Household Use of Renewable Energy and the Perception of Solar Panel Attributes

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Introduction

Growth in the solar energy sector has resulted from European Union (EU) policies obligating all member countries, including Poland, to generate at least 15% of their energy needs from renewable energy feedstock by 2020 (Dziennik Urzedowy, 2009). In Poland, the share of renewable energy in total energy consumption reached 11.3% in 2013 (GUS, 2017). Current emphasis on renewable energy use is driven by the desire to limit harmful consequences of burning fossil fuels, such as air pollution. Air pollution in rural areas is location-specific and depends on several factors including seasonal weather, access to various fuels, and their prices. Although modern fuels such as natural gas may be preferred, access to natural gas is limited by the pipeline distribution system. In Poland, the piped gas network is uneven, and many rural areas depend heavily on fossil fuels for heating, mostly coal. The use of coal in domestic heating has been attributed to fluctuating concentrations of sulphur dioxide and nitrogen dioxide in Poland (Krochmal and Kalina, 1997), although rural areas in general have lower levels of both gases than urban areas. Home stoves also emit other toxins in the process of combustion (Hlawiczka *et al*., 2003) and many Polish households continue to depend on coal for heating.

The EU created support programs encouraging investment into types of equipment that generate renewable energy. As an example, technological enhancements have increased usage of solar energy in recent years across Europe, including countries that are located in cool temperate climate zones, e.g., Germany, Slovakia, and Poland. The novelty of solar energy attracted public attention, especially because the size of solar panels made them suitable for installation on residential properties such as farm homesteads. But the novelty has been accompanied by skepticism regarding performance and the appearance of the solar panels themselves.

This paper examines perceptions of selected solar panel attributes and user expectations associated with solar panel installations in 123 rural households located in four counties in the Mazowieckie Voivodship (region) in Poland in the spring of 2015. The participants have taken advantage of the renewable energy program which subsidizes the purchase and installation of passive solar panels. The program received substantial funding from the EU. Surveying owners of solar panels was expected to provide insights from actual users about panel attributes and to use such knowledge to possibly widen solar energy utilization. Such knowledge was lacking and is sought by panel sellers and installers as well as government agencies including local governments directly administering the solar energy utilization subsidy programs.

Solar energy support program in Poland

The purpose of promoting solar energy use was to improve air and environmental quality, lower dependence on fossil fuels, and increase renewable energy use at the village level (Skolimowski, 2015). The European Commission (EC) renewable energy mandate was accompanied by a subsidy program for investors in solar energy panels. Subsidy funds transferred to the Polish government were distributed to each of 16 voivodships, including Mazowieckie Voivodship, in 2010. The EU-originating funds could be used to cover up to 70% of the purchase and installation costs of solar panels by a home owner. To distribute the EU funds in Poland, each voivodship government issued a call to its county governments to apply for subsidy funds under the provision that a county government adds another 15% of the costs from its own resources. The funds were distributed on a “first come, first served” basis. By late 2011, county governments that successfully secured subsidy funds called for individual residents to apply for funding under the stipulation that an awardee would pay the remaining 15% of purchase and installation costs. Consequently, the cost of purchase and installation of a passive solar panel was subsidized 70% by the EU and 15% by the county government, while the homeowner covered the remaining 15%.

The use of passive solar panels used to heat water benefits larger households more than smaller ones. The subsidies granting approach used in counties distinguished between the installation of two and three panels depending on the household size; namely, families of 4 or fewer members qualified for a two solar panel subsidy, while those of more than four members could get a subsidy for three panels. The subsidy equaled 85% of 8150 Polish zloty ($2,246.60 at the exchange rate as of January 1, 2013) for two solar panels and 85% of 9330 Polish zloty ($2571.87) for three panels. The panels were installed in qualified households in 2012 and 2013. Two panels had a surface of 3.6m^2 and heated a 200 liter hot water tank, while the three panel installations covered 5.4m^2 and heated a 300 liter hot water tank. In four counties considered in this study, a total of 1396 two (667) and three (729) panel sets were installed and serve a total of 6,575 residents, or 30% of the four county population. Total installed capacity of the solar panels is 4,434 kW, saving 11,070 GJ/year of thermal energy. It is estimated that the installed panels also lowered gas emissions by 1,351 tons/year. Overall, the program received very favorable responses among rural residents, who took advantage of the very generous subsidies. The installed solar panels on roofs or walls of rural homes are a powerful display promoting modern technology among neighbors who did not participate in the program and visitors.

The direct effects of the program on the expansion of solar energy utilization are reflected in growth of thermal solar collector installation and capacity in Poland. In 2011, the total area of the installed thermal collectors in the country amounted to 909,423 square meters. It increased by 302,074 square meters, or 33.2 percent in 2012, and an additional 273,503 square meters in 2013 (EurObserv'ER, 2013; 2014). In the period of two years (2013-2014), the thermal collector area increased by 63.3 percent and the installed capacity increased proportionately. The demonstration effect of the program likely influenced decisions of other county governments and their residents because the solar energy installations grew in subsequent years. In 2015, the total surface area of thermal collectors reached 2,018,497 square meters and 1,413 MWth capacity.

Despite the rapid growth of solar energy utilization, the use of solar passive panels has not been observed in some of Poland's regions with favorable natural conditions. Mazowieckie Voivodship receives 985 985 kWh/m^2 solar radiation annually and only about 10% of the country's area receives more solar energy measured at 1081 kWh/m^2 (Tyminski, 1997). Due to Poland's climatic conditions, solar energy is easiest to obtain between April and October (Grzybowska, 1998). Solar collector sales equaled 248,000 m^2 in 2011, an increase of 70% as compared to 2010 (EkoNews, posted April 6, 2012), the year before the solar panel support program was implemented in the area considered in this study. However, knowledge of user perception of selected features of solar panels has received little attention from researchers, yet it is useful to promote the collector purchase in other rural counties. Additionally, knowing the degree of satisfaction with specific aspects of solar energy and features of the collector can be used to encourage the installation of new generations of solar panels, for example, photovoltaic panels capable of producing electricity.

Modeling approach

Household installation of solar panels is still quite novel in Poland and rural areas of Mazowieckie Voivodship. The novelty of solar panels as a source of hot water for households and the lack of rigorous studies about users of passive solar panels required the organization of a survey to gather information about specific features of this energy type and the equipment necessary to utilize it. Perception of various attributes of solar panels and opinions about the utilization of solar energy and its effects are crucial to anticipate developments in the use of solar panels because they affect the purchase decision, even in the presence of sizable subsidies. Whereas negative attitudes slowed the adoption of some new and beneficial technologies, positive attitudes reflect approval and can significantly expand its use. The level of importance indicates the strength of belief in each statement. The attitudes towards the use of solar energy have been overwhelmingly positive because that energy source is viewed as non-polluting and readily available to anyone who chooses to utilize it.

A statement about the partial or full subsidy captured the beliefs about the importance of a subsidy as a reason for panel purchase and installation because the subsidy might have helped to eliminate an impediment to the decision about installation. In this study, all surveyed rural residents already installed a solar collector stressing the goal of understanding what influenced the decision rather than to predict the respondent behavior. Nevertheless, insights about factors influencing the decision of the participants are useful in further promotion of solar energy utilization.

The solar energy subsidy program was established to encourage the solar panel installation in rural areas. Our study surveyed rural residents who have become consumers of solar energy about reasons for choosing to pay for using renewable energy. Each surveyed resident's household had to pay 15% of the solar panel purchase and installation costs. The survey probed *ex post* what causes led to the decision about the solar panel purchase and installation to gain knowledge useful to encourage wider solar energy utilization among rural households. The theory of reasoned action (Fishbein and Ajzen, 1975) provides useful concepts linking beliefs to the behavior. Beliefs shape attitudes which eventually are demonstrated in choices. Rural residents are aware of the air pollution stemming from the burning of fossil fuels and out of concern for their own health and the health of their children would prefer modern fuels, for example natural gas. However, natural gas is unavailable because of the supply network configuration, but residents maintain preferences for cleaner energy. The solar support energy program enabled access to clean, renewable energy.

Attitudes of respondents are indirectly identified by linking the beliefs reflected in the level of importance with a statement concerning the reason behind the installation of a solar collector. Nine statements about solar panel use or panel features were presented to each respondent. A statement about convenience of solar panel use was important because this attribute drives purchase of numerous household items from food products to appliances. A rural household that used coal to heat water had to monitor the furnace, add fuel, and remove and dispose ashes, while the solar panel eliminates all these tasks. Statements related to the cost had to be considered because that sheds light on the relevance of the support program besides a statement about the importance of subsidy availability. Knowledge about renewable energy sources is viewed as a subset of a broader knowledge about the environment and its value and protection reflected in environmental consciousness. Earlier studies reported on environmental consciousness within the Polish society (Tuszynska, 2013) naming the cost of utilities the primary motive driving choices in saving energy. Consequently, statements about the costs of energy prior to solar panel installation, saving on energy used to heat space and water, and expectations of low panel service costs were presented to survey participants.

Mroczek (2011) reported survey results showing about 85% of respondents acknowledged associating solar energy with renewable energy. A study of a single county, Suloszowa in Malopolskie Voivodship, revealed that wind and, solar energy were the most well-known forms of renewable energy among the surveyed residents (Bednarowska *et al*., 2013).

One of the conclusions from the study was the need for continually educating the public about renewable energy to help change attitudes. In the current study, respondents self-assessed their level of knowledge about solar energy. Finally, three statements addressed solar panel shortcomings. Since the panel is a flat device, it could be perceived as taking too much space, especially if the program subsidized the installation not of just one, but two or three panels. Another statement referred to the difficulty in installing a solar panel without naming any specifics. Also, the panel could be perceived as visually unappealing if mounted on the roof or wall of the house, or on property grounds. Survey participants were asked about the level of importance attached to each of the three features as, if important, they could discourage investment in solar panels.

The qualitative nature of the research objective, that is the examination of various issues related to solar energy use, could be investigated only if expressed opinions permit their quantification. A commonly applied tool in empirical studies that captures the abstract concept of a product attribute's importance is a multi-step scale such as one proposed initially by Likert. The current study applies a five-step scale, where the middle step reflects neutrality (an opinion of a respondent who neither favorably nor unfavorably views a certain product attribute, for example), allowing users of passive solar panels to indicate the level of importance attached to a selected feature. Gathered responses are classified into five categories whose order implies a unique nature of the response. The response becomes a latent variable and given its ordered nature, an ordered probit is a suitable statistical technique to estimate the link between the dependent (latent) variable and a set of explanatory variables.

The survey design and implementation

The growing utilization of solar energy is captured by the aggregate data, but data about household use are scarce in Poland. To gather household-level data it was necessary to implement a survey of passive solar panel users. The data were collected from 123 respondents from villages in four counties (Korczew, Przesmyki, Paprotnia, and Repki) in central-east Poland (Mazowieckie Voivodship) in 2015 (Map 1). University researchers approached each county government and presented the idea of the project. Local leaders embraced the proposed project and offered assistance in the survey implementation. The households were contacted by local governments, which kept the list of owners of solar panels and subsidy recipients. The survey was conducted in May and June 2015 by local government office workers who distributed questionnaires to randomly selected households. The questionnaire was self-administered and the office workers collected the completed questionnaire a few days later.

Specific questions probed for respondents' opinions about several features of renewable energy including solar energy. Survey participants selected a response to each statement about the solar energy feature or its use from a five-step scale measuring the degree of importance, where 1=not important at all and 5=very important.

Summary of survey participant characteristics

Respondents shared their sociodemographic and economic information (Table1). About three of five respondents (61%) were female. Nearly 29% had finished college and another 9% had an incomplete college education. The large share of highly educated respondents is fairly common in survey studies, but it is also consistent with the reported share of Poland's population completing tertiary education, which was 28% for adults 25-64 years of age in 2015 (OECD, 2016). A large portion, almost 24% finished a technical high school, while about one in five respondents completed vocational school (Table 1).

The vast majority, 89%, were married (Table 1). Such a high share of married households is not surprising given that the targeted recipient of solar panel subsidy program were large households. Many households include 5 or more residents and have relatively high needs for hot water for heating the house or other uses. An additional distinguishing characteristic was the large share of families with three children (32%), while another 31% of families reported having one child. Thirty-seven percent of households had five members and 27% had four members. Such household size is considerably larger than the average in Poland, which was 2.76 in 2013 (Liczby.pl, 2017). About 54% of the respondents were fully employed (for wages) and 30% were farmers. The share of farmers is relatively large and underscores the rural character of the studied area. The reported household incomes are distributed across the whole spectrum of categories presented to respondents. The categories were identical to those used in the national census in 2010. Among the three largest income categories, two are among the lower categories, but one is in the highest category. Overall, households falling into any of the four lower income categories included 57% of participants, but about 25% fell into the two highest income categories.

Importance of solar program and solar panel features

Rural residents shared their perceptions by indicating the importance of nine statements. The importance was measured with the help of a five-step scale, where the assigned value equaled one if a respondent perceived a feature as "very unimportant", two if "unimportant", three if "neither important nor unimportant", four if the feature was "important", and five when a respondent opined that the statement was "very important".

To better understand what factors might have influenced the assigned level of importance, selected respondent economic and socio-demographic characteristics as well as uses of passive solar panels and their potential objectionable attributes were correlated with each statement. Table 2 shows the calculated Spearman's rank correlation rho values and their statistical significance. The choice of the rank correlation coefficient resulted from the binary or categorical measures of the respondent and panel features, and five levels of importance associated with each statement. The majority of rank correlation coefficients are statistically significant, but their number varies across the nine statements.

Solar panel convenience was positively associated with the educational attainment level and reported income. It was also positively associated with three uses for solar panels, i.e., general energy, heating water, and heating space, while negatively associated with three possible detriments of the panel, i.e., taking too much space, looking bad on the house roof, and being difficult to install. Cost considerations reflected in statements about the total and installation costs were negatively associated with education of a respondent suggesting those with more education might have been less concerned about solar panel cost. Negative features of the panel were also negatively correlated with the two statements about cost. Positive association was confirmed between the cost considerations and the three solar panel uses (Table 2). The next two statements, the importance of subsidies and the expectations regarding the return on investment in solar panels showed a similar pattern of associations in terms of statistical significance and its direction as far as the uses of solar panels and negative features were concerned. However, a positive association was established between the subsidy and income. It could be that the price of solar panels would represent a barrier even for households with relatively high incomes. Interestingly, the household size, with one exception, was found not to be statistically significant.

In the case of the remaining four statements, the pattern of statistically significant correlations was similar to previously discussed statements with regard to the three possibly undesirable features of solar panels, i.e., require too much space, look bad on the roof, and cause installation difficulties. A positive correlation across the four statements is associated with using panels to save on energy to heat space and, in the case of expected low servicing cost, save energy on heating water. Only the case of expectations of lower energy costs from using solar panels, that statement was positively correlated with income. It is quite plausible that high income households hoped for lower energy costs after deciding to invest in solar panels.

Overall, a large number of statistically significant rank correlation coefficients had largely expected signs (positive or negative), but the varying number in the case of each statement indicates what features of the solar panel mattered or did not matter to rural residents. Convenience is a very appealing attribute of solar panels. The availability of subsidies also seems to be important, suggesting that without the support program, the number of installed panels might not have been as large. In the surveyed area, more than 30% of residents were from households using two or three passive solar panels.

Results of estimated ordered probit relationships

Respondents indicated the importance of various features of solar energy and solar panels on a five step scale where the order of steps had specific meaning. Such measures of perceived importance are instantly converted into ordered dependent variables in an empirical relationship that provides more insights than can be inferred from the rank correlation coefficients. An ordered probit technique is a suitable estimation approach that identifies statistically significant variables influencing respondent perceptions. Furthermore, those effects are expressed as probability changes of perceived importance in response to a change in the explanatory variable after additional calculation.

The data allow for the specification of nine empirical relationships. However, the statement pertaining to convenience of passive solar panels as the reason for their installation was viewed as important or very important by an overwhelming majority of respondents. That large concentration of responses prevented the specification of relationship using the ordered probit approach. In the case of the remaining statements, the dependent variable was re-specified by creating three categories. The first category included observations associated with attaching no importance to a statement about solar energy or panel features, the second group contained respondents who perceived a reason as “neither important nor unimportant”, while the third ordered category contained those who perceived a reason as “important” or “very important”.

Tables A1 through A7 show ordered probit estimation results (the lack of convergence prevented the estimation of the equation regarding the return on investment over the solar panel life). The discussion focuses only on those confirmed to be statistically significant, while the changes in probability associated with each statement in response to a change in an explanatory variable are reported separately. The estimation results show that among socio-economic and demographic variables, several are statistically significant. The effect of income suggests that as it increases, the value of the likelihood of the total cost of the panel decreases. A higher educational attainment level tends to lower the likelihood that the respondent thinks installation costs are important and that the reason for having a solar panel is the future cost of energy. An increasing household size also lowers the likelihood of a respondent attaching importance to future energy costs. Unemployment or part-time employment tends to lower the possibility of attaching importance to the total cost of a solar panel. This is likely an effect of being a beneficiary of the subsidy program. The same variable strongly and positively increases the likelihood of attaching importance to expectations of lower energy bills as a result of installing a solar panel. Farmers were less likely to attach importance to the installation costs, possibly because they are likely familiar with farm machinery and have the knowledge needed to make some repairs. They were also less likely to view the importance of energy costs prior to having a solar panel as an important reason for panel purchase. Farm households likely use more energy than non-farm households because they commonly use electric farm equipment.

The influence of using solar energy to save energy for heating space was positive, causing the likelihood of viewing the total cost of a solar panel to increase. A similar effect is confirmed in relationship to the importance of installation costs and the availability of a subsidy (Table), the perception of energy costs prior to panel installation, expectations of higher energy costs in the future, and expectations of low service costs over the solar panel lifetime.

The possible undesirable features of solar panels have generally a negative effect on the likelihood of the importance of a specific reason for having one, except in the case of the importance of total cost of the equipment which was positively influenced by the opinion that a solar panel takes too much space (Table). The same panel feature lowers the likelihood of viewing the subsidy as important. The perception that a panel is difficult to install lowers the possibility of attaching importance to viewing the subsidy or expecting a decrease in energy bills after installation as a reason for having a panel.

Overall, the directional effects of statistically significant variables were as expected, for example, the effects of heating area, or education. Some, however, could only be empirically determined, such as the perceptions of certain features by farmers. Knowledge of specific effects helps solar panel traders, while local governments learn about panel owners' views.

Conclusions

The EC mandate regarding the utilization of renewable energy by all EU member countries has been accompanied by support programs for households investing in solar energy. In Poland, the program involved a subsidy in the amount of 70% for the purchase and installation of solar panels and focused on installation of passive solar panels by households in rural areas, especially large households. The funds from the EU were transferred to rural county governments, which distributed funds on a "first come, first served" basis among their residents. In the studied area of four counties in Mazowieckie Voivodship, more than 30% of residents had their to water heated by solar panels installed in 2012 and 2013.

Attitudes towards solar panels were examined after panel installation among 123 residents living in the four-county area. The surveyed participants indicated the importance of nine statements about solar energy or solar panel features. The ordinal, binary, or categorical nature of many measures regarding the beliefs of respondents, their characteristics and features of households, and solar energy permitted the calculation of Spearman's rank correction coefficients. In general, an inverse relationship was found between solar panel attributes viewed as limitations and any of the statements about reasons for having a solar panel. Among the socio-economic characteristics, income was positively correlated with the expressed importance about convenience of solar panel use, availability of subsidy to purchase a panel, expected return on investment over the panel life, and expectations of lowering energy costs after the installation. The benefits of heating water and the house were also positively related to the importance linked with convenience, costs, and subsidy as reasons for having a solar panel.

The measures of association identified by the rank correlation coefficients were further examined in the context of causal influence on the likelihood of increasing the importance of eight statements (except for convenience of using a panel because of the overwhelming indication this attribute was the main reason for buying a panel, while the model did not convert in the case of expecting the return on investment over the panel lifetime) using the ordered probit technique. Educational attainment level of a respondent negatively influenced the costs of having a solar panel, but being unemployed or having part-time employment positively influenced the importance of costs and expectations of lowering energy bill after the installation of a panel. The purpose of using a solar panel to heat space also positively influenced the level of importance of costs, subsidy, expectations of lowering the energy bill prior to having a panel and future energy costs. The undesirable features of the solar panel, i.e., a panel taking too much space or being difficult to install exerted, in general, a negative influence on the importance of the listed reasons for having a solar panel.

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Table 1. Characteristics of surveyed solar panel owners in four counties in Mazowieckie Voivodship in Poland in 2015.

Characteristics	Units of measurement	Mean	Min	Max
Education	1=University degree; 0=otherwise	0.27	0	1
Education level				
	1= Elementary School	5.7[a]		
	2= Vocational School	19.7[a]		
	3= Incomplete High School	4.1[a]		
	4= Technical School	23.8[a]		
	5= High School	9.0[a]		
	6= Some College	9.0[a]		
	7= College	28.7[a]		
Marital status	1=Married; 0=otherwise	0.87	0	1
Household size	1=Four or more persons; 0=otherwise	0.63	0	1
Farmer	1=Farmer; 0=otherwise	0.30	0	1
Employment status	1=Fully employed; 0=otherwise	0.54	0	1
Income	Income category	4	1	8
	1=<1000 PLN	17.9[a]		
	2=1001-1500 PLN	11.1[a]		
	3=1501-2000 PLN	17.1[a]		
	4= 2001-2500 PLN	11.1[a]		
	5= 2501-3000 PLN	9.4[a]		
	6= 3001-3500 PLN	8.5[a]		
	7= 3501-4000 PLN	10.3[a]		
	8= 4001 or more PLN	14.5[a]		

[a] Percent of respondents.

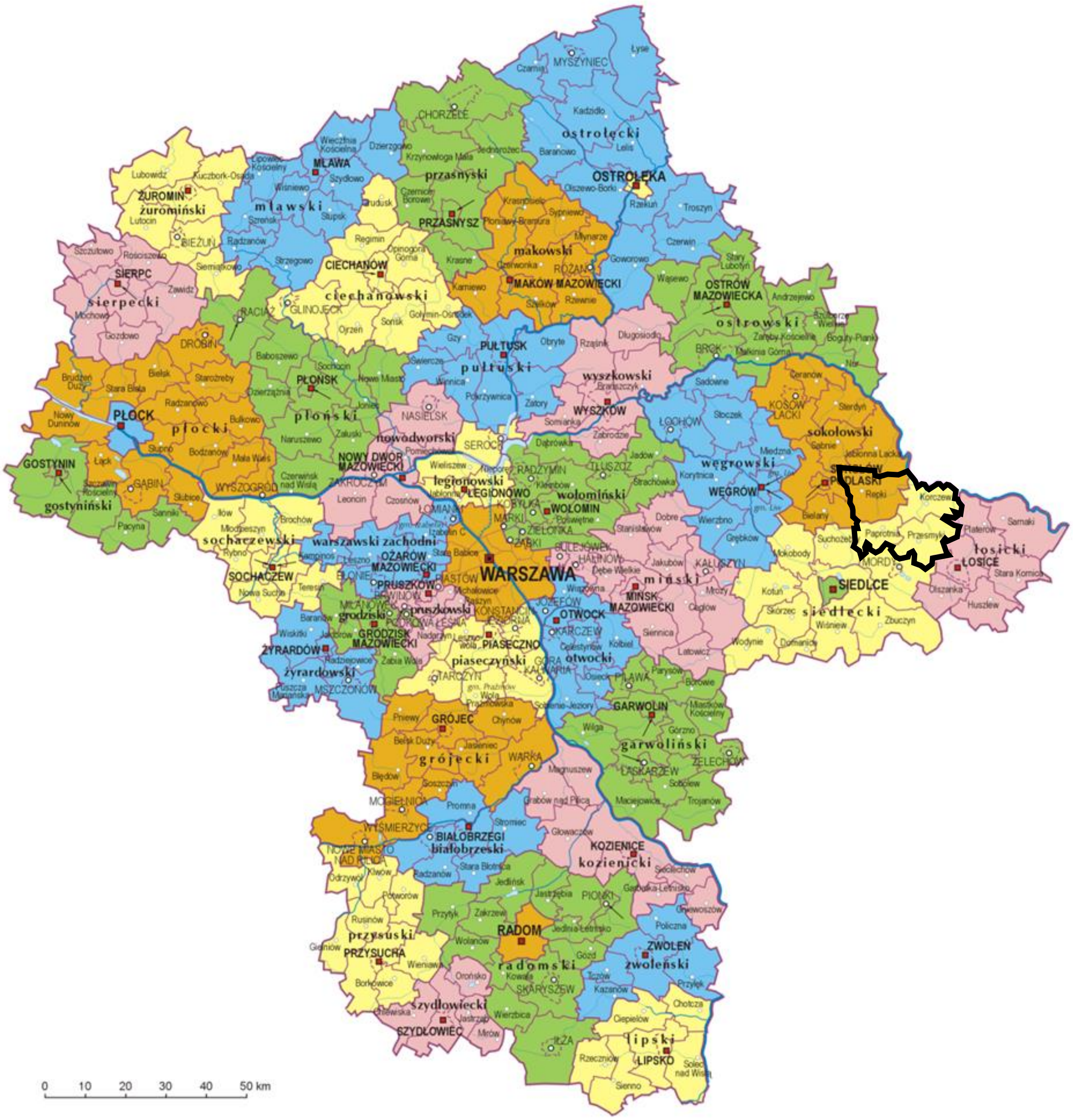
Table 2. The calculated Spearman's rank correlation rho's between selected respondent characteristics and solar panel uses and features, and reasons for having a solar panel

Characteristic	Convenience of use		Total cost of equipment		Installation costs		Subsidy for purchase		Certainty of return on investment		Expected lower energy use costs		Energy cost prior to installation		Expect higher energy in the future		Expect low panel service costs	
Education	0.17	*	-0.20	**	-0.23	***	-0.12		-0.01		0.05		-0.06		-0.14		-0.06	
No child	0.02		0.05		0.05		0.02		-0.05		-0.03		-0.11		-0.03		0.01	
Income	0.24	***	-0.02		0.08		0.25	***	0.23	**	0.29	***	0.12		0.04		0.13	
Household size	0.05		0.01		0.04		-0.06		-0.01		0.06		0.02		-0.23	**	-0.11	
Save energy in general	0.29	***	0.27	***	0.23	**	0.22	**	0.15		-0.03		0.09		0.09		0.15	
Save energy heating water	0.46	***	0.31	***	0.21	**	0.21	**	0.29	***	0.16		0.20		0.10		0.25	***
Save energy heating space	0.28	***	0.37	***	0.37	***	0.28	***	0.29	***	0.12		0.29	***	0.28	***	0.34	***
Panel takes much space	-0.24	***	-0.03		-0.13		-0.34	***	-0.30	***	-0.27	***	-0.24	***	-0.18	*	-0.26	***
Panel looks bad on roof	-0.27	***	-0.22	**	-0.30	***	-0.33	***	-0.28	***	-0.22	**	-0.23	**	-0.28	***	-0.33	***
Panel difficult to install	-0.16	*	-0.12		-0.18	***	-0.32	***	-0.26		-0.26	***	-0.20	**	-0.16		-0.16	***

[a] The importance was measured on a five-step scale: 1=not very important; 2=not important; 3 = average important; 4= important; 5=very important.

Note: *, **, and *** indicate the level of significance at 0.10. 0.05, and .01, respectively.

Map 1. Location of the four surveyed counties in Mazowieckie Voivodship, Poland (note: boundaries of four county area marked and the capital Warszawa to the west of the surveyed counties).



Source:

https://pl.wikipedia.org/wiki/Podzia%C5%82_administracyjny_wojew%C3%B3dztwa_mazowieckiego#/media/File:Mazowieckie-administracja.png

Appendix

Table A.1. Ordered probit regression results of the expressed importance associated with the total cost of equipment.

Variable name	Value	Std. error	t-value	p-value
Male (dummy)	0.2985	0.5119	0.58	0.56
Edu (category)	0.0928	0.1162	0.80	0.42
Married (dummy)	0.5817	0.8151	0.71	0.48
Having children (dummy)	0.4126	0.5836	0.71	0.48
Household size (rank)	0.2790	0.2910	0.96	0.34
Income (rank)	0.1790	0.1102	1.62	0.10
Unemployed and part time (dummy)	1.6029	0.9413	1.70	0.09
Farmer (dummy)	1.0719	0.8723	1.23	0.22
Use solar energy in general	0.1261	0.6818	0.19	0.85
Use solar energy for heating water	0.5070	0.7586	0.67	0.50
Use solar energy for heating space	1.8796	0.6176	3.04	0.00
Self-knowledge about solar energy	0.1144	0.1264	0.91	0.37
Complaint of solar panel takes much space	0.5484	0.3042	1.80	0.07
Solar panel appearance on roof	0.4197	0.4118	1.02	0.31
Solar panel difficult to install	0.3837	0.3629	1.06	0.29
Cut off 1	0.4232	2.4103	0.18	0.86
Cut off 2	2.9615	2.4414	1.21	0.23

Table A.2. Ordered probit regression results of the expressed importance associated with the installation cost.

Variable name	Coeff.	Std. error	t-value	p-value
Male (dummy)	0.4286	0.5201	0.82	0.41
Edu (category)	0.2465	0.1183	2.08	0.04
Married (dummy)	0.0557	0.8120	0.07	0.95
Having children (dummy)	0.5763	0.5835	0.99	0.32
Household size (rank)	0.1782	0.2834	0.63	0.53
Income (rank)	0.0827	0.1102	0.75	0.45
Unemployed and part time (dummy)	0.2938	0.9544	0.31	0.76
Farmer (dummy)	1.7134	0.9167	1.87	0.06
Use solar energy in general	0.0634	0.6724	0.09	0.92
Use solar energy for heating water	1.1103	0.8093	1.37	0.17
Use solar energy for heating space	1.9950	0.6547	3.05	0.00
Self-knowledge about solar energy	0.0758	0.1247	0.61	0.54
Solar panel takes much space	0.2032	0.2934	0.69	0.49
Solar panel appearance on roof	0.2926	0.3992	0.73	0.46
Solar panel difficult to install	0.3400	0.3548	0.96	0.34
Cut off 1	3.0175	2.4370	1.24	0.22
Cut off 2	0.0972	2.4112	0.04	0.97

Table A.3. Ordered probit regression results of the expressed importance associated subsidy.

Variable name	Coeff.	Std. error	t-value	p-value
Male (dummy)	0.3138	0.5987	0.52	0.60
Edu (category)	0.1226	0.1369	0.90	0.37
Married (dummy)	0.1987	1.0160	0.20	0.85
Having children (dummy)	0.5070	0.6964	0.73	0.47
Household size (rank)	0.4168	0.3393	1.23	0.22
Income (rank)	0.0472	0.1363	0.35	0.73
Unemployed and part time (dummy)	0.5009	1.3669	0.37	0.71
Farmer (dummy)	1.4311	1.0176	1.41	0.16
Use solar energy in general	0.7544	0.7851	0.96	0.34
Use solar energy for heating water	1.0038	0.9364	1.07	0.28
Use solar energy for heating space	1.4042	0.7126	1.97	0.05
Self-knowledge about solar energy	0.2391	0.1624	1.47	0.14
Solar panel takes much space	0.5483	0.3304	1.66	0.10
Solar panel appearance on roof	0.1012	0.4576	0.22	0.83
Solar panel difficult to install	1.1915	0.4380	2.72	0.01
Cut off 1	5.4166	3.0354	1.78	0.07
Cut off 2	1.6537	2.9270	0.57	0.57

Table A.4. Ordered probit regression results of the expressed importance of expected lowering costs of energy use prior to having a solar panel.

Variable name	Coeff.	Std. error	t-value	p-value
Male (dummy)	-0.0234	0.5822	-0.04	0.97
Edu (category)	0.0202	0.1306	0.15	0.88
Married (dummy)	0.7777	0.9137	0.85	0.39
Having children (dummy)	-0.4950	0.6578	-0.75	0.45
Household size (rank)	-0.0343	0.3124	-0.11	0.91
Income (rank)	0.1390	0.1319	1.05	0.29
Unemployed and part time (dummy)	16.1479	0.0000	83653,309.	0.00
Farmer (dummy)	-0.5361	0.8596	-0.62	0.53
Use solar energy in general	-1.3882	0.7842	-1.77	0.08
Use solar energy for heating water	1.1923	0.8860	1.35	0.18
Use solar energy for heating space	0.3490	0.6347	0.55	0.58
Self-knowledge about solar energy	-0.0086	0.1464	-0.06	0.95
Solar panel takes much space	-0.2164	0.3281	-0.66	0.51
Solar panel appearance on roof	0.2608	0.4420	0.59	0.56
Solar panel difficult to install	-0.5372	0.3947	-1.36	0.17
Cut off 1	-3.5374	2.8987	-1.22	0.22
Cut off 2	-0.7442	2.8282	-0.26	0.79

Table A.5. Ordered probit regression results of thinking low prior cost is important.

Variable name	Coeff.	Std. error	t-value	p-value
Male (dummy)	0.1797	0.5380	0.33	0.74
Edu (category)	0.0605	0.1206	-0.50	0.62
Married (dummy)	0.3355	0.8527	0.39	0.69
Having children (dummy)	0.4716	0.5952	-0.79	0.43
Household size (rank)	0.2382	0.2871	-0.83	0.41
Income (rank)	0.0140	0.1148	0.12	0.90
Unemployed and part time (dummy)	1.6418	1.3076	1.26	0.21
Farmer (dummy)	1.9041	0.9085	-2.10	0.04
Use solar energy in general	1.3419	0.7306	-1.84	0.07
Use solar energy for heating water	0.1277	0.7960	-0.16	0.87
Use solar energy for heating space	1.9068	0.6149	3.10	0.00
Self-knowledge about solar energy	0.0243	0.1291	0.19	0.85
Solar panel takes much space	0.0224	0.2973	-0.08	0.94
Solar panel appearance on roof	0.3268	0.4058	0.81	0.42
Solar panel difficult to install	0.8001	0.3746	-2.14	0.03
Cut off 1	3.5379	2.5878	-1.37	0.17
Cut off 2	1.4080	2.5541	-0.55	0.58

Table A.6. Ordered probit regression results of the expressed importance of increasing energy cost.

Variable name	Coeff.	Std. error	t-value	p-value
Male (dummy)	0.2278	0.5022	-0.45	0.65
Edu (category)	0.2377	0.1158	-2.05	0.04
Married (dummy)	0.0814	0.8481	-0.10	0.92
Having children (dummy)	0.4755	0.5657	0.84	0.40
Household size (rank)	0.8037	0.2936	-2.74	0.01
Income (rank)	0.0115	0.1054	0.12	0.91
Unemployed and part time (dummy)	1.2668	0.9301	-1.36	0.17
Farmer (dummy)	1.2721	0.8401	-1.51	0.13
Use solar energy in general	0.8770	0.6507	-1.35	0.18
Use solar energy for heating water	1.0377	0.7113	-1.46	0.14
Use solar energy for heating space	2.2021	0.6128	3.59	0.00
Self-knowledge about solar energy	0.0704	0.1249	0.56	0.57
Solar panel takes much space	0.0531	0.2826	-0.19	0.85
Solar panel appearance on roof	0.5509	0.3671	-1.50	0.13
Solar panel difficult to install	0.1243	0.3335	0.37	0.71
Cut off 1	6.1960	2.4865	-2.49	0.01
Cut off 2	4.0426	2.4410	-1.66	0.10

Table A.7. Ordered probit regression results of the expressed importance regarding the expected low panel service costs.

Variable name	Coeff.	Std. error	t-value	p-value
Male (dummy)	0.0384	0.5259	-0.07	0.94
Edu (category)	0.0437	0.1198	-0.36	0.72
Married (dummy)	0.8739	0.8349	1.05	0.30
Having children (dummy)	0.1685	0.5862	-0.29	0.78
Household size (rank)	0.4611	0.2895	-1.59	0.11
Income (rank)	0.0392	0.1109	-0.35	0.72
Unemployed and part time (dummy)	0.2991	1.0447	-0.29	0.77
Farmer (dummy)	0.6674	0.8624	-0.77	0.44
Use solar energy in general	1.3409	0.6841	-1.96	0.05
Use solar energy for heating water	0.7989	0.7691	1.04	0.30
Use solar energy for heating space	1.2777	0.5880	2.17	0.03
Self-knowledge about solar energy	0.1203	0.1296	-0.93	0.35
Solar panel takes much space	0.0873	0.2821	-0.31	0.76
Solar panel appearance on roof	0.6053	0.3930	-1.54	0.12
Solar panel difficult to install	0.0440	0.3448	0.13	0.90
Cut off 1	4.6405	2.5152	-1.85	0.07
Cut off 2	2.3620	2.4811	-0.95	0.34