to behavioral changes obtained during pilot study conducted in Lithuania (0,18 Mtoe/year) with goals and potential set by Lithuanian energy efficiency improvement programme (The Government of Republic of Lithuania, 2006) one can notice that the goals set in Lithuanian policy documents under evaluates energy saving potential in households. According Programme the total energy saving potential in Lithuania makes about 0.44 Mtn/year. Energy saving potential in industry makes 0.19 Mtoe; in households and service sector—0.1 Mtoe; in transport sector—0.15 Mtoe. Therefore the evaluated energy saving potential in Lithuanian households makes more than 40% of total energy saving potential in Lithuania and is significantly higher that established by National energy efficiency programme.

## **6. Conclusions**

- Structural and psychological interventions have been employed in several studies to encourage household energy conservation, with varying degrees of success. The determining the effectiveness of interventions aimed at behavioural changes, it is important to examine the extent to which the intervention results in energy savings, behavioural changes and changes in behavioural antecedents

because these measures provide a suitable basis for the further development of effective intervention planning. Interventions targeting behavioural changes can be grouped into 3 categories: antecedent interventions, consequence interventions and social interactions

- The provision of tailored or customized recommendations—based on home energy audits—can provide for significant energy use reductions in households. An example of personal information in an energy conservation context is the home energy audit. This audit is a home visit by an expert on home energy savings. This expert gives personal advice for reducing energy in several ways, often focused on energy for space heating.
- The provision of feedback (i.e., specific information about the amount of energy being used)—especially when the feedback is frequent or continuous—can also significantly reduce households energy consumption. Feedback is the other form of personalized information. The advantage of feedback in this context lies in the chance for households to see the relationship between their behaviour and their energy requirements. Encouraging people to set an energy reduction goal—especially if they are given feedback about their progress toward the goal can significantly reduce household energy consumption.
- The communication campaigns promoting household energy savings impact have ranged from no behaviour change at all to a relatively great deal of public and household change. The more successful campaigns typically used what are now commonly accepted as good campaign design practices: simple clear messages, repeated often (e.g., through a variety of interpersonal and media channels, electronically and in print), by a variety of trusted sources (e.g., scientists, community leaders, journalists). Using mass media (TV) to model ways to reduce household electricity use can achieve about 10% reduction in household electricity use
- The pilot energy saving study conducted in Lithuania in 2010 was aiming to evaluate the impact of several intervention measures on energy savings and GHG emission reductions in Lithuania achieved due to behavioral changes (curtailment behavior). The interventions applied: the goal setting and provision of information on energy saving measures in households. The feedback was applied for control group seeking to evaluate results achieved. The control group was selected based on households survey. The 6 households living in multi-flat buildings on capital of Lithuania were selected.
- The pilot study conducted in Lithuania indicated that the average GHG emission reduction potential at Lithuanian households due to behavioural change makes about 16.6% or 1.96 Mt CO<sub>2</sub> per year. This makes about 9% of total GHG emission reduction potential in Lithuania. Comparing the results of pilot study conducted in Lithuania one can notice that evaluated GHG emission reduction potential in Lithuania (16.6%) is similar to results obtained in Netherlands, UK and other countries. In Netherlands according study conducted (Nonhebel, Moll., 2001) GHG emission reduction potential due to be-

behavioral changes of households makes about 27%; in UK according (Fisher, Irvine, 2010) GHG emission reduction potential due to behavioral changes at households makes 17%.

- Comparing energy saving potential at households due to behavioral changes obtained during pilot study conducted in Lithuania (0.18 Mtoe/year) with goals and potential set by Lithuanian energy efficiency improvement programme (The Government of Republic of Lithuania, 2006) one can notice that the goals set in Lithuanian policy documents under evaluates energy saving potential in households. According Programme the total energy saving potential in Lithuania makes about 0.44 Mtoe/year and energy saving potential in households and service sector—0.1 Mtoe. Therefore the evaluated energy saving potential in Lithuanian households makes more than 40% of total energy saving potential in Lithuania and is significantly higher than established by National energy efficiency programme.

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## INTERVENCINIŲ PRIEMONIŲ POVEIKIS ENERGIJOS TAUPYMU IIR ŠILTNAMIO DUJŲ EMISIJŲ SUMAŽĖJIMUI LIETUVOS NAMŲ ŪKIUOSE

Dalia ŠTREIMIKIENĖ

**Santrauka.** Energijos taupymas ir šiltnamio dujų emisijų mažinimas keičiant gyventojų elgseną jau keletą dešimtmečių yra tiriamas sociologų bei aplinkosaugos psichologų. Tarptautinės

klimato kaitos grupei nutarus savo penktojoje ataskaitoje pagrindinį dėmesį skirti šiam klausimui, mokslininkų tyrimai šioje srityje labai suaktyvėjo visame pasaulyje.

Straipsnyje analizuojamas intervencinių priemonių, skirtų keisti gyventojų elgesį, susijusių su energijos vartojimu namų ūkiuose, efektyvumas. Lietuvoje atlikto pilotinio tyrimo rezultatai palyginti su kitose šalyse atliktų panašių studijų rezultatais. Lietuvoje atliktas energijos taupymo ir šiltnamio dujų emisijų mažinimo, keičiant gyventojų elgesį, potencialo vertinimas parodė, kad Lietuvos namų ūkiuose per metus galima sutaupyti 0,132 tne energijos ir taip sumažinti šiltnamio efektą sukeliančių dujų emisijas 1.95MtCO<sub>2</sub> per metus. Kaip rodo kitose šalyse atliktos studijos, Lietuvoje energijos taupymo namų ūkiuose potencialas panašus kaip ir kitose šalyse, tačiau Lietuvos klimato kaitos švelninimo politika nukreipta į gamybos sektorių, o vartotojų pusėje taikomos priemonės yra nepakankamos, siekiant išnaudoti energijos taupymo potencialą Lietuvos namų ūkiuose.

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