Is Society Ready for Long-Term Investments?—Profiles of Electricity Users in Silesia

Sylwia Słupik and Joanna Trzęsiok

Abstract The objective of this article is to identify and characterize electricity users in terms of their attitudes towards energy saving. The analyses applied data from the proprietary survey conducted among the inhabitants of the Silesian Province. The respondents were asked, inter alia, about saving electricity through short- and long-term investment actions. Model types of users were defined, so that it was possible to assign the surveyed people to appropriate groups using distance measures dedicated to non-metric variables. Moreover, the user classes formed in this way were characterized; and for that purpose, the measures to study the dependence of qualitative variables—the chi-square test and the Cramer's *V* coefficient—were used. As expected, it turned out that the respondents' actions were significantly impacted by financial considerations, i.e. income, which determined the nature of the undertaken investments, and thus significantly influenced the result of the classification. However, as the research results have shown, also aspects related to environmental protection significantly differentiate the investors' attitudes. People focused on long-term actions, aimed at reducing energy consumption, more often declare their interest in subsidies for environmental protection, spending higher amounts on energy-saving devices, or are even guided by ecological signs when doing shopping. The authors' original contribution is the proposed segmentation of respondents and their characterization based on the obtained empirical data.

Keywords Energy consumption · RES · Social ecological awareness · Linear ordering · Chi-square test

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1 Introduction

Global warming of the climate is a fact and an issue that should define the way we function in the coming years; if we do not want our grandchildren, or maybe even our children, to wage wars over food and water. Another pro-ecological activity is saving electricity, which translates into lower emissions of carbon dioxide into the atmosphere. Such activities do not always have to originate from our beliefs, they are often the result of financial calculations, but what counts is the end result—reducing the negative impact on the natural environment.

Therefore, in recent years, we have been observing major changes in the global and European energy market. The energy sector is undergoing a low-emission transition and the role of the consumer in this process is significantly increasing. It is widely believed that the way to reduce environmental pressures and mitigate climate change is to increase energy efficiency while reducing energy demand. Owing to technological progress and established legal regulations, protecting the environment and limiting the impact of consumption on its degradation, it is possible to increase energy savings (Steg et al. 2005). Nevertheless, already now, more and more often in the studies of economists and behaviourists (Zhou and Yang 2016; Lutzenhiser 1993), it is recognized that behavioural factors are of great importance for this process. It is the encouraging of ecological mindsets of individual consumers that seems to be crucial in the fight for the future shape and volume of total energy consumption in the world. It is also becoming the goal of energy and environmental policies, both regionally and locally, of many countries, especially European ones (Gardner and Stern 1996). Hence, it is vital to know the needs of consumers, the level of their demand for electricity, and to be aware of the changes taking place in the attitudes of energy end users.

According to researchers of sustainable consumption in households (Frederiks et al. 2015; Clancy and O'Loughlin 2002; Hille 2016), the most important determinants of behaviour change and the emergence of the so-called *greening of consumption* (Matel 2016, p. 56) can be summarized as follows (Nagaj 2018, pp. 4–5; Matel 2016, pp. 56–57):

- consumers are increasingly aware of the value and need for sustainable energy practices and climate change issues,
- the sense of responsibility of consumers for the choices they make increases, they prefer to buy raw materials and energy-saving products as well as products that are safe for human health (Kiełczewski 2005, 2015, p. 55),
- energy-saving people, apart from their propensity to save and ecological awareness, are also characterized by such features as high aversion to consumption and interest in investing in energy-saving technologies (Clancy and O'Loughlin 2002),
- consumers often give up purchasing products manufactured in a way that pollutes the environment, striving to minimize the use of non-renewable resources,
- very often, they limit or give up gadget consumption (Dąbrowska et al. 2015, p. 43),

- it is observed that consumer actions, including those related to the will to save energy, are the result of behavioural rather than rational or physical factors (Nakamura 2016),
- at the same time, there is often a significant discrepancy between consumers' declared knowledge, values, attitudes and intentions, and their observable behaviour.

Taking into account the above reflections, it seems imperative to anticipate and understand the behaviour of energy consumers and to evaluate them. The achievements of behavioural economics and psychology can be of help, where in combination with the experience of consumption theory, environmental economics and natural resources, the development of incentives for the use of renewable energy and sustainable energy consumption will be developed.

This work aims to identify and characterize electricity users in terms of their attitudes towards energy saving. The authors of the article have based their analysis on the results of the proprietary research conducted among households in the Silesian Province in 2018 and on a review of the literature on profiling individual energy consumers. In the article, the authors also characterize the obtained segments and identify fundamental factors influencing the respondents' behaviour towards save energy.

2 Study of Energy Consumers' Behaviours and Their Impact on Shaping Pro-ecological Attitudes

Currently, household consumption patterns, including energy consumption, are shaped by various factors. Patterns are individualized under the influence of socio-economic changes, such as, on the one hand, an increase in income; an increase in the number of one-person households and, on the other hand, demographic ageing, which forces a change in lifestyles and consumer choices (cf. OECD 2002). Greater autonomy in the actions of consumers allows to form a full identity with the use of consumer goods and services available on the market, and it even enables the co-creation of these goods on the basis of presumption (Popczyk 2014; Bylok 2014). At the same time, in the subject literature much attention has been drawn to develop behavioural and psychological models of consumers. Also, the behaviour of households in terms of energy consumption and factors influencing these behaviours have been scrutinized (Zhou and Yang 2016). Efforts have also been made to design effective intervention strategies aimed at stimulating the behaviour of households and improving energy efficiency, as well as leading to a significant reduction in energy.

Many years of observation and research have shown that in order to encourage the use of measures and instruments to improve energy efficiency, it is necessary to understand how consumers behave and how they use energy in their everyday personal and professional lives. It is necessary to answer the questions why people

stop taking action, even when the economic calculation shows the possibility of obtaining potential benefits, and why are they not interested in optimizing their consumption and reducing the negative impact of excessive energy consumption on the environment. A full understanding of the motives of behaviour and the elimination of barriers will contribute to better communication and prepare decision-makers to create interventions that will successfully bridge the gap between pro-ecological knowledge, values, attitudes and intentions and the daily energy-related behaviour of consumers (Frederiks et al. 2015). It will also allow consumers to receive better recommendations on how to become more energy efficient. Yet, in order to devise effective behavioural change interventions, it is imperative to tailor interventions to different target groups and to consider the differences in their willingness to change behaviour (Seidl et al. 2017).

Table 1 presents an overview of selected profiles of individual energy consumers along with their brief characteristics. These segmentations have been developed on the basis of empirical research, often conducted at regular intervals. The literature on the subject is dominated by studies carried out in Great Britain, the USA and other Western countries. The table also includes Polish examples, but it should be noted that so far in Poland little research has been performed in which attempts have been made to segment energy consumers (cf. Słupik 2015; Ropuszyńska-Surma and Węglarz 2018a). The absence of such analyses and comprehensive studies is perceived by the authors of the article as a research gap and a field for further studies.

One of the classifications quoted in the table is segmentation developed as part of the currently implemented project "Personalised ICT-tools for the Active Engagement of Consumers Towards Sustainable Energy" abbreviated as "eco-bot"[1]. It is a 43-month project co-financed by the European Commission under the Horizon 2020 program: "Reducing energy consumption and carbon footprint by smart and sustainable use", implemented in 2017–2021 as part of an international consortium which includes the University of Economics in Katowice, and the authors of this chapter compose the core of the research team.

The aim of the project is to create a personalized virtual assistant. It will provide a consumer with information about his/her current energy consumption, disaggregated to the level of individual electrical devices. In addition, it will play an educational and advisory role by providing recommendations tailored to the user's needs regarding energy efficiency measures in order to motivate and encourage the users of the program to behave more energy-efficiently. Due to the fact that the project is in the pilot-verification phase, the behavioural model of energy consumers developed as part of the study along with their segmentation (presented in Table 1) is being tested in partner countries; hence, the authors of the article do not currently have the full results of the study and have not made comparisons with the studies obtained in 2018.

[1]Detailed information about the project is available at www.eco-bot.eu.

Table 1 Review of selected profiles of energy consumers

Source	Identified segments	Brief characteristics
Albert and Maasoumy (2016)	Behavioural greens	Think and act in an environmentally friendly way
	Think greens	Have a positive attitude towards environmental issues, but are less likely to act if it requires effort on their part
	Potential greens	Willing to take environmentally friendly actions if it is in their interest
	True browns	They are not interested in environmental issues and energy efficiency
SECC (2019)	Green innovators	Care for the environment is their driving force behind behavioural changes in order to save energy
	Tech-savvy proteges	They are very interested in saving energy and using technology for it, but keeping the same comfort and lifestyle
	Movable middle	They do not reject the idea of energy saving, but the actions they take are usually easy to perform, such as installing energy-saving lighting
	Energy indifferent	Environmental issues have a low priority here, and they are less interested in how to save energy
Pluskwa-Dąbrowski (2016)	Prosumers	Actively participate in the electricity market and become energy producers
	Aware consumers	They are not active and committed, but are aware (at least generally) of their rights in the energy market
	Passive consumers	They are not interested in their entitlements or possibilities of action
Accenture (2010)	Proactives	Focused on taking action to reduce the use of home appliances, low interest in environmental issues
	Eco-rationals	Interested in environmental issues and increasing energy efficiency
	Cost conscious	Focused on saving on electricity bills
	Pragmatics	Ready to change products and brands, but not to implement new technologies
	Skepticals	Less sensitive to savings on bills, little influence of social groups, they seek and use professional advice
	Indifferents	Not interested in pro-efficiency activities, reducing the use of home appliances and reducing energy consumption
Słupik et al. (2019)	Ecological idealist	They care about the environment, and it motivates them to save energy, they have high ecological awareness
	Aspiring ecologist	Follow current trends, (currently "eco") fashion and choices in line with their own lifestyle
	Dedicated saver	Motivated to save energy by financial matters
	Opportunist	Only save energy when it is easy to do
	Indifferent	Uninterested in any change of behaviours

The research presented in the table was mainly aimed at finding out about consumers' perception of their own energy consumption and their readiness and willingness to take pro-ecological as well as pro-efficiency measures. Nonetheless, the resulting segmentations differ due to the contracting subject material scopes, geographic scope and methodology applied. Among other things, consumer attitudes towards electricity management programs; awareness and level of knowledge; involvement and activity in the energy market; motivations; habits, opinions and preferences regarding the application of energy efficiency measures have been studied. The obtained characteristics of individual segments have been largely influenced by the ongoing socio-cultural changes, as well as the emergence of new opportunities related to, for example, the increase in the use of IT tools to manage energy consumption at homes and companies. From the analysis of the segments obtained, a general conclusion emerges that consumer behaviour related to energy efficiency is very complex and is characterized by a large variety of perceptions, attitudes and preferences. It can be noticed, however, that in each study there has been a segment of consumers that are uninvolved and not interested in any change in behaviour, as well as the segment of "green leaders" consumers for whom concern for the environment has become a priority and motivation to savings and change of behaviours and to increase energy efficiency. Each group of respondents also included consumer segments motivated by financial issues and interested in saving money. Research has also shown that consumers have more control over energy use and savings over the years.

3 Characteristics of the Surveyed Electricity Users and Description of the Methods Applied in the Study

The analysis performed in this article uses data from the original survey conducted in 2018 among the inhabitants of the Silesian Province. The Silesian Province is located in southern Poland and covers an area of 12,333 km^2, which accounts for almost 4% of the country's area. The region is the second most populous in Poland, while the Mazowieckie Province ranks first. It has 4.5 million inhabitants, with 368 inhabitants per 1 km^2. Accordingly, the area of the province has the highest population density index in Poland. In addition, as many as 77% of the residents of the province live in towns and cities (the average for Poland is 60.1%) (GUS 2020; Polityka gospodarki niskoemisyjnej dla Województwa Śląskiego. Regionalna polityka energetyczna do roku 2030-projekt 2020). The Silesian Province has a long-standing tradition of using coal as the main energy fuel, and today, it is the last large hard coal mining area in the European Union. Its high degree of urbanization and industrialization has caused serious environmental damage, which has resulted in deteriorating living conditions. The region's energy industry is built on conventional energy sources. Although the region ranks high in electricity generation, only a small share is produced from renewable energy sources, which amounted to

mere 3.2% in 2018. In 2018, 24,905.9 GWh of electricity were produced in the Silesian Province (14.64% of domestic production), which ranked the region third in the country after the Łódzkie Province (22.7%) and the Mazowieckie Province (17.9%). In the same year, 27,273 GWh of electricity was consumed in the region, which accounted for 16.3% of the energy consumed in the country, and, apart from the Mazowieckie Province, it was the highest consumption in Poland. Due to the industrial character of the Silesian Province, the largest amount of electricity generated in 2018 was used by the industrial sector (9,107 GWh) and the energy sector (6,973 GWh). Substantial electricity consumption was also reported for households, which—in 2018—consumed 3,520 GWh of energy, which placed the region in the second place behind the Mazowieckie Province (4,828 GWh). (GUS 2020; Polityka gospodarki niskoemisyjnej dla Województwa Śląskiego. Regionalna polityka energetyczna do roku 2030-projekt 2020). The main air pollutants in the region are the emissions generated by the industry, households and transportation. Point emissions are related to the operations of the main industries in the Silesian area, such as mining, iron, zinc and lead metallurgy, and electricity generation. Surface emissions have a decisive impact on air pollution in the Silesian Province and they are mainly associated with local boiler plants, small- and medium-sized enterprises using coal for heating and technological purposes, and coal heaters used in households (Polityka gospodarki niskoemisyjnej dla Województwa Śląskiego. Regionalna polityka energetyczna do roku 2030-projekt 2020).

During the authors' research in 2018, information was collected from 1,237 people representing households, although due to the missing values of some key variables for this analysis, the answers of 1,147 respondents were ultimately used. A non-random sample selection was applied. The study was carried out by the method of a diagnostic survey with the use of a questionnaire distributed by the snowball sampling method. The survey questionnaire contained questions with a semi-open cafeteria. The questions in the survey concerned the attitudes and level of environmental awareness of energy consumers. However, taking into account the purpose of this paper, the study covered only those questions that allowed to classify respondents in terms of their attitude to energy saving. Therefore, the respondents when asked *How do you save electricity*? could choose any number of responses from the following options:

- I turn off unnecessary lighting,
- I replace light bulbs with energy-saving ones,
- I buy energy-saving kitchen equipment,
- I do not leave the equipment in standby mode,
- I cook in an energy-saving manner,
- I have two energy tariffs: day and night,
- I buy energy-saving household appliances (TV, computer, etc.),
- I invest in thermal modernization of the building,
- I invest in systems for obtaining energy from renewable sources.

Marking a statement from the above list indicated that an activity related to energy saving was performed, and therefore, each surveyed person indicated their attitude to energy use.

Technically, each of the listed statements represented a separate variable (X_1–X_9). Indication of the statement number j (for $j = 1, \ldots, 9$) by i—this respondent was assigned the implementation x_{ij} with a value "1". Otherwise, when the respondent did not perform and did not mark a given answer, "0" was entered as the value of the appropriate variable. This means that in the study aimed at determining the respondent's profile, nine nominal, dichotomous variables were used.

In further analyses, to profile the formed classes, variables were used that characterized:

- the respondent in terms of his/her attitude to green energy as well as problems related to environmental protection,
- the respondent's attitude to the issue of energy prices, but also to environmental protection programs and subsidies,
- the surveyed person's household.

The list of questions representing the variables, on the basis of which the mentioned class profiling was performed, is presented in Table 2.

As already mentioned, the aim of the article was to classify electricity users in terms of attitudes towards energy saving. But, based on the analysis of the literature on the subject (Accenture 2010; Słupik et al. 2019; Pluskwa-Dąbrowski 2016; Albert and Maasoumy 2016) as well as the research on attitudes and awareness of energy consumers in the Silesia Province (Słupik 2015) carried out in previous years, it was assumed that energy consumers are divided into two basic groups, i.e.:

- people who only perform easy and ad hoc activities (so-called short-term ones) aimed at saving energy (SI),
- people interested in long-term investments (more difficult ones, requiring greater financial and time outlays), which will bring significant energy savings, but at the same time the financial return on investment will take longer (LI).

Moreover, the authors of the study put forward a hypothesis, which will be verified later, that the above division was mainly conditioned by financial possibilities or motives, indicated as a significant factor influencing energy saving by the surveyed respondents.

The research procedure was planned and carried out in four successive stages:

Stage 1. Defining two reference energy consumers: long-term and short-term investor.
Stage 2. Calculating the distance between each respondent and reference objects.
Stage 3. Assigning the respondent to the appropriate class (SI or LI).
Stage 4. Characteristics of the classes obtained.

Table 2 Variables used for class profiling

Type	Question in the survey representing the relevant variable
Financial aspects	What is your view on the cost of electricity?
	Are you ready to pay more for green energy?
	Have you used any co-financing to change the heating or thermal modernization of the building?
	Are you interested in a subsidy for environmental protection?
	Have you used the prosument program?
Aspects related to environmental protection	Do you heat your house with coal?
	Do you have renewable energy sources?
	How much do you spend on devices related to environmental protection?
	Do you pay attention to the eco-label when shopping?
Household characteristics	What is the average monthly income per one member of your household?
	How many people make up the household?
	How many people in your household work?
	What type of apartment/house do you have?
	What municipality do you live in?

The assumed classification of energy users determined the definition of "ideal consumers" in terms of their attitude to energy saving. It has been assumed that the actions determining the attitude of a long-term investor who is willing to take effort and bear financial costs, despite a much longer repayment period, are:

- purchase of energy-saving kitchen appliances (X_3) as well as household appliances (X_7),
- switching to two energy tariffs: day and night (X_6),
- carrying out thermal modernization of the building (X_8),
- installation of a system for obtaining energy from renewable sources (X_9).

The performance of the remaining activities is not characteristic of any of the adopted types. A short-term investor will probably decide to replace light bulbs with energy-saving ones much sooner than, for example, to buy a refrigerator with a higher energy class, however, a person who thinks about saving energy in the long term, usually also changes light bulbs or pays attention to turning off unnecessary lighting. Therefore, the statements represented by the variables: X_1, X_2, X_4 and X_5 are not essential for defining reference objects.

This means that the reference long-term investor will be represented by observation:

$$P_{LI} = (*, *, 1, *, *, 1, 1, 1, 1), \tag{1}$$

where, as previously, "1" means indicating a given option, and "*"—providing any answer.

However, the reference energy consumer with a short-term approach, i.e. "anti-ideal consumer", will have the form:

$$P_{SI} = (*, *, 0, *, *, 0, 0, 0, 0). \tag{2}$$

For reference objects defined in this way, the distances have been calculated between:

- every observation O_i (for $i = 1, \ldots, 1147$), showing the answers of the respondent with the number i, and as a reference for a long-term investor

$$d_{iLI} = d(O_i, P_{LI}), \tag{3}$$

- every observation O_i (for $i = 1, \ldots, 1147$) and the anti-ideal of the short-term investor

$$d_{iSI} = d(O_i, P_{SI}). \tag{4}$$

Due to the scale of the variables' measurement X_1–X_9, the Sokal-Michener metric was used to calculate the distance (Rogers and Tanimoto 1960; Walesiak 2011)—a weighted variant of this measure was used.

Moreover, it was decided to use weights to calculate the distance, due to the varying degree of difficulty and the amount of potential investment costs. The purchase of new, energy-efficient home appliances or the switch to two energy tariffs requires much less investment on the part of the investor than the thermal insulation of the house or the installation of a renewable energy system. It was found that the indication of the latter two activities determines the respondent's behaviour and clearly proves the nature of the investment. Therefore, when calculating the aforementioned distances between the observations and the reference points, a vector of weights was adopted:

$$w = (1, 1, 1, 1, 1, 1, 1, 2, 2). \tag{5}$$

Consumer number i has been classified to the group of long-term investors if the observation that represents him/her O_i lies closer to the reference/ideal consumer P_{LI} than the anti-ideal consumer P_{SI}

$$d(O_i, P_{LI}) < d(O_i, P_{SI}). \tag{6}$$

Similarly, the respondent i was assigned to the class of short-term investors, if

$$d(O_i, P_{LI}) \geq d(O_i, P_{SI}), \tag{7}$$

where the distance d is calculated using the weighted Sokal-Michener metric, implemented by the presented proprietary, original procedure.

After all respondents were assigned to one of two groups (LI or SI), the last stage of the research procedure was conducted, i.e. these groups were characterized, and then, class profiling was performed. For this purpose, it was examined what influence on the classification result had the following variables:

- used to segment energy consumers (X_1–X_9),
- characterizing the respondents (presented in Table 2).

Taking into account that all analysed variables are measured on poor measurement scales, chi-square statistics was used to investigate whether the considered relationships are significant. In addition, a Cramer's V coefficient was also used in order to determine the strength of this dependency.[2]

4 Results and Discussion

The procedure described in the previous chapter allowed for the classification of the respondents into two groups. On the basis of the obtained results, it was found that among the respondents from the Silesian Province, 326 electricity users (28.4% of the sample) were assigned to the group of long-term investors (LI), and 821 (71.6%) were designated as short-term investors (SI) (Fig. 1).

When studying the behaviour of individual electricity consumers (cf. Ropuszyńska-Surma and Węglarz 2018b), it can be stated that in households, also in the Silesian Province, activities aimed at achieving energy savings are divided into two basic groups: (1) using energy-saving devices and changing the habits of energy use to more efficient ones, and (2) investing in thermal modernization of buildings and installing renewable energy sources, which is associated with the transition from the function of a passive electricity consumer to an active participant in the energy market, and acting as a prosumer. Already existing research (Ropuszyńska-Surma and Węglarz 2018b; Zhou and Yang 2016), on the one hand, confirms that behavioural factors have a significant impact on energy consumption in households, and on the other, indicate that financial factors and the possibility of long-term savings are the greatest incentives to invest in RES systems. The cited studies also point to the potential barriers to becoming a prosumer, the most important of which seem to be: high costs and a complicated installation process as well as the lack of technical possibilities of their application. It should also be remembered that the social acceptance of installing this type of energy sources is also important and translates into an increase in investments.

The analysis of the subject literature and the conducted empirical research confirm the correctness of the division adopted by the authors into two groups of

[2]As it was already mentioned, in conducted study, a non-random sample selection was applied. However, the authors used the tools of mathematical statistics, hoping to select a sample close to a random one. Considering the use of only descriptive statistics measures in the characteristics of the obtained groups would significantly reduce the value of this part of the study.

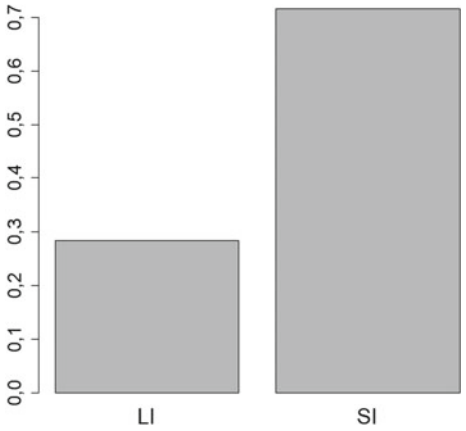

Fig. 1 Division of energy users into short-term and long-term investors

energy consumers in terms of short-term or long-term investments and potential energy savings, while the obtained results and disproportion in the number of segments are not surprising. It can be assumed that the reason for this is the tendency of consumers to *discount future energy savings* (Cabinet Office Behavioural Insights Team 2011, pp. 6–10), i.e. greater attention to achieving immediate effects without incurring high costs, even when the long-term effects of the investment may turn out to be much higher. Moreover, one could risk the statement that consumers focus more on short-term ad hoc measures, as especially in the case of energy efficiency they find it difficult to understand the long-term benefits that are likely to be achieved. Investments in energy efficiency can be perceived as unattractive or requiring a lot of knowledge and patience.

4.1 Characteristics of the Short-Term and Long-Term Investor Classes

Taking advantage of the division of respondents into two classes: short- and long-term investors, the distribution of answers to individual questions from people from both groups was analysed.

First of all, it is worth paying attention to the fact that increasing the weights for the last two variables, representing questions regarding investments in thermal modernization of the building (X_8), and in systems for obtaining energy from renewable sources (X_9), caused that all respondents who declared such actions were assigned to the long-term investors (LI) class. Among the short-term investors (SI), however, there are not those who, in response to the question about the forms of energy saving, indicate the eighth or ninth statement (Fig. 2). It was these investments that required the greatest financial outlays and long-term energy-saving way of thinking. Thus, they clearly show the nature of the investment, and, in some

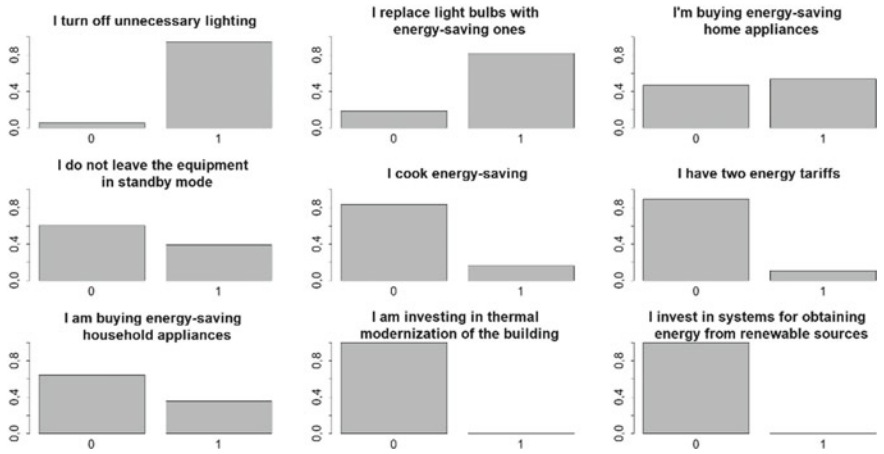

Fig. 2 Distribution of answers into individual segmentation questions of respondents classified as short-term investors

measure, determine the behaviour of the respondents. The increase in weights was aimed at classifying people with a long-term strategy of activities to the group of long-term investors, which was successful.

Comparing the distribution of short-term and long-term responses of investors (Figs. 2 and 3), it can be noticed that people from the second group more often buy energy-efficient kitchen appliances (71.5% of LI people and only 53.4% SI) and household appliances (55.2% LI and 35.4% SI). Moreover, a larger percentage of people with a long-term attitude to limiting energy consumption declare an energy-saving manner of cooking (24.9% LI vs. 16.3% SI). Such people are also more likely to decide on two energy tariffs (24.7% LI vs. 10.8% SI).

Many surveyed respondents indicated performing activities such as turning off unnecessary lighting (93.3% LI and 94.5% SI), or replacing light bulbs with energy-saving ones (83.4% LI and 81.6% SI). However, in this case, the fractions of people who marked these responses were very similar, suggesting that these activities will not significantly affect the obtained classification. Such a high percentage of declarations of this type of behaviour (in both classes) may be the result of information and education campaigns in the media related to energy saving as well as the methods of this saving. The most promoted and popular methods, also available to every consumer, are only illuminating the rooms where somebody stays in, as well as the use of energy-saving light sources (cf. Murawska and Mrozińska 2016).

In the next step, it was verified which of the considered energy-saving statements represented by the X_1–X_9 variables significantly affect the result of the obtained classification. For this purpose, the chi-square statistics (χ^2) and the Cramer's V coefficient were applied (Table 3). It is quite obvious, due to the previously adopted research assumptions, that the greatest impact on which class the respondent will be

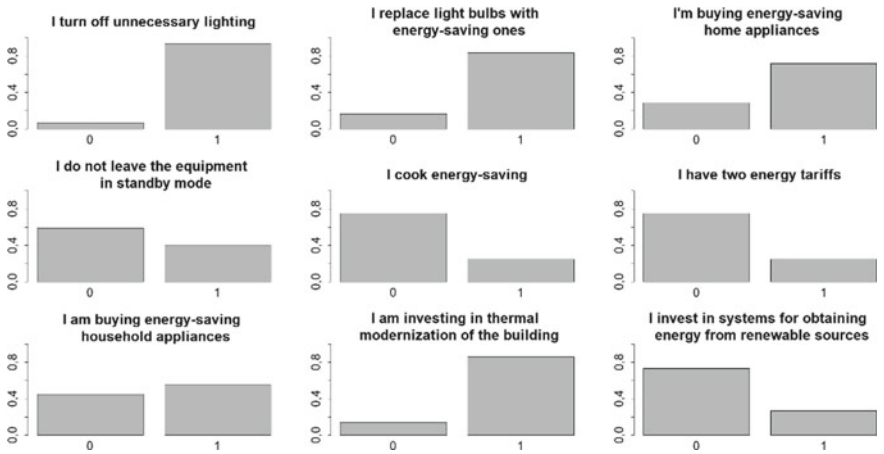

Fig. 3 Distribution of answers into individual segmentation questions of respondents classified as long-term investors

Table 3 Research results of the influence of individual questions on the obtained classification

Question	χ^2	p–value	V–Cramer
I invest in thermal modernization of the building	932.88	0	0.902
I invest in systems for obtaining energy from renewable sources	240.04	0	0.457
I buy energy-saving household appliances (TV, computer, etc.)	37.69	<0.001	0.181
I have two energy tariffs: day and night	36.26	<0.001	0.178
I buy energy-saving kitchen equipment	31.57	<0.001	0.166
I cook in an energy-saving manner	11.13	0.001	0.099
I turn off unnecessary lighting	0.68	0.409	–
I replace light bulbs with energy-saving ones	0.53	0.467	–
I do not leave the equipment in standby mode	0.21	0.650	–

assigned to has the answer that the thermal insulation of a building was performed (0.902). We observe a moderate dependency between the grouping result and the declared investments in systems for obtaining renewable energy (0.457). The purchase of energy-saving household appliances (0.181) and kitchen equipment (0.166), using two energy tariffs (0.178) or proper cooking (0.099) has an even weaker, but still significant influence on the obtained classification. As expected, behaviours such as turning off unnecessary lighting, replacing light bulbs with energy-saving ones, or not leaving the equipment in standby mode did not significantly differentiate the respondents.

4.2 Profiling of the Short-Term and Long-Term Investor Classes

At a further stage of the analysis, the influence of factors that could potentially affect the respondents' behaviour, and thus determine their belonging to the short-term and long-term investors class, was studied.

It has already been hypothesized before that the division of the respondents into the two groups in question is largely due to financial reasons, as promising, long-term investments require adequate cash. This hypothesis was verified again using the chi-square test. It was verified whether the average monthly income per one member of the respondent's household affects the result of the classification. The obtained p–values are the evidence of a significant dependence, though are weak in strength ($V = 0.149$) (Table 4). Therefore, it can be assumed that income is a factor that plays an important role on the actions of the respondents, and thus also on the result of clustering.

It was also interesting to check whether the fact that the respondents belonged to a certain class is related to the willingness to pay more for green energy (WTP). Research on the propensity of households to bear additional charges when using green energy seems to be extremely important in order to identify the existing patterns of individual energy consumption. However, it should be remembered that the obtained results indicate only the respondents' statements and not their actual behaviour. In Poland, little research of this type has been carried out so far. One of them is Profiling End User of Renewable Energy Sources among Residential Consumers in Poland (Ropuszyńska-Surma and Węglarz 2018a) conducted in 2018 and indirectly related to WTP research on the level of environmental awareness of energy consumers in the Silesian Province (Słupik 2015) carried out in 2015. The authors of the first document also made a short review of the existing subject literature on WTP for green energy, which shows a clear conclusion that there is a positive correlation between WPT for renewable energy and such variables as household or monthly income, electricity consumption and place of residence (rented or own flat/house). Moreover, the revealed other factors influencing specific attitudes of respondents in this respect turned out to be: individual beliefs; age of the respondents and their previous experiences with energy consumption, and the level of education. Research conducted in Poland also confirms these observations.

The question about willingness to pay in the current study combines financial and pro-environmental aspects. The environmental awareness of some respondents

Table 4 Study results of the impact on the obtained classification of the most important questions characterizing the respondent

Question	χ^2	p–value	V–Cramer
What is the average monthly income per one member of your household?	25.39	<0.001	0.149
Are you ready to pay more for green energy?	1.25	0.534	–

is not necessarily correlated with a sufficiently high income, which may significantly prevent such preferences. However, the people classified in the group of long-term investors declared that they had funds to carry out the relevant investments. It was also shown that their activities were significantly influenced by income, which leads to the conclusion that these people can probably afford to bear higher costs, if some of the energy supplied to them is the so-called green energy. Nevertheless, the result of the chi-square test shows no significant relationship (Table 4). The willingness to pay higher for renewable energy is therefore not related to the type of investor.

Due to the fact that 84% of all respondents indicated that they are not willing or not sure if they are willing to pay more for renewable energy, the reasons for such decisions were asked. In both the LI and SI segments, financial issues turned out to be the main motive. The respondents believe that the price of electricity is already too high (64% of indications in the LI segment and 58.53% in SI), or they say that they cannot afford to pay larger amounts (38.56% and 36.63%, respectively). It can be assumed that in 2018, there were still relatively few regional initiatives or programs enabling consumers to apply for co-financing of pro-ecological activities related, for example, to changing the heating sources of residential buildings to pro-ecological ones, which also influenced the price of electricity. It is also likely that the ecological awareness of the inhabitants of the Silesian Province was lower than it is currently observed. On the other hand, a positive phenomenon is the fact that in 2018, only a small number of respondents did not see the benefits of using green energy (9.71% LI and 12.42% SI), and only 14.29% of long-term investors and 9.89% of short-term investors believe that the environment, or rather caring for it, is not a sufficient reason to pay more for energy. Analysing other factors influencing WTP to green energy, it can be concluded that respondents willing to pay more for green energy are mainly:

- people living in a detached or terraced house (55.09% of all respondents declaring their willingness to pay more for green energy),
- people living in municipalities (84.52%),
- people living in households consisting of 3 (24.55%), 4 (23.35%) or 5 (28.14%) persons in the household,
- people declaring achievement of an average net monthly income per 1 person in a household in the amount higher than or equal to PLN 1,000 (63.7%), of which as many as 21.4% declare achieving an average net income in the amount exceeding PLN 2,000 net per 1 person in the household.

The financial aspect of the research was extended with four additional questions from the questionnaire (Table 5). Namely the respondent was asked whether s/he intends to use co-financing to change the heating system or to modernize the building. In addition, what is his/her relation to electricity costs and whether s/he used the prosument program. After the analysis, it turned out that the answers to each of these questions significantly differentiate the respondents, although once again it is only a weak correlation (Table 5). It can therefore be confirmed that the financial

Table 5 Study results of the impact on the resulting classification of questions related to financial aspects

Question	χ^2	*p*–value	*V*–Cramer
Have you used any co-financing to change the heating or thermal modernization of the building?	56.43	<0.001	0.223
Are you interested in a subsidy for environmental protection?	23.04	<0.001	0.143
What is your view on the cost of electricity?	10.51	0.015	0.097
Have you used the prosument program?	6.42	0.040	0.075

aspects influence the affiliation of the respondents to the groups of short- and long-term investors.

The respondents classified in the LI segment mostly (62.7% of responses) believe that the price of electricity is too high. The response was similar in case of 56.52% of energy consumers characterized by short-term investments (SI segment). This confirms the hypothesis put forward earlier that it is the financial issues that are an important motive for the division into individual segments. However, in the second group of respondents, at the same time, more than 40% of respondents accept the current price of electricity.

It should be noted that proper informing consumers on energy prices and its daily consumption plays an extremely important role here. When residents rarely receive energy bills, reports or information from their suppliers, most people are not able to realize which of their daily behaviour contributes most to their energy bills or which simple changes need to be made to lower their bills. A simple solution in this case seems to be the widespread introduction of smart meters or the dissemination of IT tools for managing energy consumption at homes, such as the aforementioned *eco-bot*. By using this type of opportunity, the consumer will receive real-time feedback on energy consumption and the impact of the introduced behaviour changes on its consumption, and will even be able to obtain other support in the form of opinions or individually tailored recommendations.

As the experimental research of behavioural economics indicates, consumers are not very often guided by rational motives in their decisions. On the other hand, there was a large discrepancy between people's values and material interests and their actual behaviour (Frederiks et al. 2015). It also influences investing in RES. The sense of uncertainty regarding electricity supplies, market prices, government and local government policy additionally occurs; but there is also uncertainty as to the rules for obtaining possible support and long-term financial repayments. This state of affairs makes investing in energy-efficient products and services seem like a risky decision for many consumers (Frederiks et al. 2015).

In Poland, prosumer investments in renewable energy sources can develop mainly thanks to the support of EU funds. Primarily, the funds distributed on the basis of regional operational programs (ROPs) implemented by provincial self-governments should be mentioned here. Although natural persons cannot apply for aid directly from the ROP, they use funds distributed, e.g. by the municipality

from specific programs such as: "Prosumer"; "Prosumer 2"; "Clean Air" or "My Electricity".

As in the case of the survey conducted in 2018, the respondents in both segments generally indicated that they had never used a funding or subsidy to change the heating system of the house/flat, or to modernize their buildings (72% LI; 79.46 SI), and had not used the prosumer program operating in 2015–2017 (51.39% LI; 58.48% SI). On the other hand, the majority of respondents in each of the pointed out segments was interested in receiving subsidies for environmental protection purposes (75.78% LI; 61.49% SI). The interest was in changing the method of heating; building insulation, etc. But at the same time, a very large percentage of respondents (in each segment over 40% of respondents) did not hear about the prosument program, which may indicate insufficient information campaigns by decision-makers at that time and the existence of very large information gaps influencing decisions made by consumers.

There is also the question of how the obtained classification is influenced by the respondents' attitude towards environmental protection. Four subsequent questions from the survey questionnaire were used in this study (Table 6). The obtained results mean that both the expenditure on devices related to environmental protection, the use of renewable energy sources, and paying attention to the ecological signs significantly influence the obtained classes of investors. Even heating a house with coal has a significant (albeit again slight) influence on group membership (Table 6).

The surveyed respondents are significantly differentiated by almost each of the factors presented above. For the purchase of products and devices that directly protect the environment, such as energy-saving light bulbs; building insulation and changing the heating method, relatively larger amounts are spent annually by people classified as long-term investors (LI). Consumers in this segment usually spend amounts in the range of PLN 150–299 (26.65%); PLN 300–900 (25.7%), and even 11.91% of people declare eco-expenditures in amounts exceeding PLN 1000. The expenditures of short-term investors (SI), on the other hand, oscillate mainly in the range of PLN 100–299 (55.57%). A significantly lower percentage of these people declare expenses exceeding PLN 1000 (3.13%) or in the range of PLN 300–900 (21.53%). For comparison, based on the respondents answers concerning their received income, it can be estimated that half of the surveyed households had per

Table 6 Study results of the impact on the resulting classification of questions related to environmental protection

Question	χ^2	p–value	V–Cramer
How much do you spend on devices related to environmental protection?	45.77	<0.001	0.202
Do you have renewable energy sources?	28.10	<0.001	0.159
Do you pay attention to the eco-label when shopping?	12.71	<0.001	0.107
Do you heat your house with coal?	6.53	0.011	0.077

capita income that did not exceed PLN 1412. Moreover, 25% of the households with the strongest financial situation in the group reported per capita income not lower than PLN 1950.[3]

Also, a higher percentage of consumers from the LI segment (48.10%) pays attention to the eco-label when purchasing goods, such as Energy Star, Ekoland, Zielony Punkt and others, compared to the SI segment, where such attention is declared by 36.49% of respondents. Being familiar and paying attention to ecological signs, especially those relating to energy efficiency, in everyday purchasing choices is a manifestation of the so-called *greening of consumption* (Matel et al. 2018, p. 405). This phenomenon is most often perceived as changing consumer behaviour by making more responsible and environmentally friendly choices. On the one hand, it may result from both care for the state of the environment, as well as socio-cultural conditions (such as demonstrating a specific lifestyle (Bylok 2014, p. 30), caring for health, slowing down the pace of life, deconsumption) and economic conditions (such as the increase in energy and raw material prices). It can also be noticed that people's behaviour is generally not contrary to their environmental concerns and obligations only because they also want to satisfy their material needs or look for non-ecological benefits.

At this stage of the study, the respondents also declared having renewable energy sources systems. Here, too, we can see significant differences between the segments. 5.97% LI and only 0.76% of SI have such systems, while the main source of energy in households is still coal (44.97% LI and 36.7% SI), so it can be assumed that the investment potential is quite large. On the other hand, already existing research results (Frederiks et al. 2015) indicate that many consumers—even when faced with the clear profitability of investing in energy-saving systems or measures contributing to energy saving—remain reluctant to introduce them into their lives and homes. Perhaps this is due to the belief of consumers that such activities require considerable effort, technical knowledge on the systems or concerns about the inability to operate them later. Therefore, it is very important to inform consumers reliably about the existing possibilities and methods of energy reduction, dispel all uncertainties and fears, as well as introduce comprehensive support systems; also financial ones or combined with other possible benefits (e.g. of non-financial nature).

The final stage is an analysis on which factors characterizing the respondent's household affect the classification result. The conducted statistical tests showed that membership in clusters significantly depends on the number of people composing the household, the type of premises inhabited and the type of commune in which the respondent lives. Only the number of people working in the household has no significant impact (Table 7).

[3]Some respondents were reluctant to provide information concerning their financial situation (24.5% of respondents refused to share information on income). Moreover, the last position in the rating scale question on declared income was open, so the remaining group of the respondents had only quantiles determined in the distribution of income.

Table 7 Study results of the impact on the obtained classification of the questions characterizing the household

Question	χ^2	p–value	V–Cramer
How many people make up the household?	69.64	<0.001	0.247
What type of apartment/house do you have?	24.28	0.002	0.146
What municipality do you live in?	9.89	0.007	0.093
How many people in your household work?	9.59	0.213	–

In the surveyed sample, consumers classified in the LI segment usually indicated an urban municipality as their place of residence (75.93%), then a rural municipality (14.51%) and the smallest number indicated an urban and rural municipality (9.57%). People in this segment live mainly in a detached or terraced house (74.3%), and their household usually consists of 3–5 people (75.39%). The smallest percentage of one-person households (1.25%) of all surveyed households is also in this segment. In the SI segment, the respondents live mainly in urban municipalities (83.9%) in tenement houses or in flats in a block of flats (53.01%), and their households consists mostly of 2–4 people (72.82%).

Individual energy consumption patterns vary widely, as different factors influence consumer decisions. As J. Popczyk rightly points out, "social (lifestyle) changes are slow, because they are more profound, compared to the technological ones", but thanks to technological changes "*homo economicus* is transformed into a behaviourist" (Popczyk 2014, p. 30), and the importance of individualism increases, which influences the growth of autonomy in the actions of consumers on the market (Bylok 2014). The experience of other researchers (Zhou and Yang 2016; de Almeida et al. 2011) also reveals that behavioural factors have a significant impact on household energy consumption, and that these households have a high potential for savings in this regard. According to the estimates of the European Commission, this potential may even be 27% (European Commission 2006 after Zhou and Yang 2016, p. 811). Therefore, it is extremely important to understand the behaviour of energy consumers and the possibility of shaping these behaviours in the direction of increasing pro-ecological activities and improving energy efficiency. Promoting more sustainable consumption requires an approach engaging all interested parties, including government policy, market innovation, the mobilization of consumer groups through NGOs, and individual consumer initiatives alone (OECD 2002). This can be facilitated by the development of comprehensive intervention and information strategies with appropriate financial support programs that could stimulate house and flat owners to change their behaviour, promote sustainable development and effectively communicate the influence of energy consumption on the climate change.

5 Conclusions

One of the most important reasons why energy consumers do not invest in energy efficiency (whether through changing their behaviours, habits or lifestyles, or through green investments) is the lack of awareness of the high energy waste issue (Bator and Kukuła 2016). Moreover, although many energy consumers declare their concern for the natural environment and support limiting the negative impact of consumption or limiting the emission of harmful compounds into the atmosphere, this does not always translate into taking practical steps to reduce consumption (Frederiks et al. 2015)

As the research conducted in 2018 showed, for households in the Silesian Province, financial issues were a significant motivation for taking actions related to the reduction of energy consumption. As indicated in the analysis, consumer behaviour may result from both ecological (high level of ecological awareness or the will to care for the natural environment) and non-ecological reasons (where financial issues dominate, but also following existing trends or influences of social groups). Thinking and caring for the environment significantly differentiate the obtained segments. As revealed by the conducted research, long-term investors:

- more often benefit from co-financing for modernization of heating systems and thermal insulation,
- tend to spend larger amounts on environmental protection equipment,
- pay more attention to the eco-label when doing shopping,
- are more interested in receiving an environmental subsidy.

Also income significantly differentiates the obtained groups in a similar manner. As could be expected, long-term pro-ecological investments are more often made by people with higher incomes. Nevertheless, in both groups, a similar percentage of respondents is not willing to pay more for green energy. The ecological awareness of poles in 2018 was much lower than today. The conducted research confirms this conclusion; the environmental motivation of the households in the Silesian Province, which have mostly been classified among the short-term investors sector, is much lower. Moreover, the higher percentage of respondents from the SI sector have not used or heard about the prosument program. Owing to the fact that the attitudes of poles regarding electricity consumption and environmental protection are dynamically changing, it is important to continue research and observe the developing trends. In 2018, the public was to a small extent ready for long-term pro-ecological investments, but it can be hypothesized that the percentage of respondents who could be classified as long-term investors has currently increased. This issue, nonetheless, requires further, in-depth research.

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