sustainability

MDPI

Article

Do Consumers Want to Pay for Green Electricity? A Case Study from Poland

Anna Kowalska-Pyzalska

Faculty of Computer Science and Management, Wroclaw University of Science and Technology, Wyb. Wyspianskiego 27, 50-370 Wroclaw, Poland; anna.kowalska-pyzalska@pwr.edu.pl; Tel.: +48-71-3202524

Received: 31 January 2019; Accepted: 25 February 2019; Published: 2 March 2019

Abstract: This paper analyses the willingness to pay (WTP) for green electricity among residential consumers in Poland, which is the sixth most populous and eighth largest and most dynamic economy in the European Union. The current share of renewable energy sources (RES) in energy consumption is around 13.5% and is expected to increase. To estimate the mean WTP of the residential consumers in Poland, as well as its main determinants, an empirical survey has been conducted and a contingent valuation method has been used. The results obtained indicate that—above all—age, income, environmental attitudes, peer support, but also education and knowledge play the most important role in explaining consumers' WTP for green electricity. Statistical analyses indicate that the mean WTP of Polish households is currently quite low (additional 3.5 USD per month), which is due to the relatively low GDP per capita, lack of knowledge about green energy and no past experience with green electricity tariffs.

Keywords: green energy; green electricity tariffs; willingness to pay; telephone survey; contingent valuation method (CVM)

JEL Classification: D12; D90; Q20; Q42; Q48

1. Introduction

For the last few decades there has been a strong pressure to protect the natural environment of our planet by means of sustainable development in the energy market, among other methods. Within the energy market, such a development is based on three main pillars: increase of energy efficiency (and thus, lower energy consumption and reduced losses in energy transmission and distribution), decreased emissions of CO_2 and, finally, an increase in share of renewable energy sources (RES) in the energy mix. The latter aim is supported by many strategic and legislative regulations (e.g., The Paris Agreement, EU Directives, national RES-acts), and obliges the countries to support further development of RES. Recently two main support mechanisms have become the most popular, namely a feed-in-tariff and an auctioning scheme. By means of these tools, generation of energy from RES, dependent on the type of a source and its installed capacity, is subsidized by the governments and supported from the public and private sources.

Sustainable development requires finding a compromise and balance between private and public interests [1]. The general rise in public awareness of adverse environmental effects caused by the consumption of fossil fuels, does not exclude the need to consider possible external costs and benefits associated with RES while making socially optimal renewable energy investments [1,2]. Even though green energy can bring social benefits, such as a cleaner environment, generation of electricity from RES is usually more expensive than that based on fossil fuels such as coal or lignite. Because some of those costs and benefits do not hold monetary values, it is very difficult to assess them in an accurate manner. One must be aware that these additional costs of production in RES, as well as of subsidies, are usually finally shifted to the end-users of electricity, that is, households and companies, so the private sector typically bears most of the cost connected with the development of RES.

Consumers may support the development of RES by either investing in microgeneration or by switching to green electricity tariffs or programs. The consumers' willingness to support RES in both of those options has been widely examined in the literature, see for example [1,3–6].

The concept of green electricity tariffs is built on the assumption that consumers of green electricity **voluntarily pay an extra premium**, which covers additional production expenses of generating electricity from renewable energy sources (RES). According to [7], this additional premium is an expression of consumer's willingness to pay (WTP)—an appraisal of energy production by RES—and hence, is an expression of consumer choice. In other words, WTP is considered to be a means of capturing public preferences. WTP indicates the level of the financial contribution that people are willing to make in order to reach certain goals [2]. WTP is affected by social and technological development and, in turn, can be used to shape the behavior of society via the use of public support [1].

In the case of green electricity, WTP describes *compensation variation, which is the amount of monetary income that is paid by the consumer to attain an increased level of utility as a result of the provision of an impure public good (i.e., green electricity)* [7]. WTP for green electricity describes a compromise between increased social utility because more electricity is generated from clean energy sources, and a higher electricity bill is incurred by an individual electricity consumer. The consumer can also derive individual utility from buying green electricity, such as the "warm glow of giving" effect or increased social status [8]. In that sense consumers behave as impure altruists benefiting from increased environmental quality but also contributing financially to this sustainable development.

Consumers' WTP is usually investigated by means of methods based on stated preferences, like a contingent valuation method (CVM) or a choice experiment (CE). Although this topic is not new, and has been broadly researched in various countries, such as: Germany, Greece, UK, Slovenia, South Korea, Sweden, Japan, China and the U.S. [5,8–20], to the best of the author's knowledge, the WTP of Polish consumers has not been explored yet. Bartczak et al. [21] explored willingness to pay to avoid externalities of renewable energy. They showed that although the majority of respondents support the development of RES in Poland, most of them want RES to be installed far from their place of residence. Moreover, they proved that people who are willing to pay for further development of RES are more risk-seeking and less cost-sensitive in comparison to those who are more loss- and risk-averse with regard to money and who require more compensation before they accept the externalities from RES. At the same time, in a study conducted in 2014 by Optimal Energy, as many as 95% of investigated Poles support an energy policy which would develop RES in Poland and 78% would like to produce energy in their own household, if it were possible (Report "Electrical energy in Polish households" (in Polish), https://optimalenergy.pl/raport-o-rynku-energii-w-polsce/, accessed on 4 April 2018).

In Poland, at the end of 2017, around 13.5% of energy was produced from RES, mainly from wind (15.6%) and biomass (11.5%) (https://www.ure.gov.pl/en). Recently, production using photo voltaic (PV) panels has also begun to expand, in particular due to interest from residential consumers (90% growth rate in the installed capacity of PVs between 2016 and 2017) (https://pv-polska.pl). Based on EU regulations, by the year 2020, the share of RES in Polish energy production should increase to at least 15%. The Renewable Energy Act, which provides an auction system and feed-in-tariff, should encourage completion of the most cost-effective projects and installation of green technologies. According to a report titled: Renewable Energy Prospects for Poland [22], the perspectives for further development of RES in Poland are promising. The authors of this report believe that the share of RES in the capacity of Polish power generation could, by 2030, increase as much as up to 38%, and energy consumption up to 25%, by 2030.

Although these prospects look encouraging, it must be underlined that, so far, active involvement of Polish consumers in the development of RES has been limited mainly to investments in small-scale energy generators like PV, solar panels, small water or wind turbines—all household installations.

At present, residential consumers are unable to opt for a generic green electricity tariff, because they are not offered on the energy market. However, a few years ago, one of the largest energy suppliers tried to launch a green electricity program (with some guaranteed percentage share of the electricity generated in RES) but because of the customers' indifference and their lack of interest, the project has been suspended.

Nowadays, an electricity bill of a typical Polish household, in the so called G tariff group, consists of a price of electricity in PLN/kWh and a fixed price for energy distribution through the power system. Among the latter, since 2016, a payment for RES has been included and explicitly stated in the electricity bill. This payment is a result of a new RES-Act and the auctioning mechanism supporting RES. In 2017, the unit subsidy for each MWh of consumed energy produced from RES was established as 3.7 PLN by the Energy Regulatory Office (URE). The money collected from the end-users should be used for the feed-in-tariff system (supporting investments in RES), also introduced within the new RES-Act. However, at present, there is no such subsidy, as there is a surplus of RES in comparison with the auctions already won by RES producers. URE has decided not to pay such a subsidy, in order to not increase this surplus. So, in 2018 and 2019, the RES payment is equal to 0 PLN/MWh (https://www.ure.gov.pl/en).

It must be underlined that this study takes into account only voluntary payments for green electricity in the form of a flat monthly surcharge. The level of mandatory payments, such as a RES-payment, is not investigated here.

As many studies have already revealed, the WTP estimates vary substantially across countries due to significant differences in the level of economic development, environmental awareness, social customs and cultural background [5,8,12,13,23–25]. Poland is one of the largest EU member states, with a power generating system traditionally based on fossil fuels and, in comparison with countries of Western Europe, citizens of Poland have relatively lower purchasing power coupled with lower environmental awareness. Hence, the energy transition to alternative sources of energy in Poland becomes a challenge. As this transition cannot be successful without social support and engagement, **the aim of this paper is to explore the determinants of WTP for green electricity among Polish households**. In particular, the author asks two research questions: (1) Which factors affect the decision to support the development of RES by paying more for electricity if it is green? (2) How do these factors affect the level of willingness to pay?

To answer the first research question on the factors affecting the decision to support the development of RES by paying more for electricity if it is green, a binary regression model has been applied. Within this model, a probability of a decision whether to support the development of RES or not, dependent on the explanatory variables, is estimated. In the literature, other model specifications are available e.g., probit model. In this paper only the results of the binary logit regression model are presented, as they are very similar to the results of the probit model.

Further, to answer the second research question, the ordered logit model is applied. This model can be viewed as the extension of the logit model and makes it possible to link probability of a certain level of WTP with explanatory factors. Another approach, which makes it possible to link the level of the WTP with the variables, is the linear regression model. Unfortunately, it cannot be applied in the presented framework, because the exact level of the WTP of those respondents who reject to support RES is unknown. Therefore, in this research, a tobit model with a threshold at WTP = 0 is used. The analyses are performed in SPSS and Gretl statistical packages.

This paper presents the results of a survey conducted on a representative sample of Polish residential consumers. Within the survey, the willingness of Polish households to pay more for green electricity in the form of a flat monthly surcharge is investigated by means of the contingent valuation method (CVM). The assumptions of the survey are as follows: (a) consumers are aware of RES and generally support its development particularly, if they do not have to pay for it; (b) consumers do not know about the RES-payment included in the electricity bill; (c) consumers might have heard about green electricity tariffs and because of their lack of interest in the energy market they may believe that such tariffs are still being offered.

As this is probably the first such study in Poland, it sheds some light on the consumers' appraisal of green electricity expressed and measured by their WTP. Based on this study, some policy implications and conclusions are drawn. The findings for Poland match the observations made in other studies from different countries. It proves that there are some general conditions regarding social-economic and attitudinal determinants that must be fulfilled to encourage consumers to pay more for green electricity. It makes it possible to draw some conclusions and provide some guidelines that can be useful not only for the Polish key stakeholders but also for all policy makers concerned about the consumers' acceptance of renewables. The findings may also be useful for the enterprises, such as energy sellers and suppliers, who are responsible for the introduction of new products and services into the energy market (e.g., green electricity tariffs or programs).

The structure of the article is as follows: In Section 2, the most popular methods used in examining WTP and the most common findings from various studies are discussed. In Section 3, the research method and the survey are presented. Next, Section 4 describes the models estimating a consumer's WTP for green electricity in Poland and discusses the main findings. Finally, in Section 5, conclusions, policy implications and limitations of the study are provided.

2. Willingness to Pay for Green Electricity—A Literature Review

2.1. Methods

A large proportion of WTP studies use either the **contingent valuation method** (CVM) [8,9,12,15,16,19,25–28] or the **choice experiment** (CE) [1,11,17,21,29–31] to determine the influence of various factors on WTP. These factors can be related to the consumer's characteristics, such as: age, income or education and to the product such as: share of renewables, source of renewables or local provider. Both methods belong to the group of methods based on stated preferences, which ask actors explicitly how much respondents value environmental goods [24,25,32].

The CVM estimates either willingness to accept or willingness to pay using responses to survey questions. Although this method is extremely popular among researchers because of its advantages, such as, relative simplicity of the method and availability to develop scenarios in which goods are presented which are outside the realm of current user experiences, it also holds some severe disadvantages [7]. Among these, the experts usually focus on hypothetical bias, which means that what people say is different from what they actually do which might be the cause for overestimation of obtained WTP. Variation in WTP is also possibly based on whether the goods are offered separately or as a part of a more inclusive package (scope effect), based on the level and nature of information provided to the respondent (information effect) and, finally, based on the format of questions used (elicitation effect). The impact of the potential disadvantages can be minimized applying some remedies, such as provision of a combination of perspective, relative expenditure and cost information and quality of goods [7].

Within the CE method, respondents are confronted with their most preferred choice between two or more products. Those products are described by several attributes such as their price, quality, distribution, etc. [7]. The role of the respondent is to decide which product they would buy. The main difference between CVM and CE methods is related to the fact that in the case of CVM, the product characteristics are fixed across the respondents and in CE the attributes of the product experimentally vary. In addition, the results are presented differently, based on the method used: in the case of CVM, the mean WTP and in the CE the marginal WTP are usually obtained [7,14,24]. Dependent on the method used, consumers' WTP is expressed as a percentage of the current electricity bill (see, e.g., [33,34]) or as an absolute value (i.e., the increase in the cost of an electricity bill [8,12] or an increase in the price per kWh of electricity supplied) [11,23]. The CE elicits the value of characteristics of the goods while the CVM elicits values of the good as a whole [35]. An important part of any CVM design is the format in which the WTP question is stated to the respondents. In the literature, typically four WTP elicitation formats are popular [7]: (1) bidding or bargaining format (i.e., a respondent is asked to accept or reject a proposed WTP value and, based on their decision, higher or lower bids are offered; (2) payment scale format (i.e., all respondents choose different values from a predefined and ordered list, as in e.g., [5,12,23,33]); (3) open-ended format (i.e., a respondent is asked to choose their own WTP valuation, unbounded and unprompted, as in e.g., [8]); (4) dichotomous choice format (i.e., a respondent receives a randomly assigned bid (or bids) and is invited to accept or reject it, as in [16,23]. As mentioned above, the format of the question may have an influence on the results obtained [7].

Some authors, such as [8,35,36], summarize the type of models used in order to estimate consumers' WTP. They mention, among other things, variants of models of discrete choice: multinominal or nested logit models, fixed effect logit models, conditional logit models, tobit or censored regression models, ordered probit models and mixed models. The choice of the model depends, among other things, on the type of WTP data set.

2.2. Main Findings

A number of studies have already investigated consumer preferences and WTP for green electricity. Even if these studies differ in terms of survey periods, countries and institutional context, survey typology, methods of elicitation, as well as the methodology and econometric techniques applied, they give some common results [2,7,24,35]. Mainly, two sorts of variables are included in the analysis, in order to account for differences in perception of green electricity: demographics (i.e., income or education) as well as attitudinal and psychological variables (i.e., such as environmental awareness, knowledge to capture the differences in perception of RES or social norms) [1,6,17,19,26,37].

Based on the literature review, the statistically significant antecedents of WTP for green electricity as well as willingness to contribute to further development of RES can be divided into those whose effect is:

- positive: attitudes towards the environment and RES, social norms, household income, being a home owner, being risk seeking, level of education, knowledge of technical aspects of energy systems and knowledge about RES (see, for example: [4,8–11,16–19,21,23,26,36]);
- negative: age (older people seem to have a lower WTP), values focused on one's own happiness and comfort, a perceived difficulty of switching an energy supplier, risk and loss aversion (see, for example [8,10,12,21,37]),
- ambiguous: prior experience with RES, household size (WTP tends to decrease with household size, but there are exceptions), gender (some studies report that WTP is lower for males than females), electricity prices and bills (sometimes, the higher the price, the lower WTP), share or source of green electricity (see, for example: [11,16,23,24]).

Sundt and Rehdanz [24] reported that the mean WTP, found in various studies, was around USD 13.3 per household per month, and the median WTP was USD 11.67. In another meta-analysis, a summary WTP estimate on the level of USD 7.16 per month was obtained [38]. The minimum and the maximum WTP were equal to USD 1 and USD 43.01, respectively (see, [24]). If WTP is expressed in kWh, then the mean WTP was 3.18 US-cents per kWh and the median WTP was 1.95 per kWh.

Among various studies the authors often do not specify renewable energy source for the generation of green electricity. In these cases respondents are asked to value green electricity or electricity from RES. In other cases, electricity from wind or solar is explicitly mentioned [7], mostly because consumers are familiar with these sources. Generally familiarity and experience with RES tend to influence the level of WTP indicated by consumers [11]. For example, solar energy is preferred over generic green and wind energy, while biomass and hydro power are the least preferred options [8,11,35]. By taking different shares of green electricity in the product mix into account, it was established that the WTP is increasing in the share of fossil fuels that is replaced by renewables, where a 1 kWh increase in the use of renewables increases the WTP by 2 Euro cent on average [8]. Finally, while investigating the differences between mandatory and voluntary programs, it has been found that the WTP is higher for the latter [11].

Last but not least, many studies reveal the intention-behavior gap between the positive WTP for green electricity and very low actual participation rate in the green electricity programs or tariffs [12,13,20]. For example, in Australia in 2014 only 7% of population had signed up to the green electricity program even if people claimed to be in favor of RES. Among the reasons mentioned by non-participants were financial cost, negative perceptions, limited knowledge and awareness, limited accessibility or other external constraints, indifference and resistance to change, disbelief in climate change, no perceived personal responsibility, etc. [39].

3. Methodology

3.1. Survey Method

Although CVM design has some important limitations, this study was based on one of its forms, namely the payment scale format. Respondents had to choose the level of extra payment for green electricity from a predefined and ordered list with interval scales to indicate the extent to which they were willing to pay extra. All individuals chose from the same list. This approach is similar to the one used in the studies by [5,12,33]. The study estimates the willingness to contribute to generic green electricity, as respondents were not asked about any particular sources of renewable energy.

The CVM design is based on the following assumption: (a) consumers are aware of RES and generally support its development especially if they do not have to pay for it (b) consumers do not know about RES-payment included in the electricity bill (c) consumers might have heard about green electricity tariffs and because of their lack of interest in the energy market they may believe that such tariffs are still offered.

As already mentioned, green electricity tariffs or programs are currently not offered in Poland, but a few years ago, one of the energy suppliers tried to launch such a product into the market. Because of a low level of customers' interest, this project has been suspended. According to the Energy Regulatory Office (URE), in Poland a very small percentage of all residential consumers have already changed energy suppliers, even if electricity prices are relatively high in comparison to the salaries (in 2017 only approx. 4.5% of all the residential consumers changed their energy supplier). According to the survey provided by the energy information agency in May 2018, 75% of the residential consumers are very passive in the energy market. The rest - 25% - sometimes change or update the conditions of the contract with their current energy supplier (for example, deciding on a loyalty program that guarantees fixed price of their electricity for a certain period of time, e.g., two years).

It is important to explore the perception of RES and green electricity of Polish consumers, even if a typical green electricity tariff or program is currently not offered. Some of the consumers could have heard about such tariffs or programs (e.g., when they were offered), so this product is not fully hypothetical and unknown. According to the conducted survey, 40% of respondents claimed to have heard about green electricity tariffs but only 7% admitted to have been offered such a tariff in the past [40]. It is also quite possible that because of consumers' lack of interest in the energy market, they may still believe that green tariffs are offered by some of the energy sellers.

In the questionnaire, the two questions stated below were intended to reveal the respondents WTP:

(Q1): If part or whole of the electrical power supplied to you would be generated from RES, would you consider switching to such an energy supplier? (possible answers: (=1) yes, (=2) no, (=3) do not know/no answer).

(Q2): How much would you be willing to pay extra for electricity, knowing that it is partially or wholly produced from RES? (possible answers: (=1) nothing, prices are already too high, (=2) 0.27–1.34 USD, (=3) 1.6–2.7 USD, (=4) 2.9–5.4 USD, (=5) 5.6–8 USD, (=6) more than 8 USD (in this case, there is an additional open question to indicate WTP)). In the questionnaire, the payments were presented in PLN. The exchange rate is: 1 PLN ≈ 0.27 USD (PLN/USD exchange rate as of 21 June 2018).

In question Q1, the respondents were asked whether they would participate in a green electricity scheme if an electricity supplier were to offer a choice of buying green electricity. If their answer was affirmative, they were asked to specify how much more per month, in addition to their current electricity bill, they would be willing to pay. Such an approach has already been used, for example, in the studies of [8,12]. In question Q2, an ordered interval scale was used, as in [5]. The starting point, intervals and a maximum bid were established by a pilot study (N = 151). In this study [34], conducted in 2016, the WTP was measured as a percentage of the current electricity bill (similar to [33]). This study indicated that even if consumers are willing to pay extra for green electricity, most of them were not ready to pay more than 10–25% of their average electricity bill, which corresponds to around 10–25 PLN per month. That is why, in the current study, the authors decided that the maximum defined WTP should be 30 PLN per month, which is around 8 USD.

3.2. The Conceptual Model

The conceptual model of consumers' appraisal of green electricity expressed by their WTP is presented in Figure 1. The model is based on the popular theory of the planned behavior (TPB) and the model of diffusion of innovation (DoI), both often used in similar studies, see for example [6,9,23]. The aim of both above-mentioned models is to explain the determinants of diffusion of an innovative product or service. Whereas the DoI model divides the adoption into 5 sequential stages starting from gaining knowledge of an innovation, through forming an opinion towards it, making a decision to adopt or not, implementing the decision and finally confirming the decision, the TPB model appropriately explains the relationship between consumers' beliefs, subjective and social norms, attitudes and behavior itself. TPB includes also perceived behavioral control variable (e.g., cost or comfort).

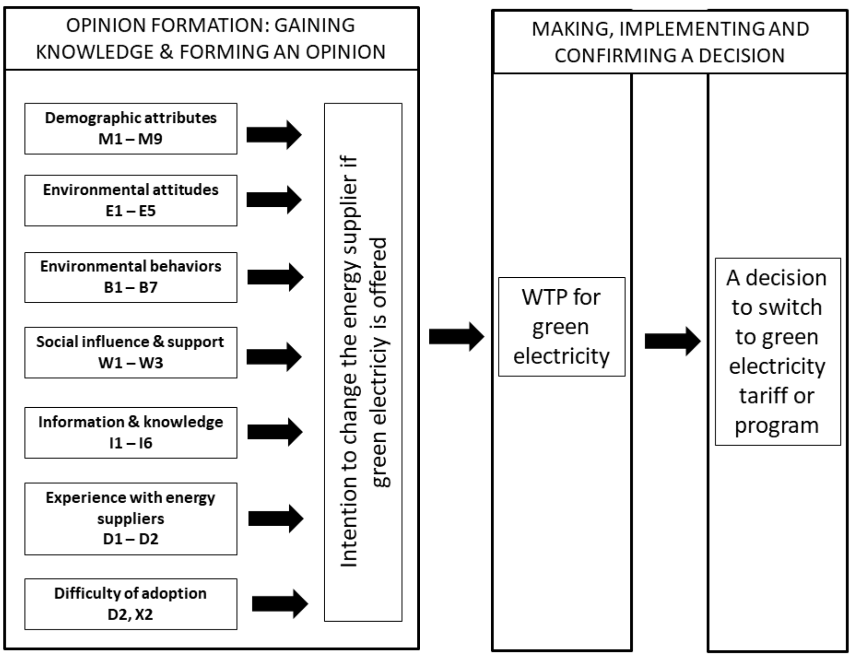

Figure 1. The conceptual model of consumers' willingness to pay (WTP) for green electricity.

In this survey, elements of both models are included. To make a decision to switch to green electricity tariff, a consumer must first form an intention to support the development of RES by paying more for electricity. It is assumed that the willingness to pay extra for green electricity is a stated declaration, which so far cannot be followed by a certain action (e.g., switching to green electricity tariffs, because these are not offered now in Poland). Since 2016, a mandatory payment in the form of the RES-payment has been included in the electricity bill of the end-users. Most of the consumers, however, are not aware of this payment, especially as it is lowered to 0 MWh in 2018 and 2019. Based on consumers' lack of knowledge and engagement towards energy market in this study it is assumed that consumers are mostly not aware whether the green tariffs and programs are offered or not (similarly to their lack of knowledge regarding the RES-payment). Consumers rarely compare offers of energy suppliers and sellers and are generally uninterested in the energy market.

However, to declare a positive WTP, the consumer must form an intention to look for such an energy supplier who offers green electricity. There are several factors that may influence the establishment of such an intention. Among those factors, this study includes: environmental attitudes and behaviors, experience and satisfaction with the energy supplier, information and knowledge (e.g., some level of awareness), social influence and demographics. The perceived behavioral control (PBC) here is described by perceived difficulty of adoption combining financial and non-financial obstacles and disadvantages of adoption of green electricity tariffs. Within this survey, those obstacles are included in items D2 and X2 of the questionnaire. In the item D2 the respondents were asked about their perceived difficulty of comparing what was in offer by various energy suppliers. Around 40% of respondents think that it is quite difficult to compare the offers by various suppliers and another 35% are not sure about it, as they do not compare the offers at all. In the item X2, the respondents were supposed to choose or define one statement presenting their general attitude towards RES. Most of them, (53%) pointed out a lack of knowledge about green energy and ways to support it. 13% of respondents claim that the cost of supporting RES is too high. For another 10%, the procedures of changing the energy supplier and the legal regulations were found to be too complicated. Finally, 2% of respondents have some negative perceptions towards RES, and 6% do not believe it makes sense to support RES by paying more [40]. Finally, similarly to the study of [6], PBC here is connected with the readiness to bear an extra cost of electricity, if it is green.

The idea to combine the DoI and the TPB models is motivated by the fact that on one hand the DoI model suggests a logical direction of stages which must be completed to adopt a certain product or a behavior. On the other hand, the TPB pays attention to the variables responsible for formation of an intention which is required before making any decision. In the case of green electricity adoption, both points of view are important: (1) the sequential process and transformation from gaining knowledge (raising awareness) through forming an opinion, towards making a decision, implementing and conforming it and (2) the impact of general attitudes and current behaviors on the adoption. The current study focuses on the first two stages of adoption: gaining knowledge (raising awareness) and forming an opinion which both influences the willingness to pay and precedes the final decision whether to switch to the green electricity tariff.

4. The Results and Discussion

4.1. Data Description

The data was collected in November 2017 by means of a standardized telephone survey (N = 502). Approximately 10,800 phone calls were made, and the response rate was 4.6%. The data were obtained by a professional polling agency. The main study was preceded by a pilot one, in order to check whether all of the questions were clear to the respondents and that the structure of the survey was correct. Hierarchical sampling was used in order to guarantee a representative sample from all of the 16 Polish regions (i.e., voivodeships) based on statistics published by the Polish Central Statistical Office (CSO). The respondents were also screened by age (lower threshold was 18 years of age) and according to the responsibility of the interviewee paying the household's electricity bills.

The questionnaire consisted of several blocks of questions. All of the questions were asked in Polish. The questions were related to: socio-demographic variables, pro-environmental attitudes and activities, social influence, knowledge and awareness of how to support green energy, satisfaction with customers' current energy supplier and readiness to change supplier and finally about willingness to pay additionally for electricity, knowing that it would be generated from RES. Table 1 presents the 36 attitudinal and behavioral variables observed within the study, together with their codes used in the analysis, description (scale used and type of variable), mean value, its standard deviation, and their minimum and maximum values. The variables were recorded according to binary (yes/no) answers or a five-point Likert scale (strongly disagree—disagree—neither agree nor disagree—agree—strongly agree). The questions and scales were proposed with regard to other similar studies conducted by e.g., [6,9,12,23,33]. More details about descriptive statistics from this survey can be found in general analysis of green electricity adoption among residential consumers in Poland [40]. To avoid malpractice of data slicing, in the data analysis the author followed the suggestions of Kirkman and Chen [41]. Based on the same data set, two analyses have been performed, in which the author has focused on different dependent variables and used different statistical and econometric tools. The description of WTP is provided in Table 2.

Table 1. Definitions of the variables and descriptive statistics (N = 502).

Variable	Code	Description	Mean	Std. Dev.	Min	Max
Gender	M1	1 = female, 2 = male	1.54	0.499	1	2
Age	M2	5 categories (nominal)	3.482	1.244	1	5
Housing	M3	7 categories (nominal)	2.13	1.460	1	7
Material situation	M4	5 categories (ordinal)	3.23	1.097	1	5
Household size	M5	6 categories (ordinal)	3.09	3.00	1	6
Size of town	M6	4 categories (ordinal)	2.36	1.266	1	4
Region	M7	16 categories (nominal)	8.39	4.509	1	16
Education	M8	5 categories (ordinal)	3.38	1.266	1	5
Mean electricity bill	M9	4 categories (ordinal)	2.87	0.915	1	4
Segregation of rubbish	B1	scale from 1 to 5	4.40	1.162	1	5
Use of energy saving bulbs	B2	scale from 1 to 5	4.56	0.911	1	5
Membership of environmental organization	B3	scale from 1 to 5	1.26	0.415	1	5
Financial support for environmental organization	B4	scale from 1 to 5	1.61	1.172	1	5
Use of public transport/bicycle	B5	scale from 1 to 5	2.75	1.635	1	5
Use of public rubbish bins	B6	scale from 1 to 5	4.58	0.969	1	5
Reuse of hotel towels	B7	scale from 1 to 5	2.84	1.540	1	5
Importance of environmental protection	E1	scale from 1 to 5	4.59	0.467	1	5
Reality of environmental degradation	E2	scale from 1 to 5	3.59	1.330	1	5
Importance of environmental policy	E3	scale from 1 to 5	3.98	1.225	1	5
Acceptance of taxation to support environmental protection	E4	scale from 1 to 5	3.13	1.444	1	5
Feeling of individual influence on the environment	E5	scale from 1 to 5	4.77	0.659	1	5

Table 1. *Cont.*

Variable	Code	Description	Mean	Std. Dev.	Min	Max
Regularity of information about domestic production from RES	I1	scale from 1 to 5	3.41	1.173	1	5
Searched for information on domestic production	I2	yes/ no/ no answer	1.04	0.507	1	3
Awareness of green tariffs	I3	yes/ no/ no answer	1.56	0.496	1	3
Searched for information on a green tariff	I4	yes/ no/ no answer	1.87	0.376	1	3
Received an offer of a green tariff	I5	yes/ no/ no answer	2.00	0.268	1	3
Influenced by advertising of green energy	I6	yes/ no/ no answer	1.94	0.773	1	3
Friends and family supportive of environmental protection	W1	scale from 1 to 5	3.91	1.052	1	5
Friends and family would support a decision to produce energy domestically	W2	scale from 1 to 5	4.13	0.879	1	5
Friends and family would support a decision to implement a green tariff	W3	scale from 1 to 5	3.82	0.903	1	5
Satisfaction with the energy supplier	D1	scale from 1 to 5	3.75	1.002	1	5
Difficulty of comparing tariffs	D2	scale from 1 to 5	3.38	1.266	1	5
Willingness to change energy supplier to switch to a green tariff	D3	yes/ no/ no answer	1.50	0.799	1	3
Best incentive for home production	X1	5 categories (nominal)	1.79	1.136	1	5
Main motivation to adopt green energy	X2	8 categories (nominal)	3.67	1.776	1	8
What sort of a car engine would you choose (EVs or CVs)	A1	1 = CV, 2 = EV, 3 = no answer, 4 = no car	1.92	0.568	1	4
Willingness to pay extra for green electricity	V25	6 categories (ordinal)	2.32	1.470	1	6

4.2. Analysis of the Willingness to Pay (WTP)

Firstly, to estimate the mean WTP for green electricity of the Polish consumers, the mid-point of each class in Table 2 was multiplied by the frequency (except the first class *C*1, excluding the cases where the respondents did not want to change their energy supplier to switch to a green electricity tariff (N = 61) or they refused to answer the question (N = 18) or they did not want to pay more for RES (N = 149)). Then, the total sum was divided by the total number of cases (i.e., WTP was estimated based on a sample of size N = 274). For Polish consumers, the mean WTP is quite low and equals 12.83 PLN (approx. 3.5 USD per month), whereas the mean WTP found in many other studies is approx. 13.3 USD (prices as per 2010), see [24]. In particular, dependent on the country, the -WTP found in other studies were equal to between 8.5–21.95 USD per month in the U.S., see [12], 2.3–4.3 USD per month in Italy, 4.1 USD per month in Slovenia, see [5] or 1.8 USD per month in South Korea, see [16]).

Table 2. Willingness to pay extra for electricity if it is green.

Classes	WTP	Class Code	Frequency	%	% for N = 274
nothing, prices are already too high	0	C1	149	29.7	
refusal to answer			18	3.6	
unwilling to change supplier			61	12.2	
1–5 PLN	1	C2	66	13.1	24.1
6–10 PLN	2	C3	89	17.7	32.5
11–20 PLN	3	C4	67	13.3	24.5
21–30 PLN	4	C5	40	8.0	16.6
more than 30 PLN	5	C6	12	2.4	4.4
total		502	100.0	100.0	

One of the reasons for the result for Poland, is a relatively low GDP per capita in Poland. According to the World Economic Outlook published in April 2018 by the International Monetary Fund, the nominal GDP per capita for Poland in 2017 was equal to 13,823 USD, which places Poland in 29th position in Europe and 59th in the world. In the same year, GDP per capita at PPP in Poland was equal to 27,216 USD whereas in, for example, Germany it was equal to 45,229 USD, in France 38,605 USD, in Spain 34,272 USD, in Estonia 29,481 USD, in Slovenia 31,400 USD, in the Czech Republic 32,605 USD. The overall GDP per capita at PPP for the EU was equal to 39,753 USD, see https://tradingeconomics.com/country-list/gdp-per-capita-ppp?continent=europe (accessed on 7 January 2019), cost-sensitivity and general reluctance to pay more than necessary for electricity. It also explains, to some extent, why energy sellers and suppliers currently do not offer green electricity tariffs in Poland. When WTP is low, the percentage of consumers who would decide on such a tariff would be negligible. Moreover, it can be suspected that green energy is treated by many consumers as a public good. This means that Polish consumers do not feel personally responsible for the development of RES, especially from a financial point of view. They rather think that others, such as the central government or local authorities, are obliged to guarantee clean environment and a certain level of RES in the power supply system. Such an approach can be caused by the fact that the power generating system in Poland is traditionally based on fossil fuel and that green energy is not promoted enough in mass-media. Consumers are now aware of the potential role of RES in the environmental protection and they do not have enough knowledge on how to support the development of RES.

4.3. Initial Correlation Analysis

First, simple correlation analyses are conducted in order to select a set of variables, which may have an impact on the WTP. The results are presented in Table 3. They indicate that, on one hand, WTP for green electricity is negatively correlated with the regularity of segregating waste (B1) and age of the respondent (M2). On the other hand, it is positively correlated with the following variables: financial well-being of the respondent (M4), level of education (M8), level of belief in the reality of threats to the environment (E2), appreciation of political importance of environmental protection (E3), the willingness to pay increased taxes for environmental protection (E4), knowledge about green electricity tariffs (I3), searching for information on green tariffs (I4), being influenced by advertising regarding green energy (I6), peer support for installing facilities for domestic production of renewable energy (W2) and for switching to a green electricity tariff (W3) and willingness to switch energy supplier in order to obtain a green electricity tariff (D3).

To sum up, the initial analysis shows that the environmental attitude (measured by variable E1–E5) and peer support (W1–W3) are among the most important factors impacting the WTP. When the knowledge variables are considered (I1–I6), it seems that more specific information on green tariffs is more influential than a general knowledge on green energy. Surprisingly, only one out of seven variables describing environmental behavior is significantly correlated with WTP.

Table 3. The results of tests of pairwise association between WTP for green electricity and other variables.

Variables	r
age (M2)	−0.103 **
income (M4)	0.199 ***
education (M8)	0.130 **
segregating waste (B1)	−0.132 **
belief in reality of environmental degradation (E2)	0.173 ***
belief in importance of environmental policy (E3)	0.082 *
acceptance of taxation to support environmental protection (E4)	0.299 ***
awareness of green tariffs (I3)	0.131 **
searching for information of green tariffs (I4)	0.139 *
influenced by advertising of green energy (I6)	0.161 ***
friends and family supportive to domestic production of energy (W2)	0.125 **
friends and family supportive to switching to green electricity tariff (W3)	0.121 **
willingness to change energy supplier to switch to green tariff (D3)	0.132 **

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ (two-tailed test). The following tests are used: Kendall's test for pair of ordinal variables; Mann-Whitney test when one of the variables in a pair was ordinal; Kruskal-Wallis analysis of variance when the grouping variable was based on more than two categories; Fisher's exact test of association for pairs or nominal (or binary) variables, unless the number of categories was too great to do the appropriate calculations. In such cases, the chi-squared test of association was used.

4.4. Logit Model of Green Electricity Support

In order to evaluate the impact of chosen factors on the decision to support the RES development, a binary logistic regression model is used. It makes it possible to condition the probability of a positive WTP on a set of exogenous variables defined in Table 1. This model reveals which variables influence the financial support of green electricity among the residential consumers. At the same time, it does not inform about the level of this support (whether the WTP is low or high). In the regression analysis, some of the items were aggregated in larger constructs, such as e.g., social influence ($W = W1 + \ldots + W7$) or environmental attitudes ($E = (E1 + \ldots + E5)/5$) as the reliability test equaled 0.765 and 0.596 respectively.

First, a binary variables Y_i is constructed, which takes value one when an i-th individual reports a positive WTP (classes C2–C6; N = 274) and zero when a respondent declares that the prices are already too high and they are not ready to pay more for electricity, even if it is green (class C1 excluding those who refuse to answer the question or were unwilling to change the supplier; N = 149). Next, a probability of a positive WTP is assumed to depend on a set of variables, X_i, which includes a constant, metric information (M1–M9) and aggregated variables: the knowledge (I_G and I_T), environmental behaviors (B), environmental attitudes (E), peer support (W) and satisfaction with energy supplier (D). The model takes the following form.

$$Prob(Y_i = 1) = \frac{e^{x_i \beta}}{(1 + e^{x_i \beta})} \quad (1)$$

where β is a vector of the model coefficients.

The results are presented in Table 4, which shows the estimates of the model coefficients and their standard deviations. The results indicate that many of the variables are insignificant. Therefore, a step-wise method (similar to [5]) was used to exclude them from the regression, resulting in a final model specification presented in Table 5. The outcomes report the coefficient estimates together with their standard deviations and marginal effects. The marginal effects have a direct interpretation and could be used to approximate the change of the positive WTP probability induced by an increase of the corresponding variable by one.

Table 4. The initial logit model for the estimation of Y_i.

	Coefficient (β)	Standard Errors
gender (M1)	−0.192	0.205
age (M2)	−0.239 **	0.090
house type (M3)	0.141	0.087
income (M4)	0.285 **	0.101
house size (M5)	−0.048	0.084
town size (M6)	−0.118	0.100
region (M7)	0.006	0.022
education (M8)	0.003	0.086
electricity bill (M9)	−0.003	0.126
knowledge about green energy ($I_G = I1 + I2 + I6$)	0.059	0.068
knowledge of green electricity tariffs ($I_T = I3 + I4 + I5$)	0.218	0.134
environmental behaviors ($B = B1 + \cdots + B7$)	−0.010	0.030
environmental attitudes ($E = (E1 + \cdots + E5)/5$)	0.897 ***	0.209
peer support ($W = W1 + W2 + W3$)	0.128 **	0.046
satisfaction with energy supplier ($D = D1 + D2$)	−0.092	0.070
propensity to choose EVs as a replacement vehicle (A1)	−0.014	0.176
constant	−4.678 **	1.370

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ (two-tailed test).

Table 5. The final logit model for the estimation of Y_i.

	Coefficient (β)	Standard Errors	Marginal Effects
age (M2)	−0.242 **	0.081	−0.038
income (M4)	0.289 **	0.097	0.087
environmental attitudes (E)	0.879 ***	0.205	0.138
peer support (W)	0.122 **	0.045	0.020
knowledge of green electricity tariffs (I_T)	0.238 *	0.127	0.075
constant	−5.512 ***	1.001	

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ (two-tailed test).

The final model prediction accuracy is presented in Table 6. The results show that 65.8% of the respondents were correctly classified by the model (as being willing to pay extra or unwilling). In particular, 76.5% of the respondents, who were willing to pay extra for electricity if it was green ($Y_i = 1$) and 52.7% of those not ready to pay more ($Y_i = 0$), were classified in the correct category. In addition, the Hosmer & Lemeshow goodness-of-fit test of the final model is greater than 0.05, which indicates that the model appropriately fits the data. The final model Log-likelihood is 604.464 and the value of a joint significance test is Chi-square: 80.441 (p = 0.000)—indicating that the model is well specified.

$$logit(Prob) = log(Prob/(1 - Prob)) = -5.512 + 0.122W + 0.879E + 0.238I_T + 0.289M4 - 0.242M2, \quad (2)$$

where W stands for peer support, E for environmental attitudes, I_T for knowledge of green electricity tariffs, $M4$ for income and $M2$ for age.

Table 6. The final logit model prediction capabilities.

	Predicted		% Correct
Observed	$Y_i = 0$	$Y_i = 1$	
$Y_i = 0$	117	105	52.7%
$Y_i = 1$	64	208	76.5%
Overall percentage			65.8%

In the final model, all of the remaining independent variables: income, age, environmental attitudes, knowledge of green electricity tariffs and peer support, are statistically significant. Age is found to be the only, statistically significant, variable that negatively influences the willingness to support green electricity. In particular, increasing the category number of age (M2) by one (e.g., going from an age of 45–59 to an age of at least 60), leaving all the other explanatory variables unchanged, decreases the probability of positive WTP by 3.8%. Environmental attitudes, peer support, knowledge of green electricity tariffs and income have a positive influence on the WTP. For example, if the category number of environmental attitudes, (E), increases by 1, leaving all the other explanatory variables unchanged, the probability of positive WTP increases by 13.8%. In the case of other variables, the probability of positive WTP increases by: 8.7% in the case of income (M4), 7.5% in the case of knowledge of green electricity tariffs (I_T) and 2% in case of peer support (W).

4.5. Ordered Logit and Tobit Models of WTP

The simple binary logit model makes it possible to find out which variables influence the general readiness of the consumers to pay for electricity if it is green. It does not explain how the level of WTP (whether it is low or high) is impacted by the explanatory variables. To shed some more light onto the determinants of the level of the WTP, two other regression models such as: ordered logit and tobit models, have been used. Within the analysis, 5 levels of WTP are taken into account, based on the payment scale format used in the questionnaire. In particular, WTP was divided into five main classes based on the data from the Table 2: C1 with WTP = 0, N = 149 (excluding those who refused to answer the question or who were unwilling to change the energy supplier); C2 with WTP = 1, N = 66; C3 with WTP = 2, N = 89; C4 with WTP = 3, N = 67 and C5 with WTP = 4, N = 52 (aggregating classes C5 with C6), so the total sample equals N = 423.

In the ordered logit model, it is assumed that there is a linear relationship between the unobserved value of the willingness-to-pay (WTP^*) and exogenous variables

$$WTP_i^* = \alpha + X_i\beta + \varepsilon_i, \tag{3}$$

where α is an intercept, X_i is a vector of exogenous variables excluding the constant and ε_i is a residual. As the result, the probabilities of belonging to a certain class, become $WTP \in \{0, 1, \ldots, 4\}$,

$$\begin{aligned}
&Prob(WTP_i = 0) = Prob(WTP^* \leq 0) = \Lambda(\alpha_1 - X_i\beta) \\
&Prob(WTP_i = 1) = Prob(0 < WTP^* \leq \mu_1) = \Lambda(\alpha_2 - X_i\beta) - \Lambda(\alpha_1 - X_i\beta) \\
&Prob(WTP_i = 2) = Prob(\mu_1 < WTP^* \leq \mu_2) = \Lambda(\alpha_3 - X_i\beta) - \Lambda(\alpha_2 - X_i\beta) \\
&\ldots \\
&Prob(WTP_i = 4) = Prob(\mu_3 < WTP^*) = 1 - \Lambda(\alpha_4 - X_i\beta),
\end{aligned} \tag{4}$$

where $\Lambda()$ is a logit function and α_k's are thresholds such that $\alpha_1 < \alpha_2 < \cdots < \alpha_4$. The ordered logit model is of particular usefulness in the context of WTP analysis due to its natural interpretation. Since the actual values of WTP^* are not observed, the regression (3) cannot be estimated directly and the model (4) could serve as an approximation of factor effect on WTP.

The tobit model comes from a different approach and concentrates on the fact that respondents reporting WTP = 0 could be diversified and hence the collected data do not represent well their evaluation of green electricity. The model assumes that the class number is a linear function of some exogenous variables, as in (3), however, the relationship is not observable for individuals with negative green energy evaluation. As a result, the model becomes

$$WTP_i = \begin{cases} WTP_i^* & WTP_i > 0 \\ 0 & WTP_i \leq 0 \end{cases} \tag{5}$$

where WTP_i^* is a latent variable described similarly to (3).

The results of the ordered logit model are presented in Table 7 and compared with outcomes of a tobit model with the threshold WTP = 0. They confirm the previous findings and indicate that age is negatively correlated to the WTP, while income, knowledge of green electricity tariffs and peer support are positively related to the WTP for green electricity. Within ordered logit model, education is also found to have a positive influence on WTP, while satisfaction with energy supplier is negatively correlated to the WTP. Tobit model has also indicated that type of accommodation has a positive impact on the WTP. Other variables do not play an important role in explaining WTP for green electricity.

In other words, the willingness to pay extra for green electricity increases with the positive perception of the consumers' material well-being, their pro-environmental attitudes and peers' support, with education and knowledge of green electricity tariffs and, to some extent, with the type of accommodation (i.e., whether occupants live in a house or a flat). At the same time, willingness to pay extra for green electricity decreases with age (the older are the consumers) and with the satisfaction level of the current energy supplier (i.e., the reluctance to change the energy supplier if consumers are satisfied with a current one).

Table 7. Estimation results of the ordered logit and tobit models.

	Ordered Logit	**Tobit Model (WTP > 0)**
gender (M1)	−0.246 (0.187)	−0.200 (0.203)
age (M2)	−0.148 * (0.078)	−0.154 * (0.087)
type of accommodation (M3)	0.116 (0.079)	0.155 * (0.087)
income (M4)	0.352 *** (0.098)	0.399 *** (0.105)
house size (M5)	−0.026 (0.075)	−0.025 (0.08)
region (M7)	0.009 (0.020)	0.0116 (0.022)
education (M8)	0.147 * (0.080)	0.133 (0.086)
electricity bill (M9)	0.119 (0.118)	0.092 (0.130)
knowledge about green energy (I_G)	0.075 (0.063)	0.06 (0.067)
knowledge of green electricity tariffs (I_T)	0.264 ** (0.119)	0.271 ** (0.128)
environmental behaviors (B)	−0.014 (0.027)	−0.016 (0.03)
environmental attitudes (E)	0.365 * (0.197)	0.442 ** (0.211)
peer support (W)	0.103 ** (0.044)	0.108 ** (0.048)
satisfaction with energy supplier (D)	−0.109 * (0.066)	−0.113 (0.071)
propensity to choose EVs as a replacement vehicle (A1)	0.242 (0.185)	0.215 (0.193)
constant		−2.762 ** (1.380)
cut 1	3.924 *** (1.282)	
cut 2	4.649 *** (1.286)	
cut 3	5.652 *** (1.294)	
cut 4	6.757 *** (1.306)	
Log-Likelihood	−611.690	−681.379
N	423	423

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ (two-tailed test); Standard errors in brackets.

5. Conclusions and Policy Implications

5.1. Final Discussion

Firstly, the results of the statistical analysis indicate that WTP of Polish residential consumers can be explained mainly by: age, material well-being, level of knowledge of green electricity tariffs, peer support and environmental attitudes. These results confirm the findings of the other similar studies performed in other countries. This leads to the conclusion that some of the attitudinal and social-economic conditions which influence the consumers' WTP for green electricity, are the same in various cultures and economies. At the same time, it makes it possible to propose some recommendations that may be valuable not only for the Polish enterprises and institutions present and active in the energy market, but also to the international audience who meets similar challenges, in particular, the challenge of how to encourage consumers to switch to green electricity tariffs and programs.

A relatively low mean extra payment that Polish consumers would be willing to pay monthly in order to get green electricity has been revealed. Average additional payment on the level of around USD 3.5 per month is much below USD 13.3, which is the average value reported by [24] or USD 7.16 provided by [38] in their meta-analysis of various CVM and CE studies of WTP for green electricity. Please notice that 13.3 USD was calculated based on the prices accurate as per 2010 [24]. Taking into consideration price increase in the last eight years, the difference between the mean WTP of Polish consumers and consumers from other countries could be even larger. Such a result can be explained by relatively low GDP per capita in Poland, cost sensitivity for citizens of Poland, and lack of previous experiences with green electricity tariffs. Due to the low level of knowledge about the energy market, lack of interest and engagement of the consumers as well as because of the dominant role of fossil fuels in the Polish energy mix, it can be suspected that green energy is treated by many consumers as a public good, which makes people believe that the central government and local authorities are responsible for further development of RES, without imposing any additional costs on the end-users.

To overcome the reluctance of consumers to pay for green electricity, three recommendations can be proposed. Firstly, as the results of this survey have proven, the environmental attitudes strongly influence the consumers' WTP. Such positive attitudes could be induced and encouraged by education and social campaigns. The role of green energy in the power generating system and the possibility of active involvement of residential consumers in further development of RES should be better explained. As this survey has shown, the lack of knowledge about how to support the development of RES by the households is one of the main barriers to adopting green electricity by the Polish consumers (see also [40]). Hence, some pilot green energy programs and opt-in trails, which have been already practiced in other countries, could be a good solution (see, for example [39,42]). Moreover, it has been found that consumers, in general, do not study their electricity bills and are not aware that the payment for electricity consists not only of the price per kWh, but also, among others, of the distribution fee and recently added RES levy (even if it currently stands at zero). Again, education could raise the awareness and level of consumers' involvement.

As the interest and decision to purchase green tariffs is often combined with a higher level of environmental attitudes in general, and with some readiness to install RES technologies in the household, it could be possible to combine offers of the suppliers of RES technologies with a green electricity tariff or program offered by the energy supplier or seller.

Secondly, as peer support matters, some elements of competition between the neighbors (as already done in case of the energy efficiency, (see, for example [43,44]) or in a given tariff group (similar households in terms of the household size and energy consumption patterns) could be implemented. In particular, households could be encouraged to compete in terms of their support of the development of RES (i.e., voluntary extra payment). In addition, positive examples by social influencers could be helpful in encouraging desired behaviors.

Competitiveness, as suggested before, could be achieved by adding information to the electricity bill (as it was done in case of energy efficiency and reduction of energy usage) about what percentage of the neighborhood, or customers with similar consumption profiles, have chosen a green electricity tariff in the last quarter or month. The information should also consider the impact of choosing green electricity tariff on the energy market (the benefits should be clearly stated in order to convince the customer either to stay with a green electricity tariff or to switch to such a tariff in the future). It could also be mentioned how much support each household has given to RES in the last period and whether this result is above or below the average. If it is below, some advice on how to support RES could be offered. Beyond the context of green electricity tariffs, it could also provide some information regarding investments in small-scale generators). The examples regarding energy efficiency and energy conservation issues show that the information about the achievements of our peers, such as neighbors, strongly motivate individuals to change their actions and to adopt new products or behaviors. Of course, reduction of energy usage is separate from the decision to pay more for green electricity. However, in both cases, the consumers have to sacrifice either some of their comfort, by adjusting their energy consumption to the electricity prices by e.g., shifting the consumption from peak to off-peak hours, or some of their spending money, in the case of supporting green electricity.

Finally, income and material well-being of the consumers can be a decisive factor to influence whether a consumer will decide on the financial support of RES. The economic growth and the increase of the citizens' welfare takes time and it cannot be expected that the average standards of living in Poland (as well as in some other countries from Central and Eastern Europe), will catch up with those in the richer countries of Western Europe or the U.S. in the nearest future. Therefore, for the time being, consumers can be convinced to offer voluntary support of RES by the education and reasonable arguments showing social benefits of green energy.

Last but not least, it could be recommended for key stakeholders in the energy sector to offer green electricity tariffs first to the selected segment of households, represented by the young and well educated, who are satisfied with their financial situation and who are pro-environmental consumers who could play a significant role in further diffusion of green tariffs.

5.2. Limitations of the Study and Future Work

The conducted survey has some limitations, of which, four of the most important need to be mentioned. Firstly, like in most CVM designs, there can be an elicitation bias connected with a close-ended question related to WTP with a predefined interval scale. It is always a challenge to design the intervals in an appropriate way. As already mentioned in the paper, a predefined payment scale was based on the results from a pilot study from 2016, as well as on the observations from an initial survey carried out before the main study, in order to validate the comprehensiveness of the questions, their order, and the scales used.

Secondly, the design survey should have been more precise about the share of RES in the green electricity mix. Leaving the consumers with a statement that a part or all of the electricity is delivered from RES, might have influenced the obtained WTP.

In Ma et al. [35], the authors propose to test whether consumers base their response on their annual/ monthly electricity bill or their actual energy consumption. The proportion of green electricity in kWh to replace non-renewable energy, and how this increased share of green electricity affects the household's total electricity bill, should be clearly stated. Both specifications would be necessary for the respondent to provide an informed reply to the WTP question taking into account their budget constraint and the premium they would be willing to pay for green electricity as opposed to non-renewables (see [35] for more details).

The third limitation is the hypothetical bias, as green electricity tariffs are currently not offered in Poland. This is to some extent limited because such tariffs were offered a few years ago and some of the consumers have heard about them. Moreover, as consumers are rather uninterested in the energy market, there is a great probability that they are not even aware that green tariffs are not available at present.

Finally, within the study, the initial knowledge of the respondents regarding the fact that RES is more costly and that the price increment corresponds to this cost instead of representing a profit to the energy supplier, has not been checked. This might have caused the result that some respondents underreported their WTP.

This study gives some first hints regarding the WTP for green electricity of Polish residential consumers. In the future, Polish consumers' WTP should be further examined by means of a choice experiment study and conjoint analysis, to explore various attributes of green electricity tariffs, such as the share and types of RES, conditions of the contract etc., influenced by consumers' socio-economic and psychological determinants and characteristics. It is also necessary to investigate various models of consumers' involvement in paying for green electricity, such as mandatory RES payment as a part of an electricity tariff, or a voluntary recruitment for opt-in trials. Finally, an AHP method could be useful to develop such green electricity tariffs and programs that would be accepted and chosen by Polish residential consumers.

Funding: This work has been supported by the National Science Center (NCN, Poland) through grant No. 2017/01/X/HS4/00246 and by the Ministry of Science and Higher Education core funding for statutory R&D activities.

Acknowledgments: The author is grateful to Katarzyna Maciejowska for useful discussions and helpful comments. The author is also grateful to the Reviewers for their constructive and insightful remarks and suggestions.

Conflicts of Interest: The author declares no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

RES	Renewable Energy Sources
WTP	Willingness to pay
CVM	Contingent Valuation Method
CE	Choice Experiment
PV	photo voltaic panels

References

1. Su, W.; Liu, M.; Zeng, S.; Streimikiene, D.; Balezentis, T.; Alisauskaite-Seskiene, I. Valuating renewable microgeneration technologies in Lithuanian households: A study on willingness to pay. *J. Clean. Prod.* **2018**, *191*, 318–329. [CrossRef]
2. Stigka, E.; Paravantis, J.; Mihalakakou, G. Social acceptance of renewable energy sources: A review of contingent valuation applications. *Renew. Sustain. Energy Rev.* **2014**, *32*, 100–106. [CrossRef]
3. Ropuszynska-Surma, E.; Weglarz, M. The ro-economical behavior of household and their knowledge about changes in the energy market. *Energy Fuels* **2016**, *14*, 01006.
4. Claudy, M.C.; Michelsen, C.; O'Driscoll, A.; Mullen, M.R. Consumer awareness in the adoption of microgeneration technologies. An empirical investigation in the Republic of Ireland. *Renew. Sustain. Energy Rev.* **2010**, *14*, 2154–2160. [CrossRef]
5. Ntanos, S.; Kyriakopoulos, G.; Chalikias, M.; Arabatzis, G.; Skordoulis, M. Public perceptions and willingness to pay for renewable energy: A case study from Greece. *Sustainability* **2018**, *10*, 687. [CrossRef]
6. Ozaki, R. Adopting sustainable innovation: What makes consumers sign up to green electricity? *Bus. Strategy Environ.* **2011**, *20*, 1–17. [CrossRef]
7. Oerlemans, L.; Chan, K.-Y.; Voschenk, J. Willingness to pay for green electricity: A review of the contingent valuation literature and its source of error. *Renew. Sustain. Energy Rev.* **2016**, *66*, 875–885. [CrossRef]
8. Zoric, J.; Hrovatin, N. Household willingness to pay for green electricity in Slovenia. *Energy Policy* **2012**, *47*, 180–187. [CrossRef]
9. Gerpott, T.; Mahmudova, I. Determinants of green electricity adoption among residential customers in Germany. *Int. J. Consum. Stud.* **2010**, *34*, 464–473. [CrossRef]
10. Zarnikau, J. Consumer demand for green power and energy efficiency. *Energy Policy* **2003**, *31*, 1661–1672. [CrossRef]
11. Borchers, A.; Duke, J.; Parsons, G. Does willingness to pay for green energy differ by source? *Energy Policy* **2007**, *5*, 3327–3334. [CrossRef]
12. Zhang, L.; Wu, Y. Market segmentation and willingness to pay for green electricity among urban residents in China: The case of Jiangsu Province. *Energy Policy* **2012**, *51*, 514–523. [CrossRef]
13. Diaz-Rainey, I.; Tzavara, D. Financing the decarbonized energy system through green electricity tariffs: A diffusion model of an induced consumer environmental market.*Technol. Forecast. Soc. Chang.* **2012**, *79*, 1693–1704. [CrossRef]
14. Murakami, K.; Ida, T.; Tanaka, M.; Friedman, L. Consumers' willingness to pay for renewable and nuclear energy: A comparative analysis between the US and Japan. *Energy Econ.* **2015**, *50*, 178–189. [CrossRef]
15. Wiser, R. Using contingent valuation to explore willingness to pay for renewable energy: A comparison of collective and voluntary payment vehicles. *Ecol. Econ.* **2007**, *62*, 419–432. [CrossRef]
16. Yoo, S.-H.; Kwak, S.-Y. Willingness to pay for green electricity in Korea: A contingent valuation study. *Energy Policy* **2009**, *37*, 5408–5416. [CrossRef]

17. Ek, K.; Soederholm, P. Norms and economic motivation in the Swedish green electricity market. *Ecol. Econ.* **2008**, *68*, 169–182. [CrossRef]
18. Clark, C.F.; Kotchen, M.J.; Moore, M.R. Internal and external influences on pro-environmental behavior: Participation in a green electricity program. *J. Environ. Psychol.* **2003**, *23*, 237–246. [CrossRef]
19. Xie, B.C.; Zhao, W. Willingness to pay for green electricity in Tianjin, China: Based on the contingent valuation method. *Energy Policy* **2018**, *114*, 98–107. [CrossRef]
20. MacPherson, R.; Lange, I. Determinants of green electricity tariff uptake in the UK. *Energy Policy* **2013**, *62*, 920–933. [CrossRef]
21. Bartczak, A.; Chilton, S.; Czajowski, M.; Meyerhoff, J. Gain and losses of money in a choice experiment. The impact of financial loss aversion and risk preferences on willingness to pay to avoid renewable energy externalities. *Energy Econ.* **2017**, *65*, 326–334. [CrossRef]
22. Gielen, D.; Saygin, D.; Wagner, N.; Budzianowski, W. *Remap 2030 Renewable Energy Prospects for Poland*; IRENA: Abu Dhabi, UAE, 2015. Available online: www.irena.org/remap (accessed on 15 June 2018).
23. Hansla, A.; Gamble, A.; Juliusson, A.; Gaerling, T. Psychological determinants of attitude towards and willingness to pay for green electricity. *Energy Policy* **2008**, *26*, 768–774. [CrossRef]
24. Sundt, S.; Rehdanz, K. Consumers' willingness to pay for green electricity: A meta-analysis of the literature. *Energy Econ.* **2015**, *51*, 1–8. [CrossRef]
25. Zhou, Y.; Chen, H.; Xu, S.; Wu, L. How cognitive bias and information disclosure affect the willingness of urban residents to pay for green power? *J. Clean. Prod.* **2018**, *189*, 552–562 [CrossRef]
26. Paravantis, J.; Stigka, E.; Mihalakakou, G.; Michalena, E.; Hills, J.M.; Dourmas, V. Social acceptance of renewable energy projects: A contingent valuation investigation in Western Greece. *Bus. Strategy Environ.* **2018**, *123*, 639–651. [CrossRef]
27. Nomura, N.; Akai, M. Willingness to pay for green electricity in Japan as estimated through contingent valuation method. *Appl. Energy* **2004**, *78*, 453–463. [CrossRef]
28. Lim, S.-Y.; Kim, H.-J.; Yoo, S.-H. South Korean houshehold's willingness to pay for replacing coal with natural gas. A view from CO_2 emissions reduction. *Energies* **2017**, *10*, 2031. [CrossRef]
29. Ozbafli, A.; Jenkins, G. Estimating the willingness to pay for reliable electricity supply: A choice experiment study. *Energy Econ.* **2016**, *56*, 443–452. [CrossRef]
30. Knapp, L.; Ladenburg, J. How spatial relationships influence economic preferences for wind power—A review. *Energies* **2015**, *8*, 6177–6201. [CrossRef]
31. Kashintseva, V.; Strielkowski, W.; Streimikis, J.; Veynbender, T. Consumer attitudes towards industrial CO_2 capture and storage products and technologies. *Energies* **2018**, *11*, 2787. [CrossRef]
32. Bateman, I.; Carson, R.; Day, B.; Hanemann, M.; Hanley, N. E*Economic Valuation with Stated Preference Techniques: A Manual*; Edward Elgar Publishing: Cheltenham, UK, 2002.
33. Liu, W.; Wang, C.; Mol, A. Rural public acceptance for renewable energy deployment: The case of Shandong in China. *Appl. Energy* **2013**, *102*, 1187–1196. [CrossRef]
34. Kowalska-Pyzalska, A. Willingness to pay for green energy. An agent-based model in Netlogo platform. In Proceedings of the International Conference on the European Energy Market (EEM), Dresden, Germany, 6–9 June 2017. [CrossRef]
35. Ma, C.; Rogers, A.A.; Kragt, M.E.; Zhang, F.; Polykov, M.; Gibson, F.; Chalak, M.; Pandit, R.; Tapsuwan, S. Consumers' willingness to pay for renewable energy: A meta-regression analysis. *Resour. Energy Econ.* **2015**, *42*, 93–109. [CrossRef]
36. Mengaki, A. Social marketing mix for renewable energy in Europe based on consumer stated preferences surveys. *Renew. Energy* **2012**, *39*, 30–39. [CrossRef]
37. Perlaviciute, G.; Steg, L. Climate change and individual decision making: An examination of knowledge, risk-perception, self-interest and their interplay. *Renew. Sustain. Energy Rev.* **2014**, *35*, 361–381. [CrossRef]
38. Soon J.J.; Ahmad, S.A. Willingly or grudgingly? A meta-analysis on the willingness-to-pay for renewable energy use. *Renew. Sustain. Energy Rev.* **2015**, *44*, 877–887. [CrossRef]
39. Hobman, E.; Frederiks, E. Barriers to green electricity subscription in Australia: "Love the environment, love renewable energy. . . but why should I pay more?". *Energy Res. Soc. Sci.* **2014**, *3*, 78–88. [CrossRef]
40. Kowalska-Pyzalska, A. An empirical analysis of green electricity adoption among residential consumers in Poland. *Sustainability* **2018**, *10*, 2281. [CrossRef]

41. Kirkman, B.; Chen, G. Maximizing your data or data slicing? Recommendations for managing multiple submissions from the same dataset. *Manag. Organ. Rev.* **2011**, *7*, 433–446. [CrossRef]
42. Diaz-Rainey, I.; Ashton, J. Profiling potential green electricity tariff adopters: Green consumerism as an environmental policy tool? *Bus. Strategy Environ.* **2011**, *20*, 456–470. [CrossRef]
43. Nolan, J.; Schultz, P.; Cialdini, R.; Goldstein, N.; Griskevicius, V. Normative social influence is underdetected. *Person. Soc. Psychol. Bull.* **2008**, *34*, 913–923. [CrossRef] [PubMed]
44. Ayers, I.; Raseman, S.; Shih, A. Evidence from two large field experiments that peer comparison feedback can reduce residential energy usage. *J. Law Econ. Organ.* **2013**, *29*, 992–1022. [CrossRef]