



WORKing papers in Management Science

WORMS/17/04

# Social acceptance of renewable energy sources in Poland - guidelines for education process

Edyta Ropuszyńska-Surma,  
Magdalena Węglarz

Department of Management and Organization  
Wrocław University of Science and Technology, Poland

WORMS is a joint initiative of the Management Science departments  
of the Wrocław University of Science and Technology,  
Wyb. Wyspiańskiego 27, 50-370 Wrocław, Poland

# SOCIAL ACCEPTANCE OF RENEWABLE ENERGY SOURCES IN POLAND - GUIDELINES FOR EDUCATION PROCESS

Edyta Ropuszyńska-Surma<sup>1</sup>, Magdalena Węglarz<sup>2</sup>

<sup>1</sup>Wrocław University of Science and Technology (Poland)

<sup>2</sup>Wrocław University of Science and Technology (Poland)

## Abstract

The basic education in Poland focuses on environmental issues such as garbage segregation, recycling and water saving. The curriculum includes these topics and they are addressed to children and pupils mainly from elementary schools and from lower secondary schools. In Poland, we observed that there is lack of knowledge about pro-ecological behaviours at the higher education level (at the university level), and the curriculums do not include the knowledge about energy saving nor about the creation of energy-saving behaviour. The pro-ecological behaviours should be created during education process and they could focus on the following aspects: knowledge, skills, attitudes, motivation and commitment.

In our article we will present some good examples of non-conventional education project in Poland. Next we will present the results from our project called 'Modelling prosumers' behaviour on the energy market'. This research investigates the social acceptance of renewable energy sources (RES) from households' perspective in Lower Silesia region in Poland. In our research we identified the correlation between the behaviours of households and their willingness to install RES, and between some features (including attitudinal variables) and pro-ecological behaviours. We identify segments of the energy end-users who have more pro-ecological behaviours. They are mainly people with the secondary and higher technical education. Therefore, we would like to propose them an appropriate educational course at technical universities. Thus, additionally we conducted survey among students of the Wrocław University of Science and Technology (WUST) and the Wrocław University (WU) to verify their pro-ecological attitudes and their knowledge of energy conservation.

We created the guidelines for education process at university level, which could be useful to create one-semester course. This solution could influence the social acceptance of RES implementation which is especially important in Poland, where energy and ecological awareness is at low level.

Keywords: education, social acceptance, pro-ecological attitude.

## 1 INTRODUCTION

The main goal of the environmental education theory is to "develop a world population that ... has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively towards solutions of current problems and the prevention of new ones" [27].

Increased knowledge about the environment is assumed to change environmental attitudes. Arcury in his work [2] examined how environmental knowledge and attitudes are related sociodemographic factors (gender, age, education, income and residence). Environmental knowledge is found to be consistent and positively related to environmental attitudes, although the relationship is not especially strong. High school students' environmental knowledge and attitudes were evaluated from a questionnaire that they fulfilled before and after a 10-day environmental science course. A statistically significant correlation was found between the pre-test knowledge scores and the pre-test attitude scores and between the post-test knowledge scores and the post-test attitude scores. In both cases, students having higher knowledge scores had more favourable environmental attitudes compared with the students with lower knowledge scores [4]. In the Dutch National Assessment Program, environmental knowledge, environmental attitudes, and environmentally responsible behaviour were studied in a nationwide sample of students. The relation between environmental knowledge and environmental attitudes and behaviour proved to be very weak. There was a substantial relation between environmental attitude, willingness to make personal sacrifices, and environmentally responsible behaviour. Consistent with theories on attitudes, environmentally responsible behaviour was more strongly connected with willingness to make sacrifices than with attitude toward the environment [15].

A skill could be defined according [7] as performance of an act acquired through extended practice and training. Within the environmental education theory one put emphasis on teaching of skills and motivations to implement skills. However, it is often difficult to articulate clearly what skills we teach in conservative education and environmental education focusing on behaviour change or influence [11].

The research conducted by Diaz–Rainey and Ashton [6] underlined the aspect of attitudes. They focused on households attitudes towards willingness-to-pay for green energy. They analysed not only typical demographic and economic factors influencing households' behaviour, but also social factors and, the related psychological factors, too. Scarpa and Willis dealt with similar aspects and they analysed the attitudes towards willingness-to-pay for RES micro-installations among households in UK [21]. Psychological aspects are the subject of growing interest in scientific studies on waste management in households. It has been shown that the consumers who are positively evaluating the effectiveness of activities towards waste management manifest pro-ecological behaviour [23]. Moreover, it has been shown that subjective, individual norms play a significant role in shaping attitudes towards waste management [3]. Solomon had conducted surveys among students for a three-year period to determine the ease or difficulty with which they learned the energy conservation principle. It was emphasized that attitudes towards energy conservation before beginning the course was crucial [22].

Katzev and Johnson analysed three ways to motivate people to change their energy-related behaviour: antecedent communications, consequences, and social influences [12]. Additionally Hines conducted a meta-analysis of environmental behaviour research [9], where he determined the variables that are most influential in motivating individuals to take responsible environmental action, such as: knowledge of issues, knowledge of action strategies, locus of control, attitudes, verbal commitment, and an individual's sense of responsibility.

There were a lot of studies performed within the field of social and environmental psychology connected with the effectiveness of interventions aiming to encourage households to reduce energy consumption. Particular attention was given to the following evaluation criteria: (1) to what extent did the intervention result in behavioural changes and/or reductions in energy use? (2) were underlying behavioural determinants examined (e.g. knowledge, attitudes)? (3) to what extent could effects be attributed to the interventions and? (4) were effects maintained over longer periods of time? Providing information tends to result in higher knowledge levels, but not necessarily in behavioural changes or energy savings. [1]

Similarly, in Poland there was also conducted similar research, e.g. the researchers from Pedagogical University in Kraków show that the ecological awareness and attitude are different among students who study humanities and science (including natural sciences). The students of science have more pro-ecological attitude than humanities students. They participate more often in pro-ecological actions and have bigger knowledge. However both groups of students do not initiate individual pro-ecological actions and they do not react any actions or behaviours negative for environment as carried by other people. In this light the students are indifferent to non-ecological behaviours [28].

In 2015 the report [17] focused on the analysis of research of ecological awareness, attitudes and behaviours among Polish society from 2009 to 2015. This analysis was made for Environmental Ministry (EM) in Poland and it was prepared basing on individual research conducted in the mentioned period. The conclusions said that Polish people generally: have insufficient ecological awareness, their relation to environment is positive but their knowledge and attitudes are not deep enough. The authors of this report think that the knowledge about target groups who is important for a dedicated educational schedule taking into consideration their needs [17]. Thus, the research which could identify the target groups and fit to an educational curriculum to each of them has additional value and it is the supplement to educational gap in Poland.

Our research made among households and students shows similar results on the subject of ecological behaviours, awareness and attitude, and allows us to define separated activities address to students as a target group.

## **2 PRO-ECOLOGICAL EDUCATION IN POLAND**

In Poland, the pro-ecological education is developing all the time, but – as we see in next sections of this article – the pro-ecological students' behaviours are developed at different levels. There are people who always behave pro-ecologically in the most of the researched dimensions as well as there are persons who behave in a less pro-ecological way. The psychological theories say that the

children's behaviour is shaped by education, but we should remember that the education process is carried out not only by teachers in schools but, first of all, by parents [24] and social environment, mainly reference groups like grandparents, neighbours and friends. Children who come to the school have already acquired some behaviours, and school education can modify them. Moreover, if we take into consideration the diffusion of innovation, we see often that children teach older people (e.g. grandparents). It seems that a similar educational process is related to the diffusion of pro-ecological behaviours such as: garbage segregation, recycling. This approach found use for teaching parents and grandparents how to segregate waste. The intensive education on segregation in a form called 'games and fun' in kindergartens, before the introduction of the regulation related to mandatory waste segregation, illustrates well this process. The creation of pro-ecological behaviour among society is multidimensional, and the teacher-students relation is bi-directional.

The pro-ecological education is contained in the social policy and the conception of the sustainable development. The pro-ecological education complies with the idea presented in The Delors's Report from 1996 [18] which says about the integrated concept of education. It bases on two key elements: 'learning throughout life' and four pillars of learning (learning to: know, do, be, live together [5]). Paraphrasing Delors's words that 'education and competitiveness are closely linked [5] we can write education and sustainable development of economy are closely linked. The above mentioned Report says that the consumption pattern should be 'based on limits to growth, not unbridled consumerism' [18]. Relating to Asian education the authors say about universal values, which should be cultivated by education, write about 'sense of obligation to environment protection and sustainable development' [18]. This aspect seems important in countries outside Asia, too. A contemporary man should be not only appropriately educated in new technologies, responsibilities and social behaviours, but also in pro-ecological behaviours. He needs appropriate knowledge (including new resource-saving technologies and techniques) but he should have some pro-ecological awareness.

Polish system of education contains the environmental aspects, e.g. 20 years ago there were lessons on topics like: 'what is ecology?', 'its importance in our life' or the effects of pollution'. Of course, there were organized actions in schools called 'cleaning the world' or 'collection of waste paper by pupils and their families', and others. In our subjective opinion it was averagely one action per year. However this system is still evolving because the environmental challenges are changing. Recently, these actions are more complex, but their intensity is different in different schools and the regions. In this context, the educational system and curriculum at educational levels are significant.

Nowadays, Polish education system is divided according to the reform from 1999 (fig.1), but since September 2017 it is going to change to the similar state before that act. In this paper and in fig. 1 we use the terms typical for Polish educational system and to avoid ambiguity we provided the exact ages for each stage. The medicine studies are not presented on the figures. After a professional school, a person cannot go to study.

1999-2016						
Educational level	Pre-school	Primary school	Lower secondary school (gymnasium)	Higher secondary school	Higher education (academic level)	Master studies (graduate level)
Length of education [in years]	3	6	3	3 - 4 according to kind of school such as: high school, technical school or professional school	3-4 according to kind of study such as: bachelor's studies (licentiate), engineering study or bachelor of art)	1,5 - 2 according to kind of studies
Age of students	3, 5, 6	12, 13	15, 16	18, 19	21, 23	23, 26

Fig. 1 Polish education process (system) since 1999 to 2016

The basic knowledge related to pro-ecological issues is presented according to the curriculum at primary and secondary school. The teachers and the heads of schools can create an individual special educational programme. This programme is consulted with parents and pupils. The children in the kindergarten have pro-ecological education too, but this level of education is not obligatory. At the higher (secondary and academic levels) educational levels the pro-ecological educational issues are more connected with professional knowledge and they are correlated with the profile of studies. Therefore, the humanist studies do not develop pro-ecological behaviours as much as engineer studies or nature science studies. This fact was confirmed by our survey research conducted among the students (look at point 4).

Beside obligatory education connected with ecological education we observe positive and less conventional educational projects. One of them is project shortly named "50/50"<sup>1</sup> which was conducted among primary schools, junior (lower) high schools (gymnasium) and higher secondary schools. This project was the background for the next project conducted by Lower Silesian Ecological Club (LSEC) and addressed mainly to lower and higher secondary schools during last 13 years. The main idea for all projects is active participation of different stakeholders, such as: pupils, teachers, headmasters, LSEC workers, local society, companies (mainly municipal companies), local governments, research institutions and sometimes parents. The first edition of the project '50/50' was in the school year 2004/2005 and its 10<sup>th</sup> edition was in the school year 2013/2014<sup>2</sup>. This project was the result of the cooperation between LSEC and German Foundation EURONATUR from Bonn<sup>3</sup> and it used German experiences. The main aims of the project was to reduce the consumption of electricity, heat, gas and water in the schools. The other goals strongly related to main aim were: (1) the acquisition of knowledge related to innovative technologies and equipment for effective use of energy and other sources, (2) improving the ecological awareness, (3) implementing pro-ecological behaviours.

If some school saved energy, the saved funds were divided and 50% was forwarded to this school and the other half was sorted on the energy fund. Next, the energy fund would have support energy conservation investments at schools. Every edition was slightly modified, e.g. the schools outside Wroclaw could participate in the project. The activities according to this project were addressed to: the teachers, the headmasters of schools, administrative workers and mainly to learners. Besides them, other persons and institutions was involved in this project such as: LSEC workers, science institutions or researchers, Department of Education in Wroclaw City<sup>4</sup>, which was responsible for the correct energy fund settlements (i.e. settlement of saved funds). The realized activities were the following: (1) seminars organized by LSEC, the school coordinator (teacher) and his/her learners participated in seminars. Sometimes the presenter was a scientist, (2) LSEC provided professional consulting about energy conservation, (3) The energy team (consisting of a teacher, learners and an administrative worker at each school, who all participated in the project) initiated pro-saving actions in their school focused on, inter alia, monitoring the consumption of electricity, heat, gas, and water each month, and sent this information to the Department of Education in Wroclaw City, (4) Information actions focused on energy conservation, (5) Art, music and theatre competitions addressed to energy conservation, (6) educational trips and lessons about energy conservation and new technologies.

The most interesting was the project's results. 18 schools from Wroclaw participated in the first edition. Six of them saved electricity (they reduced the consumption of electricity from 1% to 20%). Three schools saved heat (4%-25%), but the heat consumption decreased in two schools (1%). Ten schools saved water and sewage (1%-85%). In project there also participated one kindergarten, and it saved 10% of electricity, 8% of heat and 16% of water. But the Department of Education in Wroclaw City decided to establish not the energy fund because the results were uncertain, it could have errors or the time is too short (only 10 months) [14]. Of course, the awareness and the knowledge about energy conservation improved. It was evaluated by surveys.

In next edition of the project 26 schools from Wroclaw participated. Six schools saved electricity (from 1% to more than 35%), three schools saved heat (1%-6%), and seven schools reduce the consumption of water (since less than 1% to more than 27%) [8].

Similar projects were:

- 'We protect the climate' (conducted from 1.09 to 10.12.2015) and 'RES as the chance for environment' (conducted from September to December 2016). The teams, called 'Climate Angels'<sup>5</sup> participated in educational meetings (lectures, workshops). Other activities were [10]: (1) the transfer of knowledge from meetings to schools by 'Climate Angels', (2) 'Climate Angels' had to initiate activities in their schools related to climate protection, (3) artistic competition – the poster about theme 'We protect the climate', (4) educational trips. In this project were involved teachers and learners, Kogeneracja S.A.<sup>6</sup>, the Department of Climatology and Atmosphere Protection at Wroclaw University, Voivodship Fund for Environmental Protection and Water Management in

---

<sup>1</sup> Full title of project is 'Non-investment energy conservation in Wroclaw schools'.

<sup>2</sup> The title of project was 'Non-investment energy conservation in Wroclaw schools' (the authors of project do not use name '50/50').

<sup>3</sup> In German schools 10-15 % of Energy was limited [13].

<sup>4</sup> It was the financial coordinator of the project for schools, calculated cost and saved funds related to energy and water conservation by schools. It also manages energy funds.

<sup>5</sup> This work group consisting of 10-15 pupils and their coordinator (teacher).

<sup>6</sup> Wroclaw company generates heat and electricity.

Wroclaw. The main effects of project were: (1) the participation of 10 schools; (2) the improvement of skills related to the transfer of ecological knowledge and the calculation of the amount of pollutant emissions during, different activities, and the amount of carbon footprint for both schools and home, (3) the development of ecological awareness.

- 'Friendly Energy' (conducted from January to June 2016). The target group of projects at the educational level were primary schools and gymnasiums. The main activities were similar to above mentioned projects (the participation in educational meetings, the transfer of knowledge, and the educational trips). In this project were involved teachers and learners, LSEC workers, the Solar School in Bielawa, the Centre of Renewable Energy UP and Voivodship Fund for Environmental Protection and Water Management in Wroclaw. The effects were similar as above.

Of course similar educational actions were made in Poland much more often, but the project '50/50' seems the most interesting.

The experiences from different Polish projects and theory of education show that the active participation of the learners, their experiences and their own discoveries lead to better memorizing knowledge, and learners more often change their behavior as well as the educational process is perceived as more interesting by students [16], [25]. This educational method is called Constructive Learning Environments (CLEs).

### **3 PRO-ECOLOGICAL ATTITUDE / BEHAVIOUR (AMONG HOUSEHOLDS)**

The article [26] presents the results of environmental education and communities' attitudes to the problems connected with the natural environment. On the basis of research considering the problem of the level of Polish societies' environmental awareness, on the one hand, a positive image of pro-environmental attitudes is being formed, and on the other hand, it turns out that activities which protect natural environment are not intended by the respondents. For Polish people, the priority is to save money and if it coexists with pro-environmental behaviour, they do this "by the way". The results of European Values Study (EVS) conducted in 1990, 1999 and 2008 showed that Polish people characterized with decreasing willingness to support their money against pollution. The amount of people willing to give their income had sunk dramatically by 30%, over the last twenty years.

Although total emission in Poland was reduced in years 2005-2014, but the households did not reduced emission of SO<sub>2</sub>, NO<sub>x</sub> and CO and they still emit significant amounts of pollution. Therefore, the industrial companies are responsible for the reduction of emission, especially energy companies. The expenditures on energy in households are at the same level for last 10 years, it 10% of disposal income.

In this section we will present the results from our project called 'Modelling prosumers' behaviour on the energy market', which is funded by the National Centre of Science by grant no. 2013/11/B/HS4/01070. We conducted a survey of households in Lower Silesia in November and December 2015. The sample was made up of 2000 households, but the number of correctly completed questionnaires was 949. Only 4.76% of the respondents have installed RES, but 31% of the households 'not having RES' would like to install it.

The results showed that, according to 28 households, the reason for installing RES was long-term savings. The most important advantages from having RES were: 'smaller fees or savings' (48.4%), 'financial profits' (22%) and 'ecology and clean air' (13.2%). Therefore, saving and financial profit are the main advantages, whereas ecological aspects is not such important benefits. On the other hand, the biggest barriers of installation RES were: lack of financial assets, high installation costs, long return period of investment, the technical impossibility of installation, too expensive. More specific results are presented in following papers [20], [19].

In our research we identified the correlation between pro-ecological and pro-effectiveness behaviours of households and their willingness to install RES. The results are presented in Table 1. The importance of the factors influencing the RES installation was verified by a Chi-square test.

Among pro-ecological behaviours we analysed: switching off the lights, sorting rubbish, the utilization of electro-rubbish. The results are presented on Fig.2. Over 64% respondents always behave pro-ecological. The lowest pro-ecological attitude was in case of the utilization of electro-rubbish, where 16% of respondents never utilize electro-rubbish.

**Table 1.** The association of behaviours of households with the willingness to install RES.

Factor	Chi-square(3)	p-value
the utilization of electro-rubbish	15.687	0.001
using energy-saving lights (LED)	27.47	<0.001
installing energy-saving household equipment	13.881	0.003
sorting rubbish (garbage)	10.345	0.016
battery utilization	9.962	0.019
switching off the lights	8.819	0.032
washing or ironing at particular times	7.828	0.05

Source: [19]

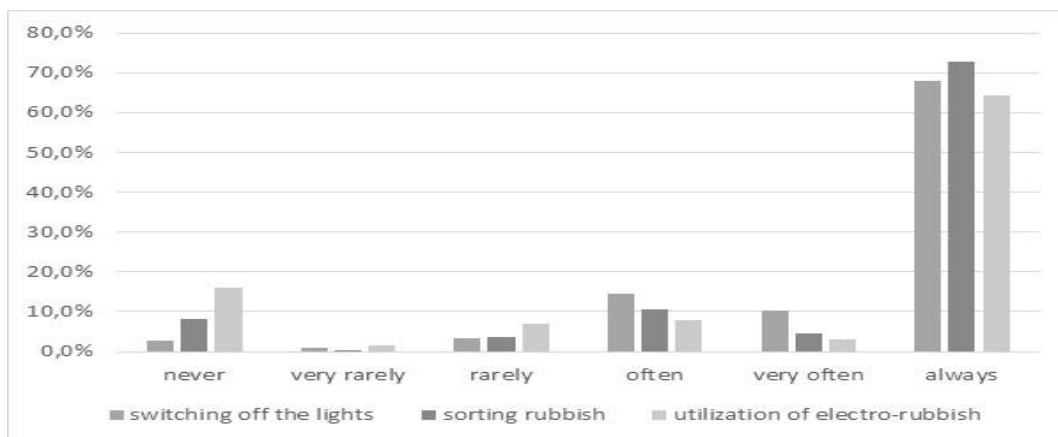


Fig.2. Pro-ecological behaviours of households.

In case of pro-effectiveness behaviours we analysed households' attitude to washing or ironing at particular times and using eco-option in washing machine (Fig.3). We checked if the households have one-time zone or two-time zones tariff, and we analysed their attitude. Almost 60% of households do not have two-time zone tariff, so they cannot use them if we talk about washing and ironing. Among 41% of the households have two-time zone tariff and they said they always wash or iron in particular times using cheaper energy. Almost 27% of the households have old type of washing machines so they do not have eco-options. The rest of the households have washing machines with eco-options. 62.6% of them always use eco-options washing clothes.

The complement of our analysis on pro-effectiveness behaviours were questions about dwelling equipment in: energy-saving lights, LED lights bulbs, home appliances A+++ (Fig. 4). Over 70% households have most or only energy-saving lights older type. The more energy efficiency equipment, such as: LED lights and home appliances A+++, have less than 46% households. Only LED lights have 18.5% households and only home appliances A+++ class have 16.2% households.

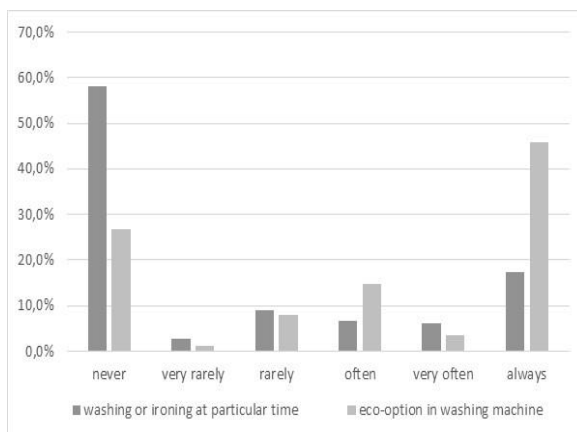


Fig.3. Pro-effectiveness behaviours of households.

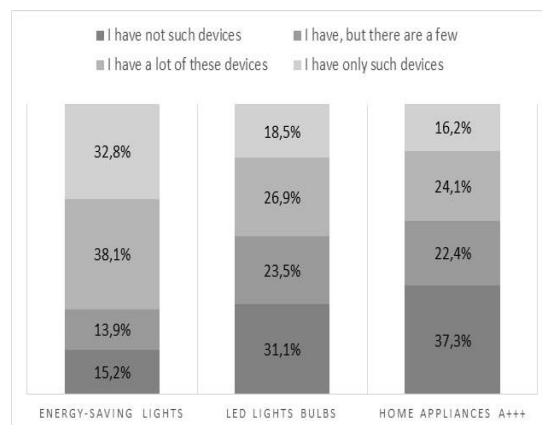


Fig.4. Energy-saving household equipment.

Additionally we made the segmentation of households on the base of the proposed coefficient that divided the respondents into different groups according their relation to social acceptance of RES. The coefficient is formulated as multiplication of the number of households having RES and the probability to become a prosumer that was estimated on the base of the survey results. We identify segments of the households who have more pro-ecological behaviour. They are mainly people with the secondary technical and higher technical education and they people in the age range of 30 - 49 years [19].

#### 4 PRO-ECOLOGICAL ATTITUDE AMONG STUDENTS

We conducted a survey among 175 students at universities to verify their pro-ecological attitudes and knowledge focused on energy conservation. They are studying at Wroclaw University of Science and Technology and at Wroclaw University at different faculties. We divided the students into two groups: technical (81 students) and non-technical (94 students). To technical group we included students from faculties of technical university: chemistry, architecture, electronics, geoenvironmental engineering, mechanical engineering, mechanical and power engineering and energy, biomedical engineering. In the non-technical group we included the students from the faculties: mathematics, management, English philology, and music. In the analysed sample there were 2/3 women, most of them studying (57%) non-technical science. Over 55% of men were studying technical science.

In the case of pro-ecological behaviours among students we analysed: sorting rubbish, the utilization of electro-rubbish and battery utilization. The results are presented in Fig 5. The positive pro-ecological behaviour is observed for sorting rubbish where 62% of the students very often or always do that. Negative tendency can be observed in the case of the utilization of electro-rubbish and battery utilization where respectively 7.5% and 4% of the students said they don't care about it. And a quite big percent of students never utilize electro-rubbish and battery or do it very rarely.

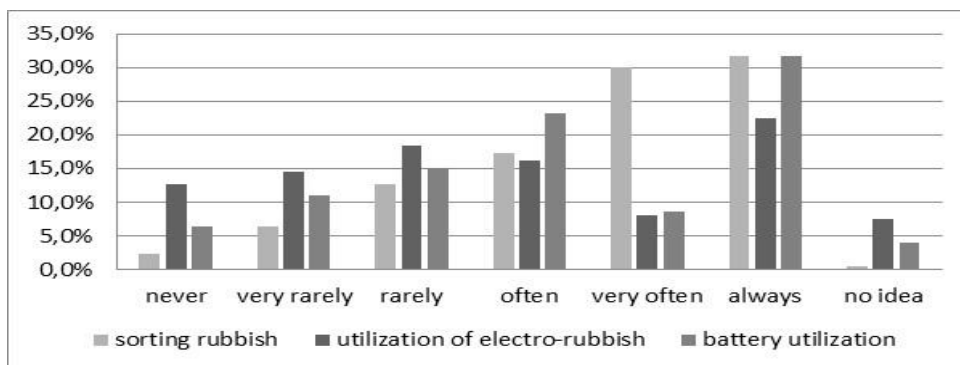


Fig.5. Pro-ecological behaviours of students.

The students have good attitude towards switching off the lights, 80% of them switch off the lights very often and always (Fig.6). Pro-effective behaviour are very similar in case of: unplugging power supply or a battery charger and switching off electrical equipment if nobody uses it. Less than 50% of the students switch off their computer and unplug battery charger always or very often. Negative behaviour can be observed for unplugging devices that are in standby. As much as 72.3% of the students never or rarely unplug devices that are in standby.

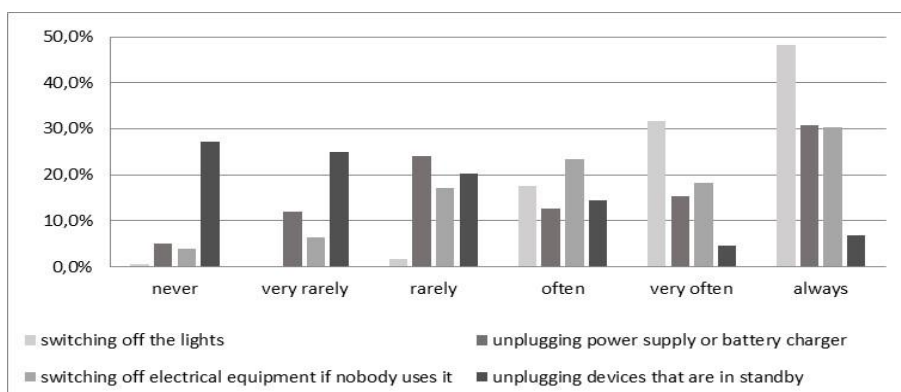


Fig.6. Pro-effective behaviours of students.



Moreover, students don't know if they have home A+++ appliances (38.3%) or LED lights bulbs (19.4%). Over 70% of the students declared they have a lot of or only energy-saving lights of the older type.

The students answered the questions about environmental education at different stage of their education. The results are presented in Fig.7. Most of them have been taught ecological behaviours at elementary and lower secondary school. Less than 40% had some ecological lectures at higher secondary school. The lowest level of environmental education is at universities, only 13% of the students had any ecological courses. They are mainly studied at chemistry faculty (73%). The most extensive environmental programmes are offered by professional courses in environmental conservation, environmental engineering or sanitary engineering. In other courses, environmental protection issues appear in the curriculum sporadically.

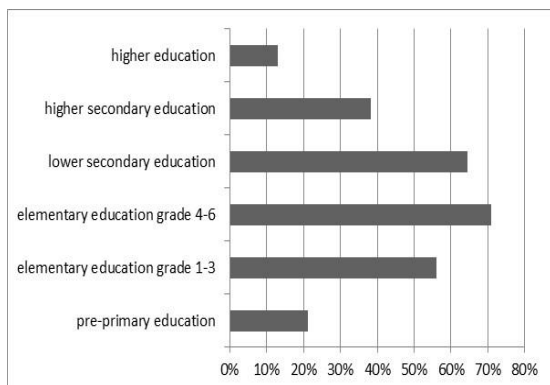


Fig.7. Environmental education at different stage.

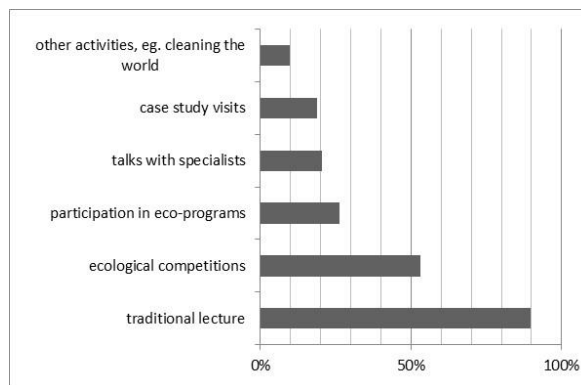


Fig.8. Methods of environmental education.

The research results mentioned in section 1 showed that for adult people and students environmental knowledge is found to be positively related to environmental attitudes and behaviour, but the relationship is weak. We also noticed weak correlation between environmental education and some ecological behaviour, such as: the utilization of electro-rubbish (Chi-square(12)=23.9, p-value=0.021); battery utilization (Chi-square(12)=31.9, p-value=0.001); using eco-option in washing machine (Chi-square(12)=27.3, p-value=0.007); switching off electrical equipment if nobody uses it (Chi-square(12)=25.9, p-value=0.011). It could be connected with low level of environmental education at different stages.

The students have to select teaching methods used during their environmental education process. They can chose more than one method. The results are shown in Fig.8. The most commonly used method (in 89.7%) is the traditional didactic lecture, the second one is ecological competition (53.1%) and the third one is participation in eco-programs (26.3%). Some examples of eco-programs are presented in Table 2. There is no correlation between teaching methods and ecological behaviour. We suggested that low level of pro-ecological and energy conservation behaviour is connected with already used teaching method - traditional didactic lecture. Students need to actively participate in lectures to maintain their engagement with the content. Indeed, a structured interactive session is a better lecture format. In engaging lectures, students are given short periods of lecture followed by " breaks " that may consist of one-minute papers, problem sets, brainstorming sessions, or open discussion.

The environmental knowledge and skills are delivered during educational process, but attitudes are also created in family houses. We observed positive correlation between pro-effectiveness attitude in family and environmental attitudes and behaviour, such as: sorting rubbish (Chi-square(12)=26.5, p-value=0.009); the utilization of electro-rubbish (Chi-square(12)=36.1, p-value=0); battery utilization (Chi-square(12)=27.2, p-value=0.007).

## 5 GUIDELINES FOR EDUCATION PROCESS

Taking in to consideration the results of our research and other research as well as the positive effects of CLEs, we would like to propose some actions addressed to engineering students at our university. The main method will be coaching and experiments (e.g. in laboratories). The students who live in student houses could compete with to conserve the most energy and water. It should fix switching off

the lights and should encourage students to unplug power supply or a battery charger and to switch off electrical equipment if nobody uses it as well as to use the LEDs. Analogous activities will be offered for water conservation.

Next action could be a one-semester course. The students from different faculties could participate in it because each of them has different technical knowledge. The teacher would be a coach or a moderator and students from such faculties as: Environmental Protection, Construction, Mechanics & Power Engineering, Chemistry would be experts at technologies. The course should have practical and economic character. On the one hand students will make experiments saying e.g. how much energy could you conserve if you use other building materials or if you use LEDs in all home. On the other hand the total saved energy should be analysed in the concept of social and ecological advantages and, it should be calculated into money, because the students are introduced into independent life and the financial aspects will be more and more important for them. They should participate into educational trips where the passive building, energy self-sufficient regions and the most efficiency installations will be presented.

## ACKNOWLEDGEMENTS

This article is prepared on the basis of the results from a project called 'Modelling prosumers' behaviour on the energy market', which is funded by the National Centre of Science by grant no. 2013/11/B/HS4/01070.

## REFERENCES

- [1] W. Abrahamse, L. Steg, C. Vlek, T. Rothengatter, A review of intervention studies aimed at household energy conservation, *Journal of Environmental Psychology*, Volume 25, Issue 3, pp. 273-291, 2005.
- [2] T. Arcury, Environmental Attitude and Environmental Knowledge. *Human Organization*: Winter 1990, Vol. 49, No. 4, pp. 300-304, 1990.
- [3] S. Barr, Factors influencing environmental attitudes and behaviors: A UK case study of household waste management. *Environ. Behav.*, 39, pp. 435–473, 2007.
- [4] J. Campbell Bradley, T. M. Waliczek, J. M. Zajicek, Relationship Between Environmental Knowledge and Environmental Attitude of High School Students, *The Journal Of Environmental Education* Vol. 30 , Issue 3, 1999
- [5] J. Delors, The treasure within: Learning to know, learning to do, learning to live together and learning to be. What is the value of that treasure 15 years after its publication?, *Int. Rev Educ* 59, pp. 319-330, 2013.
- [6] I. Diaz –Rainey, J. K. Ashton. Profiling potential green electricity tariff adopters: green consumerism as an environmental policy tool? *Business Strategy and the Environment* 20, pp. 456-470, 2011
- [7] K.A. Ericsson, W.L. Oliver, "Cognitive skills". In *Learning and Skill*, Edited by: N.J. Mackintosh, A.M. Colman, 37–55. London, Longman. 1995.
- [8] K. Gans, Bezinwestycyjne oszczędzanie energii. Podsumowanie projektu 50/50, *Zielona Planeta* 4(67), pp. 23-25, 2006
- [9] J. M. Hines, H. R. Hungerford, A. N. Tomera, Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *The Journal of Environmental Education*, Vol 18(2), 1986-1987, pp.1-8
- [10] K. Haladyn, Anioły Klimatu, *Zielona Planeta* 3(126), pp. 24-25, 2016
- [11] J. E. Heimlich, N. M. Ardoin, Understanding Behavior to Understand Behavior Change: A Literature Review, *Environmental Education Research*, vol. 14 no. 3 pp. 215-237, 2008.
- [12] R. D. Katzev, T. R. Johnson. Promoting energy conservation: An analysis of behavioral research. 1987
- [13] A. Kowalska, Projekt 50/50 bezinwestycyjne oszczędzanie energii we wrocławskich szkołach, *Zielona Planeta* 5(56), pp. 22-24, 2004

- [14] A. Kowalska, Podsumowanie projektu 50/50, *Zielona Planeta* 3(60), pp. 24-26, 2005a
- [15] H. Kuhlemeier, H. Van Den Bergh, N. Lagerweij, Environmental Knowledge, Attitudes, and Behavior in Dutch Secondary Education, *The Journal Of Environmental Education* Vol. 30 , Issue 2, pp. 4-14, 1999.
- [16] T. Lord, H. Travis, B. Magill, L. King, Comparising Student-Centered and Teacher-Centered Instruction in College Biology Labs, Accessed 15 May, 2017. Retrived from <http://k12s.phast.umass.edu/stemtec/pathways/Proceedings/Papers/Lord-p.doc>
- [17] Raport z analizy badań świadomości, postaw i zachowań ekologicznych Polaków przeprowadzonych w Polsce w latach 2009-2015. Analiza TND Polska dla Ministerstwa Środowiska, July 2015, Retrieved from [https://www.mos.gov.pl/fileadmin/user\\_upload/Raport\\_z\\_analizy\\_badan\\_swiadomosci\\_\\_postaw\\_i\\_zachowan\\_ekologicznych\\_Polakow\\_przeprowadzonych\\_w\\_Polsce\\_w\\_latach\\_2009-2015.pdf](https://www.mos.gov.pl/fileadmin/user_upload/Raport_z_analizy_badan_swiadomosci__postaw_i_zachowan_ekologicznych_Polakow_przeprowadzonych_w_Polsce_w_latach_2009-2015.pdf)
- [18] Report to UNESCO of the International Commission on Education for the Twenty-first Century. Learning: The treasure within, UNESCO, Paris 1996, Retrieved from [http://www.unesco.org/education/pdf/15\\_62.pdf](http://www.unesco.org/education/pdf/15_62.pdf)
- [19] E. Ropuszyńska-Surma, M. Węglarz, The pro-economical behaviour of households and their knowledge about changes in the energy market. *Energy and Fuels* 2016, E3S Web of Conferences Vol. 14, 2017, DOI: <https://doi.org/10.1051/e3sconf/20171401006>
- [20] E. Ropuszyńska-Surma, M. Węglarz, Bariery rozwoju energetyki rozproszonej, *Przegląd Elektrotechniczny*, no. 4/2017, s. 90-94., 2017, doi:10.15199/48.2017.04.23
- [21] R. Scarpa. K. Willis. Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies. *Energy Economics* **32** (2010) pp. 129-136.
- [22] J. Solomon, Teaching the Conservation of Energy. *Physics Education*, vol. 20 no. 4. pp. 165-170, 1985
- [23] V. Swami, T. Chamorro-Premuzic, R. Snelgar, A. Furnham, A. Personality, individual differences, and demographic antecedents of self-reported household waste management behaviours. *J. Environ. Psychol.*, 31, pp. 21–26, 2011.
- [24] M. Szyszka, Edukacja w Polsce – konieczność reform i nowe wyzwania, *Roczniki Nauk Społecznych*, Tom 2(38), pp 255-274, 2010.
- [25] M. Tarabula-Firtak, E. Gajus-Lankam, M.A. Wójcik, Environmental Teaching in Higher Education, *International Research in Geographical and Environmental Education*, Vol. 13. No. 3, pp. 284-290, 2004
- [26] L. Tuszyńska, Environmental Education and Awareness of Polish society, *Edukacja ustawiczna dorosłych*, vol. 86, no.3, pp. 54-61, 2014.
- [27] UNESCO-UNEP. The Belgrade charter. *Connect: UNESCO-UNEP Environmental Education Newsletter*, 1(1): 1–2, 1976.
- [28] B. Wójtowicz, The level of students awareness and their attitude towards the natural environment, *Rocznik Świętokrzyski, Ser. B – Nauki Przyr.* 31, pp.111-121, 2010.