energies

MDPI

Article

Energy-Related Behaviour of Consumers from the Silesia Province (Poland)—Towards a Low-Carbon Economy

Sylwia Słupik [1,*], Joanna Kos-Łabędowicz [2] and Joanna Trzęsiok [3]

[1] Department of Social and Economic Policy, University of Economics in Katowice, 1 Maja 50, 40-287 Katowice, Poland
[2] Department of International Economic Relations, University of Economics in Katowice, 1 Maja 50, 40-287 Katowice, Poland; joanna.kos@ue.katowice.pl
[3] Department of Economic and Financial Analysis, University of Economics in Katowice, 1 Maja 50, 40-287 Katowice, Poland; joanna.trzesiok@ue.katowice.pl
* Correspondence: sylwia.slupik@ue.katowice.pl

Abstract: The issue of energy behaviour among Polish consumers, and especially the motives and attitudes they manifest, is relatively under-researched. This article attempts to identify individual attitudes and beliefs of energy consumers using the example of the residents of the province of Silesia (Poland). The authors conducted the expert segmentation of respondents in terms of their motivation for saving energy, based on the results of their proprietary survey. The second stage of the study involved using a classification model that allowed for the characterisation of the obtained groups. Psychological and financial factors were of greatest significance, which is confirmed by the results of other studies. Nonetheless, the obtained results explicitly indicate the specificity of the region, which requires transformation towards a low-emission economy. Despite the initial stage of changes both in the awareness of the consumers and the public interventions of the authorities, it should be emphasized that a majority of the respondents—at least to a basic extent—declared taking energy-saving measures. Financial motives are predominant among the respondents, although pro-environmental motives can also be noticed, which might translate into increased involvement and concern for the environment and climate.

Keywords: energy behaviour; low-carbon economy; Silesia province; energy consumer segmentation; financial motives; pro-environmental motives; classification tree

Citation: Słupik, S.; Kos-Łabędowicz, J.; Trzęsiok, J. Energy-Related Behaviour of Consumers from the Silesia Province (Poland)—Towards a Low-Carbon Economy. *Energies* **2021**, *14*, 2218. https://doi.org/10.3390/en14082218

Academic Editor: David Borge-Diez

Received: 21 March 2021
Accepted: 14 April 2021
Published: 16 April 2021

1. Introduction

Energy efficiency is an important issue from the perspective of sustainable and responsible development, reducing CO_2 emissions to the atmosphere and energy consumption in line with EU-adopted objectives for 2020 and 2050.

Energy behaviour is a complex issue, hence household electricity consumption patterns are essential for shaping low-carbon economy, especially in the light of the observed climate changes [1,2]. This is critical for the countries of Central and Eastern Europe, such as Poland, where many years of negligence in the field of environmental and climate protection force decisive actions by both central and regional authorities. According to Central Statistical Office (GUS) data from 2018, Polish households accounted for over 18% of domestic energy consumption (compared to a EU average of 17.2%), with an average of 21.3 GJ of energy consumed per capita. Furthermore, the share of energy from renewable sources in the domestic household consumption in Poland was relatively low and amounted to only 13.7% (EU—17.5%) [3]. The presented data and the fact that Poland is the leader in household hard coal consumption (hard coal consumed per capita in Poland was tenfold higher than in EU countries) [3] proves the exceptional significance of the addressed issue. It is extremely important to shift the behaviour of consumers towards energy-effective consumption, among others, through increasing the awareness among

individual consumers. Although we can observe the emerging trend concerning the greening of consumption among household members, the energy-efficient behaviour of Polish consumers remains relatively under-researched. In consequence, it is of great importance to acquire knowledge about the needs of consumers, their demand for energy and the changes in the attitudes and awareness of energy end users. The article aims to address this research gap and makes an attempt to identify individual attitudes and beliefs of energy consumers on the example of the inhabitants of the province of Silesia (Poland).

The authors selected Silesia for the study due to its regional specificity, resulting primarily from the long-standing tradition of using coal as the main energy fuel, and also due to its high degree of urbanization and industrialization, which leads to high environmental degradation. Silesia province is inhabited by 4.5 MM people, with 368 inhabitants per 1 km^2 (the highest population density index in Poland). In 2018, Silesia province was the region which consumed the most electricity (over 18% of the domestic energy consumption), right after Mazowsze, and where the household consumption was around 3520 GWh. Such a significantly high individual energy consumption ranked the region as the second in the country [3]. Moreover, a decisive influence on the air pollution in Silesia province is the surface emissions, mainly due to the operation of local boilerhouses, small and medium-sized coal burning plants for heating and process purposes, as well as coal boilers used in households. In the face of the ongoing climate changes, the region is faced with a challenge of a radical energy transformation towards a low-carbon economy, where an efficient development policy should take into account the modernization of the entire fuel and power sector. Furthermore, it is crucial to draw attention to the issues of increasing awareness, both in terms of energy and environment, among the residents, thus striving to shape the attitudes of sustainable energy production and consumption.

The paper also tries to answer the following research questions: (1) which factors impact consumer energy-saving behaviours? (2) is it possible to distinguish consumer groups relative to differences in their motivations and attitudes towards sustainable consumption? (3) do the consumer groups, potentially distinguished relative to motivations, exhibit other individual differentiating features? For the purposes of the article the authors recognize as the definition of sustainable consumption the 1994 one from the Oslo Ministerial Roundtable Conference on Sustainable Production and Consumption, Oslo Syposium: "The use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations".

The main contribution of the authors of this article, filling the existing research gap in considering the patterns of behaviour of individual energy consumers, can be identified as follows:

- Creating a unique segmentation of consumers in the Silesia region together with the characteristics of the obtained segments based on both experts' knowledge and building a classification model. However, the classification tree, a data mining method, was only used for the characterisation of the classes.
- An innovative approach in the conducted research, where expert knowledge results from the implementation of the past experiences of the authors of the article, inter alia, from the combination of: (1) the results of previous research conducted in Poland among the inhabitants of the Silesia region [4,5] (2) analysis of the existing segmentation of other authors dealing with energy consumption [6,7] (3) observation of changing trends in the behaviour of Polish consumers as well as (4) analysis of the conditions and specificity of the region in which the study was conducted. As a result, the classification rules for the identified groups of consumers were obtained and the variable importance ranking was built, which proved crucial in answering the research questions.

One of the strengths of the applied method is the ease of the interpretation of the model, which other classification methods (e.g., random forests, neural networks, SVM) do

not ensure, as they generate complex models operating based on the "black box" principle. The use of the classification tree allowed for obtaining classification rules that enabled the description of each consumer segment. Furthermore, the method led to the identification of the factors that had the strongest impact on the classification results.

The article begins with an introduction, which outlines the fundamental objective and highlights the significance of the addressed issues. Section 2 provides the background from the conducted literature review, whilst Section 3 describes the methodology used both for data collection and procedures for respondent segmentation. In Section 4 obtained research results are presented and then discussed in Section 5. Section 6 concludes the paper.

2. Literature Review

The energy efficiency gap for the household sector is not a new issue [8–10] and its sources can be singled out in various behavioural biases [11]. Despite numerous activities taken to mitigate it, the research in this regard indicate that it is still present in many countries [12,13], in relation to urban residents in particular [14,15].

2.1. Household Energy Consumption and Factors Influencing It

The source literature contains many examples of studies on the various aspects associated to household energy consumption and attempts to identify the crucial factors that can enable predicting this value in the future. Nevertheless, when analysing the obtained, often contradictory results, one should remember the limitations of individual research (both in terms of methodology, as well as substantive), and their context.

Household energy consumption can depend on numerous factors, such as income, building type, house/apartment area, owned/used appliances, number of people in the household, region, seasonality or climatic conditions [16–23]. The importance of income and its impact on energy-related behaviours (especially associated with investing in more energy-efficient solutions) have been clearly observed in French households [24]. Sanquist et al. [25] indicated in their study that lifestyle factors can play a more significant role than income for forecasting the consumption by American households. The importance of lifestyle related factors in energy consumption were also noticed in case of Belgian households [26]. An important factor impacting energy consumption that should be taken into account in models attempting to predict its level, is the behaviours of the residents of a given house/apartment [27–30].

Energy consumption level and energy behaviours differ depending on the economic development of a given country [31,32]. Environmental awareness itself is not a factor sufficient to develop energy-saving behaviours and improve energy efficiency—this requires conducting additional activities and developing an appropriate policy for the implementation of Energy Efficiency Measures [EEMs] [33]. Various attempts at classifying and segmenting users or households in terms of their features are made in order to get a better understanding of energy behaviours and to appropriately plan interventions aimed at changing them [7,13,34]. The co-financed by the European Commission with the Horizon 2020 scheme: "Reducing energy consumption and carbon footprint by smart and sustainable use" and currently implemented project with the acronym eco-bot ("Personalised ICT-tools for the Active Engagement of Consumers Towards Sustainable Energy") is an example of such intervention implementing a segmentation of the energy consumers. Eco-bot is aimed at developing a personalised virtual assistant with an informative role, through providing a user with information on the current energy consumption, disaggregated to a level of individual electrical appliances, and an education and advisory role through personalised recommendations motivating the user to more energy-saving behaviours. Within one part of the eco-bot project, the authors were responsible for developing a user behavioural model, which takes into account the diverse energy consumer motives behind pro-ecological behaviours [35].

The type, area and features of a residential building significantly impact energy consumption [36] and constitute one of the aforementioned areas for planned investments.

Nonetheless, such interventions, despite their usually positive reception, are not always perceived by their beneficiaries as associated with energy efficiency [37] and, combined with bad habits [38], can actually lead to increased energy consumption [39]. It should be noteed that all undertaken actions face various barriers and obstacles [40] that can be typical for all activities associated with improving energy efficiency or be unique to such interventions or local conditions [41].

The most frequent obstructions in EEM implementation are related to technological aspects, financing and/or owned/required information [42]. Some EEMs are tailored to provide users with the necessary information, nonetheless, they are not always effective and they may result in particular behavioural failures [43]. Research on the broadly understood impact of the community and social capital on motivating energy efficiency measures are increasingly more frequent [44]. Fornara et al. [45], pointed to the significance of information originating from the milieu/community (family, friends, neighbours) when making decisions of RES installation—including the possibility formation of a virtuous circle of such interventions and the consequent greening of the whole community. Common reservation associated with the implementation of energy-saving solutions is the required change in the behaviours of users/residents [46] and their impact on perceived comfort [47] related to e.g., lowering or increasing the room temperature [48,49].

2.2. Review of Factors and Motivations behind Energy-Saving Activities in Households

Studies attempting to determine the factors influencing energy-saving behaviours have been reported [50], but just as with the studies on energy consumption, various studies on energy-saving behaviours focus on individual aspects and the obtained results are not always easily reconcilable. Research covering French households that was based on statistical data indicated five attributes relevant in terms of energy-saving behaviours, namely, energy price, household income, education level, age of household head and dwelling energy performance [51]. They did not take behaviours, attitudes or motivations into account. The research by Martinsson et al. [52], which searched for links between socio-economic factors and exhibited attitudes towards environmental issues, showed significant differences in the efficiency of measures encouraging to save energy and related to various motivations—e.g., homeowners responded more strongly to financial incentives and households with higher income to pro-environmental stimuli. People renting an apartment were less likely to take energy-saving measures [15]. Nonetheless, research on the influence of higher environmental concern covering several countries showed its impact on the taken energy-saving activities, but not necessarily on the investments made or taken actions, which were more apartment time-consuming and required higher expenditures for their purchase and implementation [53]. Some studies demonstrated a correlation between the sex or occupation of the respondents and their energy-saving behaviours, in addition to the significance of pro-ecological values and the knowledge in this regard [54]. The role and significance of both socio-demographic and psychological factors are studied in order to get a better understanding of the motivations behind energy-saving behaviours among consumers [55]. Energy users pointed to a number of motivations behind energy-saving behaviours, such as environmental concern, financial incentives to take actions, moral obligations, their money-saving aspect, and the significance and role of individual actions [56].

A model that takes into account the energy-saving consciousness, behavioural ability, situational factors and demographic factors impacting energy-saving behaviours of Chinese users indicated the presence of differences within a single province, which clearly points to the need for adapting interventions to local conditions [57]. Studies show differences in motivations behind energy-saving actions between the residents of urban and rural areas [58].

Naturally, the importance of individual motivators behind energy saving will differ depending on cultural circumstances. For example, according to a study by Hori et al. [59] on energy-saving behaviours in five Asian cities from different countries, their general level

was similar but the types of taken activities and their motivations differed. Pro-ecological behaviour (which is in line with the research from other areas) was an important factor in all of the studied cities, as were social interactions in four out of five cases (which may be a cultural-specific factor for Asia) [59]. Similarly, in a study covering 10 EU Member States and Norway, the differences in the approach towards energy saving were noticeable both in terms of motivation (financial or pro-ecological), knowledge or solution implementation, and depended on numerous socio-economic factors (e.g., age and household composition, education) [60]. In the case of Greek consumers, moral predictors were not statistically significant for energy-saving behaviours [61], while for Chinese consumers, moral and social standards played an important role in motivating energy-saving behaviours [62]. Nevertheless, even in the case of varying significance and the influence of individual factors on energy-saving behaviours, the impact of income is usually similar in different countries—the higher the income, the higher the likelihood of purchasing energy-efficient appliances, but also the lower the probability of engaging in energy curtailing behaviours [63].

There is some evidence that pro-environmental self-identity motivates people to act in a pro-environmental way [64]. In a conducted study on the impact of personal pro-environmental motivation on participation in community energy initiatives (relatively weak relationship), Sloot et al. [65] showed that pro-environmental motivation was significantly related to self-reported energy behaviours, and to household and communal sustainable energy intentions—the more sustainable energy behaviour intentions are important to a given person, the more likely it is for this person to save energy or use energy-efficient appliances. Affinity for technology can be a factor explaining energy-saving behaviours and energy consumption, but only when measured in a given context [66]. Perception and assessment of energy-saving behaviours are hindered by, e.g., symbolically significant behavioural attribute bias, which focuses the attention of a potential observer/assessor on visible and positively associated pro-ecological behavioural aspects (e.g., setting a lower room temperature or having an electric/hybrid car) and omitting actual data (e.g., heated area dimensions or the actual mileage) [67].

In order to investigate the gap between intention for energy saving behaviours and actual behaviours (so-called behavioural failure), Corradi et al. [68] focused on cognitive abilities supporting the implementation of individual EEMs. The obtained results (given the study limitations) suggest a high importance of the "ease" of application of individual solutions on their efficient implementation—the more attention and reminding a given activity requires, the lower the chance for its effective and continuous introduction. The solutions suggested by the authors include more ergonomic designs of home appliances or targeted interventions, e.g., appropriate training supporting the implementation of specific behaviours [68].

Both environmental factors and money can motivate people to adopt energy-saving behaviours [69]. Experiments with customized information strategies revealed that, out of four differently themed interventions, the environmental contribution and cost-benefit feedbacks were the most influential in terms of increasing household electricity savings [70]. Nevertheless, the studies on factors impacting the household implementation of eco-innovations showed a greater significance of the desire to reduce expenses than the pro-environmental reasons [71] or financial incentives in the case of young people [72].

The pro-ecological and financial motivations behind energy-efficient measures most frequently mentioned in the aforementioned studies point to their crucial importance and are the reason for adopting this approach by the authors of this study. In the case of Polish consumers, the study on green consumption [73], energy consumption and energy behaviours [4], especially in the context of motivating consumers to more energy-efficient activities are of fragmentary nature [5,74], and hence, the research undertaken by the authors may contribute to closing the current research gap in this regard.

3. Materials and Methods

The conducted analysis was based on the result of the authors' own empirical survey performed in 2018 and covering households of the province of Silesia (Poland). Its objective was to identify and assess the main motives behind individual behaviours of electricity consumers, learn their attitudes and views regarding everyday electricity consumption, and analyse the conditions impacting the showed behaviours.

Due to the current circumstances and features of the region, the authors of the study decided that households in the Silesia province would constitute an appropriate research sample serving the purpose of the research, and the obtained results would be used as a material for analysing the social awareness level, as well as the attitudes and behaviours characterising individual energy consumers. The authors wanted to verify whether the inhabitants of the province were ready to change their energy consumption behaviours and exhibited pro-ecological and pro-saving attitudes. For this purpose, the selected research method was a diagnostic survey technique through a standardized survey questionnaire distributed in person in accordance with the snowball sampling method. A non-random sample selection was applied, and the information collected from 1237 people representing households was used to conduct the analysis below. The survey questionnaire used in the study is provided in Appendix A.

A total of 42 questions regarding the primary objective of the study and five demographic questions for characterising households were asked. It should be noted that due to the study being conducted among household representatives, the respondents were only asked about the most important household-characterising issues, such as the place of residence and commune type; number of people in a household; average monthly net income per 1 person in the family, and the dwelling type (tenement house or block of flats versus a detached or terraced house), and about the heating energy sources in the household.

The questionnaire contained closed alternative questions, as well as closed and semi-open cafeteria-type questions of disjunctive and conjunctive nature. It should be pointed out that some of the questions asked within the survey were of declarative nature, expressing respondent opinions on the willingness and possibility to conduct or refrain from future actions associated with saving energy. Other questions were of informative character. They enabled the respondents to indicate individual answer options, and to express their opinion going beyond a predefined set of available answers. The analysis discussed in the article follows the original numbering of questionnaire questions, however it only uses some of them, given the focus of the analysis objective on identifying the motives behind saving (or not saving) electricity among the respondents, as well as characterising the behaviours of individual energy consumers.

The study was conducted in two stages. The first step involved segmenting the respondents based on expert knowledge, using answers to selected questions enabling such a division. In the second step a classification model was built, which allowed characterising each of the created groups via discovering classification rules.

3.1. Respondent Segmentation—Methodological Assumptions

By way of a preliminary statistical analysis of the obtained results, it was concluded that the respondents constituted a set of objects diverse in terms of motivation behind saving energy. Given the above, the studied persons were divided into four groups (segments), based on the expert knowledge, using questions that allowed to clearly identify the dominant behavioural motives of the respondents; ecological on one side and mainly financial on the other. The list of questions used for clustering respondents is shown in Table 1.

Table 1. Questions used for respondent segmentation together with possible answers.

Designation	Question	Responses
Q40	Do you try to save electricity in any way?	yes (a), no (b)
Q32	Would you be willing to pay more for energy, if it was the so-called green energy?	yes (a), no (b), don't know (c)
Q31.1	How do you rate electricity costs (price)?	the price is too high (a), low (b), acceptable (c), does not apply (d)
Q10	What are the annual expenses in your household for purchasing products or devices directly protecting the environment (waste containers and bags, household composting plants, soundproof windows, building insulation, energy-saving lightbulbs and others)?	up to PLN 99 (a), PLN 100–149 (b), PLN 150–299 (c), PLN 300–499 (d), PLN 500–999 (e), more than PLN 1000 (f)

The respondents were segmented pursuant to the diagram shown in Figure 1.

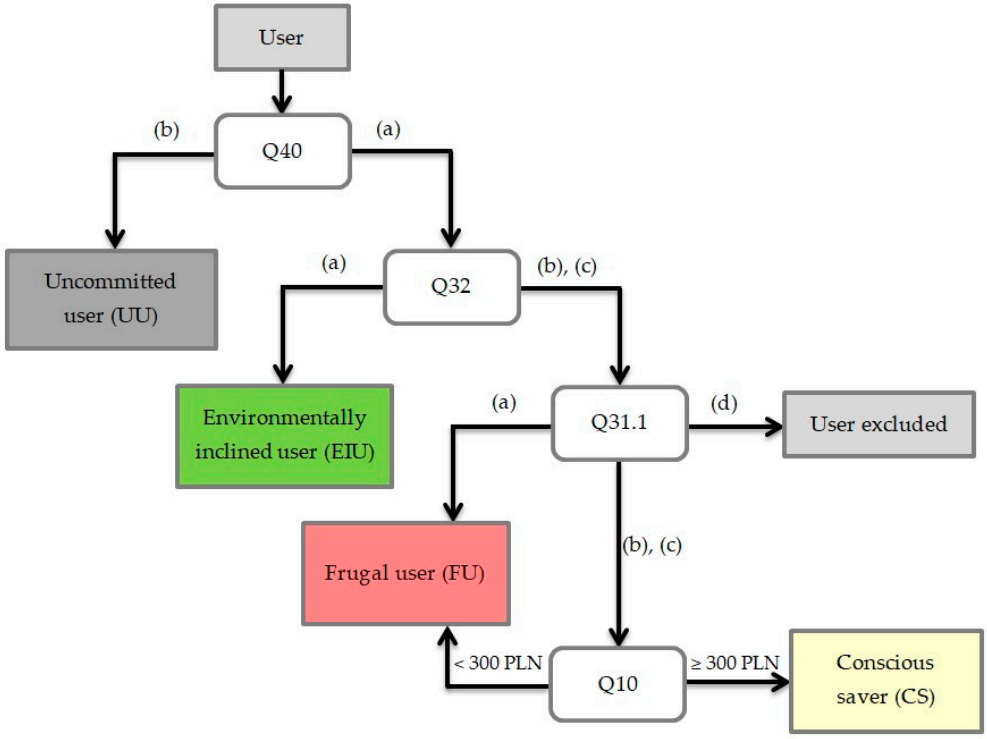

Figure 1. Diagram showing the process of dividing (segmenting) respondents into 4 groups.

The procedure of identifying individual segments was as follows:

Step 1. Question 40 (Q40) regarding the declaration to save electricity (in any way) was used as a base to isolate a group of people failing to exhibit even the slightest activities in this regard. The authors called such respondents Uncommitted Users, thus creating the first consumer segment (designated UU).

Step 2. A group of people who were likely saving electricity mainly for ecological reasons was distinguished among the remaining respondents. Such a division was possible based on answers to question 32 (Q32), where the respondents declared their willingness to pay more for electricity, if it was so-called green energy. The authors called this consumer group Environmentally Inclined Users (designated EIU).

Step 3. Next, answer to question 31.1 (Q31.1) on electricity prices was determinant for the remaining respondents. All those people, who declared that electricity price was too high for them were classified into another, separate segment called Frugal Users (designated FU). Simultaneously, at this stage, the authors removed those respondents,

who claimed that electricity costs did not apply to them. Therefore, the authors assumed that such persons could not constitute the subject of this study.

Step 4. The last segmentation step involved the final division of people declaring that they believed price was too low or acceptable in question 31.1 (selected answer 'b' or 'c'). In this case, the answer to question 10 from the survey was the decisive segmentation factor. This question related to household expenses for purchasing products and devices for environmental protection. A median (Me) was determined using all answers to this question. The obtained median was in the range of PLN 150–299. Thus, the respondents declaring expenses of more than PLN 300 can be recognized as persons with higher environmental awareness. Therefore, it was decided that due to the probable tendency of such people to invest in products or devices for environmental protection, at the same time increasing the value of the house or apartment, these persons would form a separate segment called—Conscious Savers (designated CS). All respondents whose answers to this question indicated that they spent not more than PLN 300 per annum on products and devices for environmental protection, were assigned to the existing Frugal Users segment.

3.2. Classification Methods Used to Characterise Created Segments

Another stage of the analysis, as already mentioned, involved segment characterisation. The R environment for statistical computing was used to build the machine learning classification model. The modelling algorithm was the recursive partitioning method (also known as the classification tree). It is a popular method, first used for classification and regression issued by Breiman et al. [75]. Admittedly, other classification methods, i.e., random forests, neural networks, or SVM, could have been used to perform the analysis. However, the recursive partitioning method was chosen due to the ease of the interpretation of the model form. The classification tree delivers the classification rules that characterise the respondents assigned to the appropriate segments. In addition, during the process of running the model building algorithm, we also obtain the variable importance ranking, which reflects the impact of the factors on the final outcome of the classification, in this case, on energy saving attitudes.

Given the numerous publications in this regard [76–78], as well as the fact that this article is of implementation nature, the section below presents only the idea behind this method, without a formal notation of the algorithm or an analytical model formula.

The study subject matter in this part of the work was a data set, where observations representing individual respondents were characterised by the Q_j and M_k variables corresponding to questions from the questionnaire. The values of these variables were coded respondent answers (the list of all variables with possible (coded) answers is shown in the Appendix A (Table A1)). Q_j variables related to survey questions on respondent attitudes, motivations, habits or behaviour. Whereas M_k marked variables corresponding to the demographic questions). The designated variable was the information on the affiliation of each studied respondent to a specific segment. Therefore, this was a nominal variable with four categories (UU, EIU, FU and CS).

The classification tree method involves a recursive partitioning of a feature space into R_s subspaces (hypercubes). One of the considered partitions is selected in each of the procedure stages—this is a selection of both the variable (Q_j or M_k in our case) and the way of partitioning the space by category or value of this variable (the vast majority, apart from the number of people and the number of working people in a household, of the used variables were measured at weak measurement scales). The partitioning is conducted until each R_s subspace reaches a low, pre-assumed homogeneity level in terms of object affiliation (respondents) to an appropriate class (segment). R_s subspace homogeneity is measured through, e.g., Gini index and controlled through setting proper parameter values in the model building algorithm. After the partitioning, all observations belonging to each of the R_s areas are assigned a class label with the highest frequency indication in a given subspace [75].

An undoubted advantage of the classification tree method is it non-parametricity—it does not assume the knowledge of examined variable distributions. Furthermore, they can be measured at different measurement scales. Missing respondent answers, as well as the presence of outlying values are also permissible. It can be said that it is an appropriate tool in the absence of the study sample randomness. It enables in-depth analysis of constructed segments representing respondents with different attitudes towards saving energy. In addition, a tree visualizing a classification model allows easy reading of classification rules that can characterise these segments.

It should be emphasized once again that an important advantage of the recursive partitioning method is also the ability to obtain a variable importance ranking, where the explanatory variables can significantly influence the form of the model. As mentioned above, when building a tree model, a variable and the way for partitioning space by category or value of this variable are selected at each algorithm stage, so as to obtain the most homogeneous subspaces (where the homogeneity assessment criterion is based on, e.g., the Gini index). Variables selected by the algorithm (visible on the tree) provide the greatest improvement in the homogeneity of obtained segments. However the variables that were a good alternative are also remembered, because they allowed obtaining successive high values of the criterion in question. This means that determining the importance of a given variable to the classification result takes into account not only the frequency of such variable within the model, but also the fact that it was a potential "substitute" for another variable, which was ultimately selected by the algorithm and placed on the tree chart. The thus obtained variable ranking provides a possibility to obtain additional knowledge on the analysed data set [79,80].

4. Results

The study conducted on a set of data originating from a own survey was aimed at identifying the behaviour of energy consumers from the province of Silesia. In order to obtain a complete spectrum of these behaviours, as well given the best possible characterisation of the respondents, they were divided into groups using a segmentation procedure described in the previous section. Next, individual groups were characterised using a non-parametric classification tree method, with particular focus on factors having the greatest impact on the obtained classes.

4.1. Respondent Segmentation Results in Terms of Their Energy Behaviours

As mentioned above, according to the segmentation procedure presented on a Figure 1 and described in Section 3.1, the surveyed consumers were divided into four segments, which differed in terms of the main drivers behind energy-saving behaviour in households. Originally, the data set contained information on 1237 people. However, due to the missing answers to certain key questions, which made it impossible to classify some respondents, the data of 1174 Silesia province inhabitants was used ultimately.

The obtained distribution of respondents and class size of individual segments are presented in Table 2.

Table 2. Class size of individual electricity consumer groups.

Segments	Class Size	Percent
Environmentally Inclined Users (EIU)	173	14.74%
Conscious Savers (CS)	87	7.41%
Frugal Users (FU)	848	72.23%
Uncommitted Users (UU)	66	5.62%
Total	1174	100%

The segmentation resulted in a respondent distribution, where the largest group were people with predominant financial motivation behind taking measures aimed at limiting energy consumption, which is not surprising. In 2018, with rising electricity

prices, ecological awareness and level of knowledge on environmental hazards among the residents of Silesia province still seems to be low. The reason behind this fact is the relatively high approval of the region's inhabitants for coal as the primary energy resource in Poland, programs promoting an eco-friendly lifestyle that were fledgling at the time or the small number of existing social campaigns encouraging to save energy. However, the fact that an overwhelming majority of the respondents (in total, all distinguished sectors, apart from Uncommitted Users), namely, 94.38% of the people declared taking energy-saving measures is an optimistic phenomenon that gives hope for the future.

4.2. Classification Tree—Segment Characteristics

The next analysis step involved using the recursive partitioning method, which allowed to build a classification model. The graphical representation of the tree is shown in the Figure 2.

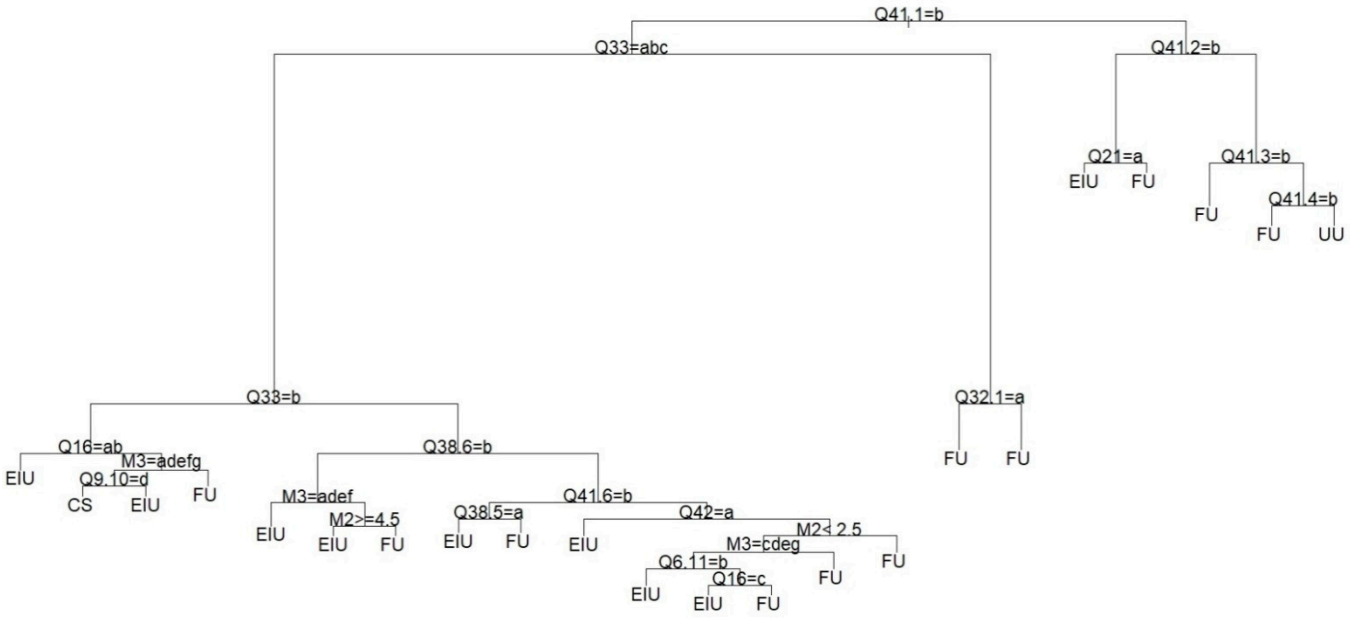

Figure 2. Classification tree characterising obtained electricity consumer segments.

The obtained model primarily enabled to find classification rules used to describe individual classes (segments) of electricity users. Detailed rules characterising respondents from individual segments can be read from the tree (when writing classification rules, it should be noted that a term noted within a tree node is true for all objects to the left of this node and false for objects to the right. A description of individual questions, together with all answer options is included in Appendix A (Table A1)). However, in the light of the complexity of the obtained model, the authors decided to leave out these detailed rules in the following description, and only include the resultant characteristic features of individual segments.

As follows from the analysis of the tree (Figure 2), that in order to assign respondents to an appropriate segment, the algorithm created 22 subspaces represented by so-called leaf nodes. Each of these subspaces can be unambiguously described via classification rules, using the conditions visible on the Figure 2. Most leaf nodes (hence, most rules) lead to identifying a Frugal Users (11 leaf nodes) respondents, followed by an Environmentally Inclined Users (EIU—nine leaf nodes), whereas the model distinguished only one classification rule for each of the remaining segments.

The tree was divided into two branches, based on the first applied variable (Q41.1), which related to the respondents saving electricity through switching off unnecessary lighting. Interestingly, Uncommitted Users and Conscious Savers were located on the opposite tree sides, hence a conclusion that this variable was significant for distinguishing

these segments. An observation of the tree structure allows a statement that UU (right tree side) is composed of people who do not save electricity. These users do not replace light bulbs with energy-saving ones and do not invest in energy-efficient equipment, whereas the Conscious Savers sector, located on the left tree side, is characterised by rather clear classification criteria. The people assigned by the model to this group declare switching off unnecessary lighting and are willing to pay from 10% to 30% more for consuming so-called green energy; what is more, they would like to restrict car traffic in the city centre, their average monthly income per family member is higher than PLN 1 000 (the entire class description omits the households with the lowest income (less than PLN 250 per person) due to the low sample size (six people) within the entire data set) and, distinctive of this group, are interested in the thermo-modernization of the building they live in.

In this context, the most numerous sectors (EIU and FU) appear to be groups of heterogeneous characteristics, since they are located on both the right and left sides of the tree. It is quite hard to point out any traits that would be clearly assigned to only one of these classes. Furthermore, sometimes only the last condition allows to differ the Environmentally Inclined Users respondent subgroup from the Frugal Users subgroup. What is interesting, there are certain conditions "true" for both sectors, e.g., some of EIU respondents, as well as FU respondents switch off unnecessary lighting, declare the readiness to pay more (from 10 to 30% and also from 30 to 60%) for green energy, want to restrict car traffic in city centres, and would even change their electricity provider if it declared greater care for the natural environment. However, other classification conditions envisaged in the tree indicate that the respondents in these sectors are characterised by specific motivations behind energy-saving behaviours. In other words, the respondents from the Environmentally Inclined Users sector, assigned by the model to this group, showed at least one of the following distinguishing features (meeting the affiliation condition), which proves a certain degree of environmental concern and indicates at least the minimum level of consumer's ecological awareness:

- previously benefited from subsidies for changing the building heating or its thermo-modernization (Q42);
- considered introducing additional fees for drainage and treatment of rainwaters and snowmelt from urbanized areas justified (Q21);
- believe that the commune where they reside, should introduce schemes enabling investments in thermo-modernization or heating change within the next 10 or even 5 years (Q6.11).

On the other hand, when analysing the features characterising Frugal Users, one can notice that most of them are related to financial motives, such as:

- application of two energy tariffs (Q41.6);
- willingness to change the electricity provider in exchange for additional products or services (Q38.5);
- replacement of light bulbs with energy-saving ones (Q41.2);
- conviction that the introduction of an additional fees for drainage and treatment of rainwaters and snowmelt from urbanized areas are not justified (Q21);
- possibility of purchasing energy-saving household appliances (Q41.3);
- devices not to be left in standby mode (Q41.4).

The finding that most leaf nodes (8) of the EIU segment are located firmly on the left side of the tree seems interesting. Only one subgroup of this segment was located on the opposite side. Its characteristic feature is that, among others, the respondents replaced light bulbs with energy-saving ones. Question 33 is also worth noting, as it enabled distinguishing two rules (leaf nodes) defining a subgroup of Frugal Users who are unable to declare the extra fee they would be willing to pay for green energy or are willing to pay even more than 60% extra, which better fits the characteristic features for ecologists. When analysing all traits characterising individual segments, it was found that the average

income per one family member or the number of people in a household are variables that do not significantly differentiate the EIU and FU segments.

The classification error of the built model is 12.95%. It can be concluded that this is a rather low value, given the size and diversity of the studied data set. Furthermore, when analysing the classification matrix (Table 3), which shows the distribution of correctly and incorrectly classified objects, it is easy to see that the model is good at recognizing Uncommitted Users, Frugal Users or even Environmentally Inclined Users sectors. Whereas almost all Conscious Savers were classified incorrectly by the model as Frugal Users. This may be related to the low population of this group, as well as the insufficient number of survey questions, where the answers would clearly differentiate between this segment and other groups. The authors of the study tried to fill the prepared questionnaire with the broadest possible spectrum of behaviours, expectations and factors impacting the change in the behaviours of energy consumers. However, every survey has certain limitations, such as the number of asked questions or their complexity, so that respondents do not feel discouraged from completing a questionnaire. Hence, the authors were unable to include all factors impacting behaviour in the study.

Table 3. Classification matrix.

	Theoretical Values			
Empirical Values	**Environmentally Inclined Users**	**Conscious Savers**	**Frugal Users**	**Uncommitted Users**
Environmentally Inclined Users	143	0	28	2
Conscious Savers	3	2	82	0
Frugal Users	32	1	811	4
Uncommitted Users	0	0	0	66

4.3. Predictor Ranking

After analysing a number of factors impacting the consumer behaviours and preferences included in the survey, the selection of key questions suggested by the model for the classification of energy consumers does not seem surprising. As can be seen in the chart (Figure 3), the model indicated 41 variables characterising individual segments, relevant from the perspective of the partitioning. These variables were ordered in terms of the impact on model form and classification result.

Highest-rank questions (first 10 variables) relate primarily to determined, specific motives behind consumer decisions, and also characterise their attitude towards the broadly understood environment. It can be concluded that there are two main behavioural motives, namely, the will to save financial resources (questions Q41.2; Q41.1; Q41.3; Q41.4 and Q41.7) and environmental concern (questions Q33; Q38.6; Q21; Q16; Q18). It can be assumed that the significance of such questions assigned by the model results from precisely specified respondent selection criteria, which enable clear identification of energy consumer motivations based on their declared answers. A distinct division into "environmental" and "saver" consumers can be seen. The model indicates an equal number of questions for both motive types (5 each), though assigns them with a different rank. However, it is important that in the case of "saver" consumers (which can be seen in the tree—Figure 2 and has been described in Section 4.2), it is impossible to conclude that they do not care for the environment in general, but only that the financial motives dominating their everyday life, through simple yet effective actions, e.g., switching off unnecessary lighting, using energy-saving light bulbs or not leaving equipment in standby mode, which also contributes to protecting natural resources.

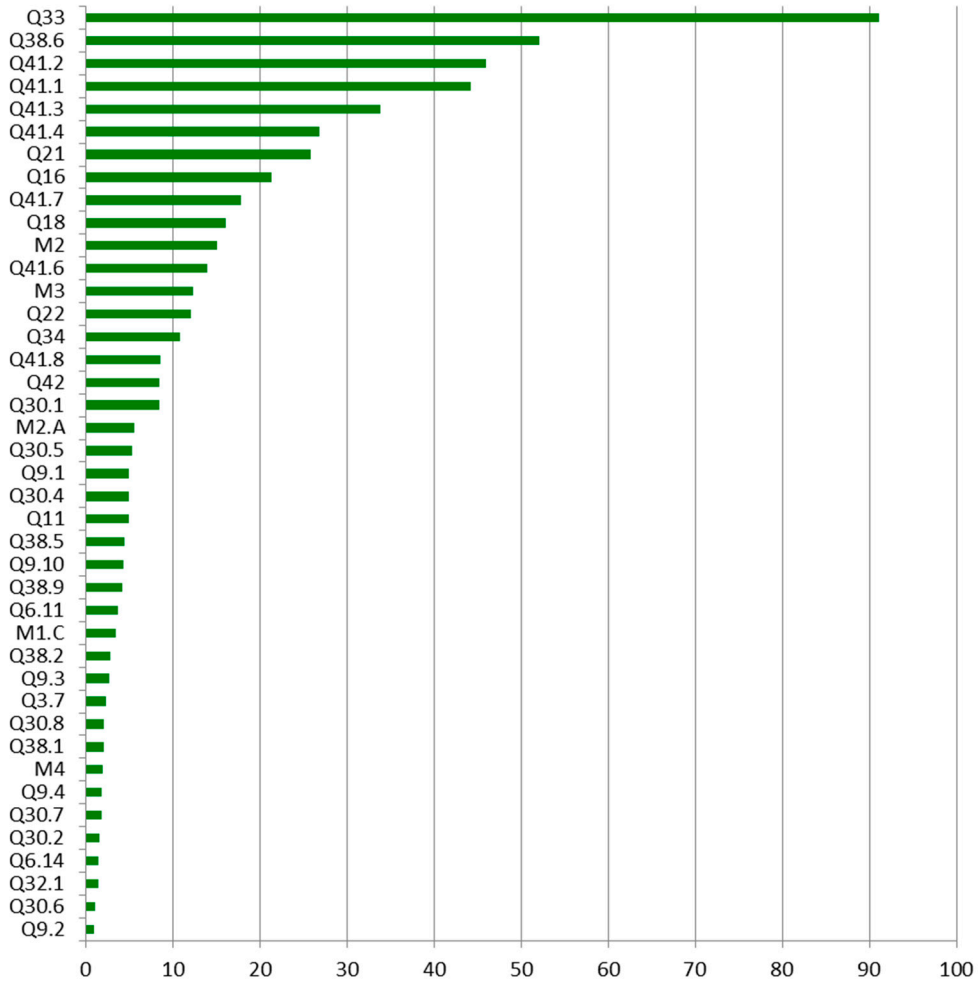

Figure 3. Variable importance.

Interestingly, the ranking is significantly dominated by the question on respondent willingness to pay more for the so-called green energy (Q33), which achieves a significance of more than 90%. As far as the opposite extreme is concerned, the model indicates a variable that determines if a consumer's house/apartment is equipped with energy-saving devices and systems, cold water meter (Q9.2) in this case, assigning a significance of only 0.917% to this variable (the last, 41st ranking place). Other variables regarding the equipment, and taken into account by the model, are also ranked rather low (21st; 25th; 30th; 35th). Such an order enables a conclusion that it is the attitudes, behaviour and opinions of the respondents, and not what individuals own in an apartment or house, that are the main factors distinguishing individual consumer types (segments). This is largely due to the fact that in 2018, the households in Silesia were equipped with systems and appliances improving energy efficiency or assisting in energy management to a similar extent. Based on the answers of the survey participants, it was concluded that approximately 40% of them declared that their house/apartment was not equipped with devices for generating energy from renewable sources (such as, e.g., heat pumps, solar panels—question Q9.6) or with devices optimizing energy consumptions (e.g., thermoregulators, recuperators—question Q9.7), and more than 30% respondents did not own low-emission and energy-saving heating systems (Q9.5).

The ecological awareness and knowledge of energy consumers seem to be extremely essential in the context of transformation into a low-carbon economy. In this case, the model also indicated questions verifying this issue as important ones, although it placed them in the 2nd (Q22 and Q34); 3rd (Q6.11) and 4th (Q3.7; Q6.14) tens of the ranking.

The questions placed highest on the scale (14th and 15th) concerned the declaration of waste segregation and the ability to identify the current electricity provider, respectively. Other variables indicated, among others, awareness of the investments in renewable energy sources implemented by the commune of residence or the knowledge on the investments or programs involving public goods and services needed to be implemented by the commune authorities, including the ones related to improving energy-efficiency or aimed at protecting environmental resources.

Finally, the model, using the ranking in Figure 3 took into account and indicated all demographic questions as important, however their degree of significance on the scale highly differed. The question on the total number of people comprising the household ranked the highest (11th place)—15% importance in classifying to individual segments; it was followed by the question regarding the income (13th place—12.24%) and the respondents indicating coal as the basic thermal energy source within the household (18th place—8.45%). The indications of other thermal energy sources (apart from coal) placed close to the end of the ranking (M5.6; M5.2; M5.7; M5.8; M5.4; M5.5 from the end). The rather low rank of the variable indicating the type of dwelling occupied by the respondents might by surprising. For the correct assignment of the respondents to relevant classes, the distinction whether a consumer lives in an apartment in a tenement house/block or dwells in a terrace or detached house has less than 2% importance for the model (M4). The variable with the type of the commune of residence is slightly higher (M1.C—3.4% importance). The authors distinguished the areas of residence into cities; district (*poviat*) cities; villages and municipal-rural communes, which turned out to be insignificant in terms of the final ranking. This may indicate the similarity in the exhibited energy-saving behaviours among the residents of both urban and rural areas of the Silesia province.

Other variables that were not taken into account in the ranking should also be discussed at this point. Such questions as the one regarding the respondent knowledge on the basic problems encountered by the commune (observed frequent power failures or blackouts—Q7.7), the declaration in terms of utilizing the Prosument (*Prosumer*) program (it enables co-financing of a electricity generation system for own needs—Q43) or the question specifying consumer knowledge in the field of possible change of the electricity provider (Q36) were considered by the model as irrelevant, not impacting the assignment into individual groups. The variables explaining other motives behind the reluctance to pay extra for green energy (Q32.2; Q32.3; Q32.4), such as the lack of tangible benefits of using green energy, lack of financial resources for an additional fee, or the perception of environmental protection as an insufficient reason to pay more for energy also did not find their way into the ranking, which may seem interesting from the point of view of respondent characteristics. The fact that the model omitted variables associated with saving electricity through energy-efficient cooking (Q41.5) or installing systems for obtaining energy from renewable sources (Q41.9) is also surprising. The reason for such rejection might be that in 2018 not many Silesian households had systems for obtaining energy for renewable sources (partially due to complicated procedures and the lack of specific, legal regulations associated with purchasing, installation and the need to resell generated energy to an electricity provider/grid), and little was said about the energy-efficient cooking of meals in public space and the entailing benefits.

5. Discussion

The primary objective of the article was to determine the basic factors impacting consumer energy-saving behaviours, and to identify the differences in individual attitudes, beliefs and approaches towards energy consumption. The authors tried to study the predominant motives behind the everyday behaviour of household members, diagnose behavioural patterns and assess what determinants influence their behaviour-related decisions. Through conducting empirical studies that allowed achieving the assumed goal, the authors paid particular attention to the achievements of other researchers [11,15,40,46,81,82], however, the addressed issue turns out to be extremely dif-

ficult to achieve and the conclusions to generalize, due to a number of methodological and substantive limitations [66–68,83]. Studying consumer behaviours, including these of energy consumers, requires a comprehensive multi-faceted approach, enabling better understanding of the human nature, taking into account cultural, social and economic conditions. Furthermore, previous studies had a limited range and research sample, while the factors impacting them could have had a varying influence [50,51,53–57,59,84].

Factors impacting energy consumer behaviours can be divided into four basic groups: (1) economic, including income [24,51,63]; energy prices [51]; age and features of the occupied building [36,85,86]; household appliances, (2) demographic, which includes age; sex; education; family material status; family life stage; place of residence [58]; number of people in a household, (3) socio-cultural, such as the impact of social groups [44,45]; and socio-political leaders; lifestyle [25,26]; following fashion and modern trends, and (4) psychological [87], where individual motives of action, habits, needs, beliefs [66], attitudes, eco-awareness and pro-environmental self-identity play an important part [64,65].

As shown by the experiences of other researchers, consumers are prone to various stimuli that impact the decisions they make. Van den Broek et al. [83] have indicated that contextual factors are extremely important in understanding energy behaviour, as studying intermediate consumer behaviour, such as attitudes, intentions and inclinations [87]. They emphasize that habits, wonts and everyday routine are more important in shaping energy consumer behaviour than, e.g., intentions. The research conducted by the authors within the Silesia province confirm that thesis. All the aforementioned factors impact the decisions made and energy behaviour of the region's inhabitants, and their weight in differentiating the approach of a consumer towards saving energy varies.

Behavioural factors, often identified by economists and behaviourists as those of great importance for developing green attitudes of private consumers [27–30] rarely become the focus of studies performed by Polish authors, especially those involved in energy consumption research. So far, only a small number of such studies have been conducted in Poland. One is the study carried out by Graczyk [88]. The author identified behaviour patterns in households and farms in Lower Silesia. Another study, conducted in 2015, examined the environmental awareness of energy consumers in Silesia province and, indirectly, the consumer willingness to pay for green electricity [4]. In her studies, Graczyk defined a new energy consumer—the sustainable *Homo energeticus* in the local area of energy management, whereas Słupik identified primary motives for energy saving among consumers in Upper Silesia. Nevertheless, Polish studies still lack a model-based approach to energy consumption, the behavioural dimension thereof in particular, which hinders its comprehensive analysis.

As indicated by the results, psychological factors are the most important for shaping energy-saving behaviours, which is evidenced by the predictor ranking in graph form (Figure 3). Based on the shown results, it can be concluded that the basic determinant of eco-attitudes among energy consumers are wonts. Everyday habits are stronger than generally presented social attitudes, and sometimes they are even contrary to the beliefs or thoughts related to the environment [25,26,56,84]. People behave routinely, without thinking in the course of daily activities and often not realizing that their actions conflict the beliefs. It seems that individuals exhibiting high environmental awareness, well educated, and showing concern about the surroundings and environmental issues, intentionally introduce pro-saving activities into their routine, primarily due to the willingness to protect the planet's resources, and to live in harmony with their beliefs.

The presented analysis confirms the findings of other researchers who pointed out that consumer behaviour is not always rational [50,89,90], and in many cases, consumers act reflexively, and often even unconsciously.

Certainly, the level of environmental sensitivity and awareness influence decision-making, but also the lifestyle and broadly understood routine consumer habits, manifested during everyday activities, are one of the more important factors impacting energy consumption. Unfortunately, these habits, wonts and routine are very difficult to change. The

Eco-bot research [35] indicate that although consumers are indeed willing to change at least some of their habits, but only under the condition of other factors, entailing additional benefits. According to Słupik, Kos-Łabędowicz and Trzęsiok, most respondents would answer the question: Would you be willing to take energy-saving measures if they required changing the behaviours of the people living in your household? positively, but only 30% of them would change their behaviour unconditionally, just to protect the environment and climate [35]. Usually, the studied consumers pointed to financial benefits (reduced electricity bills) as the factors that would make them change their habits to e.g., more ecological ones. They also want such actions to increase the value of their house or turn out to be easy to implement.

Due to the limitations of the research tool, the authors were also unable to examine the impact of social groups on energy consumer behaviours and attitudes indicated by other authors as an important factor, and to add references to the determination of the reason for not taking energy-saving actions. It should also be kept in mind that consumer declarations can significantly differ from their actual behaviours [50,90], hence the authors were unable to avoid the impact of heuristic errors and bias that could impact the study results, and that were mentioned also by other authors [67,68,91].

The obtained results indicate that, in the case of Silesian consumers, other factors such as income; the number of people in a household; level of environmental knowledge and awareness; house equipment level or the place of residence or building type they live in shaped their energy-saving behaviours, however, to a lesser extent than the said psychological factors.

By analysing the energy consumers in Silesia province, the authors attempted to answer a question whether it was possible to isolate groups due to differences in their motivation and attitudes towards sustainable consumption. This question was partially verified positively. Proprietary segmentation was used to partition the respondents into 3 basic sectors, with the cost-benefit (Frugal Users and Conscious Savers segments) and pro-environmental (Environmentally Inclined Users) motivations were dominant. This confirms the findings of other researchers [69,70], who pointed out the effectiveness of applied information measures and tools in relation to increasing the energy-saving behaviours among individual users. The developed classification model largely recognizes basic groups of energy-saving consumers; however, it is not exactly good in terms of dealing with distinguishing Conscious Savers. This group contains respondents who, apart from financial motivation, declare the need to increase the value of their house and are ready to make necessary investments in products and devices used directly for environmental protection, such as building thermo-modernization; replacing windows; domestic composting, etc. This contradicts the conclusions [71] regarding the dominating willingness to limit household expenses when implementing eco-innovations.

The UU segment, also distinguished by the model, has not been characterised due to the lack of information on the motives leading to the failure to save energy by the consumers. Nonetheless, this is an issue worth studying, since understanding the lack of taking actions by such consumers can be a valuable indication in terms of possible interventions to change such an attitude. These considerations were not the objective of this analysis, but are undertaken as part of other research projects, e.g., the aforementioned eco-bot project [35].

The authors also attempted to investigate whether consumer groups, potentially classified by motivations (financial and pro-ecological) behind energy-saving activities, displayed also other individual distinguishing features. As it turned out in this respect, the factors associated with respondent knowledge; their awareness of surrounding ecological issues or the house/apartment energy-saving equipment slightly impact the classification result, hence, fail to significantly differentiate between the obtained groups. They are placed rather low in the predictor ranking (cf. graph 3), failing to reach a significance of more than 12%. Questions related to the level of awareness and knowledge among the users were not used within the developed tree model, which also confirms that the respondents from

individual segments do not differ highly in this regard. The studies in question do not confirm the results of other scientists in this respect [64]. Furthermore, it should be stressed that the impact of demographic factors (income; number of people in a household; thermal energy sources) are important to the model and respondent classification, however, only when combined with other factors/conditions. One should not analyse these variables separately from the others since the obtained results do not contain a simple translation of demographic factors to segment differentiation, e.g., urban/rural place of residence does not directly differentiate between obtained consumer groups. In order to construct a classification tree, the model used questions covering respondent attitudes or experiences associated with investing in house/apartment thermo-modernization. Also, this variable is relevant to segment characteristics only in combination with other variables making up the classification rule. Such a state of affairs can result from the fact that in 2018 the residents of the Silesia province were a homogeneous group in terms of social and economic conditions. Similarly, the specificity of the region and the still-prevailing positive approach to coal as a thermal energy source translated into the low level of eco-awareness among the residents. This could have resulted that in the case of the small Environmentally Inclined Users (15% of the total respondents) sector, other factors (knowledge; awareness; demographics) had not been sufficiently exposed/captured by the model.

6. Conclusions

The research results partially fill the existing research gap and confirm the conclusions presented by other researchers [59,60]. The authors focused on the behaviours of energy consumers and aimed to define the segments of consumers manifesting behaviours similar in terms of motives to save energy. In the next step, they characterised the segments using classification trees. The results identify the determinants for a specific group of consumers from a country where some activities are initiated to build a low-carbon, climate-friendly economy. These activities, however, are still at a relatively early stage, so the analysis presented here can be used in the countries and regions that use a similar coal-dominated energy mix.

The results clearly point to the observation that particular consumer segments are differentiated primarily by behavioural and motivational factors, which, on the one hand, are extremely important, but on the other hand—difficult to measure and investigate. Interestingly, factors that other researchers focus on, such as income, place or type of residence and the way it is furnished and equipped, do not significantly affect the make-up of particular segments. This confirms both the observations of other researchers and the hypothesis that it is of great importance to investigate individualised energy consumption patterns, shaped by socio-economic changes, as well as individual attitudes, motives and other behavioural factors.

It should be emphasised that the research results presented in this paper, i.e., the classification rules, show that the segments of those who save energy for ecological reasons (EIU) and those whose motivation is primarily financial (CS) are not easily separable. These segments are not distinguishable by any economic and demographic features, they do not differ significantly in income, place of residence, or the number of persons in the household. They do, however, differ in their attitudes to and views on environmental protection or ecology in general, which affects their everyday decisions or life activities. This means, however, that it is not easy to identify such consumers and reach them with the right message, motivating them to become even more adept at energy saving.

Therefore, decision-makers developing strategies and plans to increase energy efficiency and designing tools to promote energy saving should take into account the motives behind energy consumption choices. The study indicates that these motives can vary significantly, although financial and environmental motives seem to be dominant among Polish consumers. While designing tools promoting energy saving, Polish national and local authorities should adapt their dimensions, impact and type, taking these differences into account.

The authors are aware of the limitations of the study. Due to the non-representative sample selection, it is hard to generalize the conclusions onto a larger population, although the source literature mentions cases indicating the presence of significant differences in the energy consumer behaviours and their motivations within a given region [41,57]. Studying smaller populations seems equally valuable and enable undertaking precise interventions, tailored to regional specificities. The authors hope that it may contribute to considerations on the effective promotion of energy saving among Polish consumers and lead to further research towards the most optimal instruments shaping the future energy attitudes of households. However, it should be noted that the authors of the article plan to repeat the 2018 studies at the beginning of 2021 on a sample of Silesia province residents, with the objective to compare the results in order to track the dynamics of ongoing changes. In the light of the aforementioned limitations, in the course of further research, the authors will try to take the omitted issues into account and avoid such limitation, whenever possible.

Author Contributions: Conceptualization, S.S., J.K.-Ł. and J.T.; methodology, S.S., J.K.-Ł. and J.T.; formal analysis, S.S., J.K.-Ł. and J.T.; investigation, S.S., J.K.-Ł. and J.T.; data curation, J.T.; writing—original draft preparation, S.S., J.K.-Ł. and J.T.; writing—review and editing, S.S., J.K.-Ł. and J.T.; funding acquisition, S.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by European Union's Horizon 2020 research and innovation program: "Reducing energy consumption and carbon footprint by smart and sustainable use", as a part of the currently implemented project "Personalised ICT-tools for the Active Engagement of Consumers Towards Sustainable Energy. Eco-bot" under grant agreement No. 767625.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Supplementary data to this article can be found online at: https://web.ue.katowice.pl/trzesiok/data_for_analysis_Energy-related_behaviours_of_consumers_from_Silesia.csv; and R-code at: https://web.ue.katowice.pl/trzesiok/codeR_tree_Energy-related_behaviours_of_consumers_from_Silesia.txt.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Questions used for the classification model together with possible answers.

Designation	Question	Answers
Q3.7	Has your community during the last 5 years implemented: investment projects in the field of renewable energy sources?	no (a), yes (b)
Q3.8	investment projects in the field of the electric grid?	
Q6.11	How soon should your commune implement: investment projects in the field of building thermo-modernization?	within 5 years (a), within 10 years (b)
Q6.12	change of the heating method to eco-friendly?	
Q6.13	investment projects in renewable energy sources?	
Q6.14	electrical grid modernization?	
Q7.7	Does your community experience the issue of frequent power outages or failures?	no (a), yes (b)

Table A1. *Cont.*

Designation	Question	Answers
	In terms of the equipment in your apartment, do you prefer:	
Q9.1	a hot water meter?	yes (a), no (b), will purchase/install in the near future (c)
Q9.2	a cold water meter?	
Q9.3	a heat meter?	
Q9.4	a water filter?	
Q9.5	low-emission and energy-saving heating systems?	
Q9.6	devices for obtaining energy from renewable sources?	
Q9.7	devices optimizing energy consumption?	
Q9.8	energy-saving light bulbs?	
Q9.9	energy-saving household appliances?	
Q9.10	investing in thermal modernisation of the building?	
Q9.11	other energy-saving systems and goods?	
Q11	Would you be interested in receiving a subsidy for purposes associated with environmental protection in your household (e.g., changing the heating method, building insulation, home wastewater treatment plants, etc.)?	yes (a), no (b), don't know (c)
Q16	Do you think car traffic should be restricted in city centres?	yes (a), no (b), no opinion (c)
Q18	Do you pay attention to eco-labels (e.g., EnergyStart, Ekoland, Green Dot) when purchasing goods?	yes (a), no (b)
Q21	Do you think that urban areas should have a set and charged additional fee for the drainage and treatment of rainwater and snowmelt?	yes (a), no (b), no opinion (c)
Q22	Do you segregate waste in your household?	yes (a), no (b)
	Is the reason why you would not be willing to pay extra for green energy that:	
Q32.1	electricity price is already too high?	no (a), yes (b)
Q32.2	you do not see benefits of using green energy?	
Q32.3	you cannot afford paying more for electricity?	
Q32.4	environmental protection is not a sufficient reason to pay more for electricity?	
Q33	How much would you be willing to pay more for energy, if it was the so-called green energy?	less than 30% (a), 10–30% (b), 31–60% (c), more than 60% (d), don't know (e)
Q34	Who is your electricity provider?	Tauron (a), Vattenfall (b), RWE (c), PGE (d), ENEA (e), ENERGA (f), don't know (g), other (h)
Q36	Do you think that you are entitled to change your current electricity provider?	yes (a), no (b), don't know (c)
	Could any of the following factors make you change your current electricity provider:	
Q38.1	lower price?	no (a), yes (b)
Q38.2	higher service quality?	
Q38.3	higher supply reliability?	
Q38.4	more reputable brand?	
Q38.5	additional services or products?	
Q38.6		
Q38.7	greater concern about the natural environment?	
Q38.8	other reasons?	
Q38.9	None, I have no reason for such a change.	
	Do you save electricity through:	
Q41.1	turning off unnecessary lighting?	no (a), yes (b)
Q41.2	replacing light bulbs with energy-saving ones?	
Q41.3	buying energy-saving kitchen appliances?	

Table A1. *Cont.*

Designation	Question	Answers
Q41.4	not leaving the equipment in standby mode?	
Q41.5	energy-efficient cooking?	
Q41.6	having two energy tariffs (day-time and night-time)?	
Q41.7	buying energy-saving household appliances?	
Q41.8	investing in thermal modernisation of the building?	
Q41.9	installing devices for obtaining energy from renewable sources?	
Q41.10	other, not mentioned measures?	
Q42	Have you ever benefited from financing/subsidy to change the heating system of your apartment or to thermo-modernize your building?	yes (a), no (b), have never been interested in such a subsidy (c)
Q43	Have you ever used the Prosument program?	yes (a), no (b), never heard of such a program (c)
M1.C	What is the type of the community you live in?	municipal (a), city with district rights (b), municipal-rural (c), rural (d)
M2	How many persons make up your household?	
M2.a	How many members of your household are active professionally?	
M3	What is the average net monthly income per 1 person in your household?	below PLN 250 (a), PLN 250–500 (b), PLN 501–1000 (c), PLN 1001–1500 (d), PLN 1501–2000 (e), more than PLN 2000 (f), refuse to answer (g)
M4	What type of apartment/house do you have?	apartment in a tenement house or block (a), detached or terraced house (b)
	Is the source of thermal energy in your household:	
M5.1	coal?	
M5.2	gas?	
M5.3	heating oil?	
M5.4	wood?	no (a), yes (b)
M5.5	electricity?	
M5.6	renewable energy sources?	
M5.7	district heating?	
M5.8	other source, not mentioned above?	

References

1. Lopes, M.; Antunes, C.; Martins, N. Energy behaviours as promoters of energy efficiency: A 21st century review. *Renew. Sustain. Energy Rev.* **2012**, *16*, 4095–4104. [CrossRef]
2. Lopes, M.A.; Antunes, C.H.; Martins, N. Towards more effective behavioural energy policy: An integrative modelling approach to residential energy consumption in Europe. *Energy Res. Soc. Sci.* **2015**, *7*, 84–98. [CrossRef]
3. GUS. *Zużycie Energii w Gospodarstwach Domowych w 2018 Roku*; GUS: Warsaw, Poland, 2020.
4. Słupik, S. Świadomy konsument energii w województwie śląskim w świetle badań ankietowych. *Stud. Ekon.* **2015**, *232*, 215–224.
5. Ropuszyńska-Surma, E.; Węglarz, M. Profiling End User of Renewable Energy Sources among Residential Consumers in Poland. *Sustainability* **2018**, *10*, 4452. [CrossRef]
6. Frankel, D.; Heck, S.; Tai, H. *Using a Consumer Segmentation Approach to Make Energy Efficiency Gains in the Residential Market*; McKinsey and Company: Chicago, IL, USA, 2013; pp. 1–9.
7. Albert, A.; Maasoumy, M. Predictive segmentation of energy consumers. *Appl. Energy* **2016**, *177*, 435–448. [CrossRef]
8. Reddy, B. Overcoming the energy efficiency gap in India's household sector. *Energy Policy* **2003**, *31*, 1117–1127. [CrossRef]
9. De Almeida, A.; Fonseca, P.; Schlomann, B.; Feilberg, N. Characterization of the household electricity consumption in the EU, potential energy savings and specific policy recommendations. *Energy Build.* **2011**, *43*, 1884–1894. [CrossRef]
10. Calì, D.; Osterhage, T.; Streblow, R.; Müller, D. Energy performance gap in refurbished German dwellings: Lesson learned from a field test. *Energy Build.* **2016**, *127*, 1146–1158. [CrossRef]
11. Häckel, B.; Pfosser, S.; Tränkler, T. Explaining the energy efficiency gap—Expected Utility Theory versus Cumulative Prospect Theory. *Energy Policy* **2017**, *111*, 414–426. [CrossRef]
12. Tovar, M.A. The structure of energy efficiency investment in the UK households and its average monetary and environmental savings. *Energy Policy* **2012**, *50*, 723–735. [CrossRef]

13. Tumbaz, M.N.M.; Moğulkoç, H.T. Profiling energy efficiency tendency: A case for Turkish households. *Energy Policy* **2018**, *119*, 441–448. [CrossRef]
14. Broadstock, D.C.; Li, J.; Zhang, D. Efficiency snakes and energy ladders: A (meta-)frontier demand analysis of electricity consumption efficiency in Chinese households. *Energy Policy* **2016**, *91*, 383–396. [CrossRef]
15. Poruschi, L.; Ambrey, C.L. On the confluence of city living, energy saving behaviours and direct residential energy consumption. *Environ. Sci. Policy* **2016**, *66*, 334–343. [CrossRef]
16. Wiesmann, D.; Azevedo, I.L.; Ferrão, P.; Fernández, J.E. Residential electricity consumption in Portugal: Findings from top-down and bottom-up models. *Energy Policy* **2011**, *39*, 2772–2779. [CrossRef]
17. Bartusch, C.; Odlare, M.; Wallin, F.; Wester, L. Exploring variance in residential electricity consumption: Household features and building properties. *Appl. Energy* **2012**, *92*, 637–643. [CrossRef]
18. McLoughlin, F.; Duffy, A.; Conlon, M. Characterising domestic electricity consumption patterns by dwelling and occupant socio-economic variables: An Irish case study. *Energy Build.* **2012**, *48*, 240–248. [CrossRef]
19. Huebner, G.; Shipworth, D.; Hamilton, I.; Chalabi, Z.; Oreszczyn, T. Understanding electricity consumption: A comparative contribution of building factors, socio-demographics, appliances, behaviours and attitudes. *Appl. Energy* **2016**, *177*, 692–702. [CrossRef]
20. Karatasou, S.; Laskari, M.; Santamouris, M. Determinants of high electricity use and high energy consumption for space and water heating in European social housing: Socio-Demographic and building characteristics. *Energy Build.* **2018**, *170*, 107–114. [CrossRef]
21. Karatasou, S.; Santamouris, M. Socio-economic status and residential energy consumption: A latent variable approach. *Energy Build.* **2019**, *198*, 100–105. [CrossRef]
22. Sakah, M.; Can, S.D.L.R.D.; Diawuo, F.A.; Sedzro, M.D.; Kuhn, C. A study of appliance ownership and electricity consumption determinants in urban Ghanaian households. *Sustain. Cities Soc.* **2019**, *44*, 559–581. [CrossRef]
23. Thapar, S. Energy consumption behavior: A Data-Based analysis of urban Indian households. *Energy Policy* **2020**, *143*, 111571. [CrossRef]
24. Cayla, J.-M.; Maizi, N.; Marchand, C. The role of income in energy consumption behaviour: Evidence from French households data. *Energy Policy* **2011**, *39*, 7874–7883. [CrossRef]
25. Sanquist, T.F.; Orr, H.; Shui, B.; Bittner, A.C. Lifestyle factors in U.S. residential electricity consumption. *Energy Policy* **2012**, *42*, 354–364. [CrossRef]
26. De Meester, T.; Marique, A.-F.; De Herde, A.; Reiter, S. Impacts of occupant behaviours on residential heating consumption for detached houses in a temperate climate in the northern part of Europe. *Energy Build.* **2013**, *57*, 313–323. [CrossRef]
27. Vassileva, I.; Wallin, F.; Dahlquist, E. Analytical comparison between electricity consumption and behavioral characteristics of Swedish households in rented apartments. *Appl. Energy* **2012**, *90*, 182–188. [CrossRef]
28. Feng, X.; Yan, D.; Wang, C.; Sun, H. A preliminary research on the derivation of typical occupant behavior based on Large-Scale questionnaire surveys. *Energy Build.* **2016**, *117*, 332–340. [CrossRef]
29. Guerra-Santin, O.; Herrera, N.R.; Cuerda, E.; Keyson, D. Mixed methods approach to determine occupants' behaviour—Analysis of two case studies. *Energy Build.* **2016**, *130*, 546–566. [CrossRef]
30. Bedir, M.; Kara, E.C. Behavioral patterns and profiles of electricity consumption in dutch dwellings. *Energy Build.* **2017**, *150*, 339–352. [CrossRef]
31. Fouquet, R. Lessons from energy history for climate policy: Technological change, demand and economic development. *Energy Res. Soc. Sci.* **2016**, *22*, 79–93. [CrossRef]
32. Shahi, D.K.; Rijal, H.B.; Shukuya, M. A study on household Energy-Use patterns in rural, Semi-Urban and urban areas of Nepal based on field survey. *Energy Build.* **2020**, *223*, 110095. [CrossRef]
33. Wang, Z.; Zhang, B.; Yin, J.; Zhang, Y. Determinants and policy implications for household Electricity-Saving behaviour: Evidence from Beijing, China. *Energy Policy* **2011**, *39*, 3550–3557. [CrossRef]
34. Sütterlin, B.; Brunner, T.A.; Siegrist, M. Who puts the most energy into energy conservation? A segmentation of energy consumers based on Energy-Related behavioral characteristics. *Energy Policy* **2011**, *39*, 8137–8152. [CrossRef]
35. Słupik, S.; Kos-Łabędowicz, J.; Trzęsiok, J. Report on Findings from Consultations and Online-Survey. Personalised ICT-Tools for the Active Engagement of Consumers Towards Sustainable Energy. Eco-Bot. Project, Katowice. 2019. Available online: www.eco-bot.eu (accessed on 18 March 2021).
36. Estiri, H. Building and household X-Factors and energy consumption at the residential sector. *Energy Econ.* **2014**, *43*, 178–184. [CrossRef]
37. Scott, F.L.; Jones, C.R.; Webb, T.L. What do people living in deprived communities in the UK think about household energy efficiency interventions? *Energy Policy* **2014**, *66*, 335–349. [CrossRef]
38. Ascione, F.; Bianco, N.; De Masi, R.F.; Mastellone, M.; Mauro, G.M.; Vanoli, G.P. The role of the occupant behavior in affecting the feasibility of energy refurbishment of residential buildings: Typical effective retrofits compromised by typical wrong habits. *Energy Build.* **2020**, *223*, 110217. [CrossRef]
39. Rau, H.; Moran, P.; Manton, R.; Goggins, J. Changing energy cultures? Household energy use before and after a building energy efficiency retrofit. *Sustain. Cities Soc.* **2020**, *54*, 101983. [CrossRef]

40. Sweeney, J.C.; Kresling, J.; Webb, D.; Soutar, G.N.; Mazzarol, T. Energy saving behaviours: Development of a Practice-Based model. *Energy Policy* **2013**, *61*, 371–381. [CrossRef]
41. Pukšec, T.; Mathiesen, B.V.; Duić, N. Potentials for energy savings and long term energy demand of Croatian households sector. *Appl. Energy* **2013**, *101*, 15–25. [CrossRef]
42. Dianshu, F.; Sovacool, B.K.; Vu, K.M. The barriers to energy efficiency in China: Assessing household electricity savings and consumer behavior in Liaoning Province. *Energy Policy* **2010**, *38*, 1202–1209. [CrossRef]
43. Ramos, A.; Gago, A.; Labandeira, X.; Linares, P. The role of information for energy efficiency in the residential sector. *Energy Econ.* **2015**, *52*, S17–S29. [CrossRef]
44. Nakamura, H. Effects of social participation and the emergence of voluntary social interactions on household Power-Saving practices in Post-Disaster Kanagawa, Japan. *Energy Policy* **2013**, *54*, 397–403. [CrossRef]
45. Fornara, F.; Pattitoni, P.; Mura, M.; Strazzera, E. Predicting intention to improve household energy efficiency: The role of Value-Belief-Norm theory, normative and informational influence, and specific attitude. *J. Environ. Psychol.* **2016**, *45*, 1–10. [CrossRef]
46. Iweka, O.; Liu, S.; Shukla, A.; Yan, D. Energy and behaviour at home: A review of intervention methods and practices. *Energy Res. Soc. Sci.* **2019**, *57*, 101238. [CrossRef]
47. Langevin, J.; Gurian, P.L.; Wen, J. Reducing energy consumption in low income public housing: Interviewing residents about energy behaviors. *Appl. Energy* **2013**, *102*, 1358–1370. [CrossRef]
48. Brounen, D.; Kok, N.; Quigley, J.M. Energy literacy, awareness, and conservation behavior of residential households. *Energy Econ.* **2013**, *38*, 42–50. [CrossRef]
49. Laetitia, M.; Song, J.; Alan, S.C.; Chen, S.; Wu, J.; Yu, W.; Xiong, J.; Zhang, Q.; Ge, J.; Liu, M.; et al. The hot summer-Cold winter region in China: Challenges in the low carbon adaptation of residential slab buildings to enhance comfort. *Energy Build.* **2020**, *223*, 110181. [CrossRef]
50. Frederiks, E.R.; Stenner, K.; Hobman, E.V. Household energy use: Applying behavioural economics to understand consumer decision-Making and behaviour. *Renew. Sustain. Energy Rev.* **2015**, *41*, 1385–1394. [CrossRef]
51. Belaïd, F.; Garcia, T. Understanding the spectrum of residential energy-Saving behaviours: French evidence using disaggregated data. *Energy Econ.* **2016**, *57*, 204–214. [CrossRef]
52. Martinsson, J.; Lundqvist, L.J.; Sundström, A. Energy saving in Swedish households. The (relative) importance of environmental attitudes. *Energy Policy* **2011**, *39*, 5182–5191. [CrossRef]
53. Urban, J.; Ščasný, M. Exploring domestic energy-Saving: The role of environmental concern and background variables. *Energy Policy* **2012**, *47*, 69–80. [CrossRef]
54. Pothitou, M.; Hanna, R.F.; Chalvatzis, K.J. Environmental knowledge, pro-Environmental behaviour and energy savings in households: An empirical study. *Appl. Energy* **2016**, *184*, 1217–1229. [CrossRef]
55. Yang, S.; Zhang, Y.; Zhao, D. Who exhibits more energy-Saving behavior in direct and indirect ways in China? The role of psychological factors and socio-Demographics. *Energy Policy* **2016**, *93*, 196–205. [CrossRef]
56. Yohanis, Y.G. Domestic energy use and householders' energy behaviour. *Energy Policy* **2012**, *41*, 654–665. [CrossRef]
57. Yue, T.; Long, R.; Chen, H. Factors influencing energy-Saving behavior of urban households in Jiangsu Province. *Energy Policy* **2013**, *62*, 665–675. [CrossRef]
58. Ding, Z.; Wang, G.; Liu, Z.; Long, R. Research on differences in the factors influencing the energy-saving behavior of urban and rural residents in China—A case study of Jiangsu Province. *Energy Policy* **2017**, *100*, 252–259. [CrossRef]
59. Hori, S.; Kondo, K.; Nogata, D.; Ben, H. The determinants of household energy-Saving behavior: Survey and comparison in five major Asian cities. *Energy Policy* **2013**, *52*, 354–362. [CrossRef]
60. Mills, B.; Schleich, J. Residential energy-Efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. *Energy Policy* **2012**, *49*, 616–628. [CrossRef]
61. Botetzagias, I.; Malesios, C.; Poulou, D. Electricity curtailment behaviors in Greek households: Different behaviors, different predictors. *Energy Policy* **2014**, *69*, 415–424. [CrossRef]
62. Ru, X.; Wang, S.; Yan, S. Exploring the effects of normative factors and perceived behavioral control on individual's energy-saving intention: An empirical study in eastern China. *Resour. Conserv. Recycl.* **2018**, *134*, 91–99. [CrossRef]
63. Umit, R.; Poortinga, W.; Jokinen, P.; Pohjolainen, P. The role of income in energy efficiency and curtailment behaviours: Findings from 22 European countries. *Energy Res. Soc. Sci.* **2019**, *53*, 206–214. [CrossRef]
64. van der Werff, E.; Steg, L.; Keizer, K. It is a moral issue: The relationship between environmental self-Identity, obligation-Based intrinsic motivation and pro-Environmental behaviour. *Glob. Environ. Chang.* **2013**, *23*, 1258–1265. [CrossRef]
65. Sloot, D.; Jans, L.; Steg, L. Can community energy initiatives motivate sustainable energy behaviours? The role of initiative involvement and personal pro-Environmental motivation. *J. Environ. Psychol.* **2018**, *57*, 99–106. [CrossRef]
66. Wittenberg, I.; Blöbaum, A.; Matthies, E. Environmental motivations for energy use in PV households: Proposal of a modified norm activation model for the specific context of PV households. *J. Environ. Psychol.* **2018**, *55*, 110–120. [CrossRef]
67. Sütterlin, B.; Siegrist, M.; Suetterlin, B. The reliance on symbolically significant behavioral attributes when judging energy consumption behaviors. *J. Environ. Psychol.* **2014**, *40*, 259–272. [CrossRef]
68. Corradi, N.; Priftis, K.; Jacucci, G.; Gamberini, L. Oops, I forgot the light on! The cognitive mechanisms supporting the execution of energy saving behaviors. *J. Econ. Psychol.* **2013**, *34*, 88–96. [CrossRef]

69. Vassileva, I.; Campillo, J. Increasing energy efficiency in low-Income households through targeting awareness and behavioral change. *Renew. Energy* **2014**, *67*, 59–63. [CrossRef]
70. Mi, L.; Qiao, L.; Du, S.; Xu, T.; Gan, X.; Wang, W.; Yu, X. Evaluating the effect of eight customized information strategies on urban households' electricity saving: A field experiment in China. *Sustain. Cities Soc.* **2020**, *62*, 102344. [CrossRef]
71. Diaz-Rainey, I.; Ashton, J.K. Investment inefficiency and the adoption of eco-Innovations: The case of household energy efficiency technologies. *Energy Policy* **2015**, *82*, 105–117. [CrossRef]
72. Broek, K.L.V.D.; Walker, I. Exploring the perceptions of drivers of energy behaviour. *Energy Policy* **2019**, *129*, 1297–1305. [CrossRef]
73. Matel, A. Przesłanki ekologizacji konsumpcji z perspektywy zachowań konsumenckich, Zarządzanie. *Teor. I Prakt.* **2016**, *16*, 55–61.
74. Mokrzecka, M. Interwencje behawioralne jako technika wspierająca zmniejszenia zużycia energii w domach studenckich Podsumowanie stanu wiedzy oraz analiza możliwości zastosowania wybranych. *Eduk. Biol. Środ.* **2017**, *3*, 37–46.
75. Breiman, L.; Friedman, J.H.; Olshen, R.A.; Stone, C.J. *Classification And Regression Trees*; Apple Academic Press: Palm Bay, FL, USA, 2017.
76. Gatnar, E. *Podejście Wielomodelowe w Zagadnieniach Dyskryminacji i Regresji*; PWN: Warszawa, Poland, 2008.
77. Rozmus, D. *Agregacja Modeli Klasyfikacyjnych I Regresyjnych*; Fundacja Promocji i Akredytacji Kierunków Ekonomicznych: Warszawa, Poland, 2008.
78. Hastie, T.; Tibshirani, R.; Friedman, J. *The Elements of Statistical Learning*, 2nd ed.; Springer: New York, NY, USA, 2009.
79. Friedman, J.H. Greedy function approximation: A gradient boosting machine. *Ann. Stat.* **2001**, *29*, 1189–1232. [CrossRef]
80. Ishwaran, H. Variable importance in binary regression trees and forests. *Electron. J. Stat.* **2007**, *1*, 519–537. [CrossRef]
81. Lutzenhiser, L. Social and Behavioral Aspects of energy use. *Annu. Rev. Energy Environ.* **1993**, *28*, 247–289. [CrossRef]
82. Abrahamse, W.; Steg, L. How do socio-Demographic and psychological factors relate to households' direct and indirect energy use and savings? *J. Econ. Psychol.* **2009**, *30*, 711–720. [CrossRef]
83. Broek, K.L.V.D.; Walker, I.; Klöckner, C.A. Drivers of energy saving behaviour: The relative influence of intentional, normative, situational and habitual processes. *Energy Policy* **2019**, *132*, 811–819. [CrossRef]
84. Sidorczuk-Pietraszko, E.; Zawistowska, A. *Stan Gospodarowania Energią w Gminach w Świetle Wyników Badań*; Wyższa Szkoła Ekonomiczna w Białymstoku: Białystok, Poland, 2011.
85. Rinaldi, A.; Schweiker, M.; Iannone, F. On uses of energy in buildings: Extracting influencing factors of occupant behaviour by means of a questionnaire survey. *Energy Build.* **2018**, *168*, 298–308. [CrossRef]
86. Hansen, A.R. 'Sticky' energy practices: The impact of childhood and early adulthood experience on later energy consumption practices. *Energy Res. Soc. Sci.* **2018**, *46*, 125–139. [CrossRef]
87. Maréchal, K. Not irrational but habitual: The importance of "behavioural lock-in" in energy consumption. *Ecol. Econ.* **2010**, *69*, 1104–1114. [CrossRef]
88. Graczyk, A. Gospodarowanie odnawialnymi źródłami energii w ekonomii rozwoju zrównoważonego. In *Teoria i Praktyka*; PWN: Warszawa, Poland, 2019.
89. Evans, M.M.; Foxall, G.; Jamal, A. *Consumer Behaviour*, 2nd ed.; John Wiley & Sons: New York, NY, USA, 2009.
90. Nakamura, E. Electricity Saving Behavior of Households by Making Efforts, Replacing Appliances, and Renovations: Empirical Analysis using a Multivariate Ordered Probit Model. *Int. J. Consum. Stud.* **2016**, *40*, 675–684. [CrossRef]
91. Nagaj, R. Metody behawioralne w ocenie zachowań konsumentów na rynku energii elektrycznej. *Rynek Energii* **2018**, *3*, 3–9.