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FROM WATER TO BIOFUELS: KNOWLEDGE AND ATTITUDES TOWARDS RENEWABLE ENERGY SOURCES AMONG RURAL RESIDENTS IN EASTERN POLAND

*OD WODY PO BIOPALIWA: WIEDZA I STOSUNEK DO ODNAWIALNYCH
ŹRÓDEŁ ENERGII WŚRÓD MIESZKAŃCÓW TERENÓW WIEJSKICH
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Słowa kluczowe: badania ankietowe, model probitowy, mieszkańcy terenów wiejskich, energia odnawialna

Abstract. This article investigates factors influencing knowledge of renewable energy types among 200 residents of 13 villages in Lubelskie province using survey data collected in 2013. Survey summary responses indicate that solar and wind energy were best known and biofuels the least known among five energy types considered in the questionnaire. Factors associated with varying degrees of renewable energy sources were identified using the multivariate ordered probit approach. The largest change in probability that a respondent's self-assessed knowledge level fell into a specific category was associated with being a farmer, viewing the subject matter of the survey as important, having high income, being from a large household and, being married.

Introduction

Renewable energy has become a current topic in Poland because of the requirement imposed on all European Union (EU) countries to increase the share of power generated from renewable sources [Jaeger-Waldau et al. 2011]. Commercial promotion of such forms as wind, solar, or bioethanol energy overshadows the prolonged use of water and biomass as sources of energy. For example, biomass largely dominates such simple daily tasks as cooking food in many areas of the globe. Water is a major source of power in Scandinavia, but it has also been used in Poland. In recent decades, there has been a renewed interest in hydro-electric power plants in many areas (e.g., Pomerania). However, regardless of how long a particular form of renewable energy has been used, knowledge about the specific form may vary among the most common energy consumer households. Knowledge is a prerequisite of realizing benefits offered by the renewable energy program in Poland that offers grants and subsidies including, for example, low cost credits for households investing in solar or geothermal installations.

This paper examines knowledge of rural residents in Lubelskie province about five renewable energy sources (wind, solar, hydro, biofuels, and biogas) as a factor influencing attitudes and the decision to invest in equipment using such sources. The selection of Lubelskie province has been encouraged by the particularly high interest of the region's residents, who used a leading search engine to comb the Internet for information about "renewable energy sources" [Derkacz 2012] despite a negligible amount of energy generated from such sources in Lubelskie (as compared to other regions of the country) at that time. The drastic spatial contrast between the actual production of energy from renewable sources and the interest shown by the Internet users should be reflected in knowledge of the region's population.

The current empirical examination is based on a convenience sample of 200 residents of 13 villages who participated in a survey implemented in 2013. Us et al. [2014] in the study based on solar collector subsidy program and investment provided a preliminary description of knowledge variable energy

based on 93 completed questionnaires from villagers residing only in the Northern part of Lubelskie province. Respondents were most familiar with solar and wind energy than other renewable energy sources, especially with biofuels. Studies in other countries provide contradictory evidence about differences in knowledge about renewable energy types between urban and rural residents. Yuan et al. [2011] indicated that knowledge of some forms of renewable energy is somewhat lower among rural than urban residents, but Zyadin et al. [2012] reported a nearly identical share of rural and urban residents knew about several energy sources including solar and wind. Results of the current study include identification of respondent socio-economic characteristics and opinions as having a statistically significant effect on the degree of knowledge about forms of renewable energy. Awareness of such factors has been limited because the focus of most studies on renewable energy ignores consumer knowledge. However, results from this study coincide with some earlier reports. Understanding what factors are relevant in their influence provides insights for promoters of renewable energy from public sector and commercial suppliers of installations and equipment for renewable energy utilization by households. Ultimately, the demand for renewable energy will allow Poland to meet the goal of at least a 15% share of total energy use originating from renewable sources by 2020, fulfilling the EU mandate.

Society's environmental consciousness

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. The latter is not uniformly defined. The Ministry of Environment includes in its definition possible actions that can be undertaken by individuals that positively influence the environment [*Badanie świadomości...* 2013].

Earlier studies reported on the environmental consciousness within the Polish society using a sample of residents in Płock [Tuszynska 2013]. The self-assessed knowledge about environmental protection was quite high and ranged from 53% among secondary school students to 74% among teachers. The primary motive driving choices in saving water or energy was the cost of utilities. Studies in other countries concluded that concern about the environment is not significantly associated with being more knowledgeable about renewable energy [Bang et al. 2000]. In turn, Guzal-Dec [2015] argued that there was a need to further environmental knowledge among the members of municipal governments in counties located in Lubelskie Province.

A study focused on wind energy probed 1169 respondents about knowledge of renewable energy sources [Mroczek 2011]. A nearly identical share of respondents, about 85%, acknowledged associating wind and solar energy with renewable energy, followed by more than 71% expressing a similar association with hydroenergy, but only about 39% thought of biomass as a form of renewable energy. In a more recent study, 60% of respondents thought Poland did not utilize any renewable energy [*Co wiemy...* 2014] although the renewable energy share accounted for 11.25% of utilized energy in 2013 [*Energia ze...* 2014]. The mentioned study [*Co wiemy...* 2014] reported that the following percentage of respondents named as renewable energy: wind – 56%, solar – 53%, water – 36%, and biomass – 12%. In a study of a single county, Suloszowa in Malopolskie province, wind and solar energy were the most known renewable forms of energy among the surveyed respondents [Bednarowska et al. 2013]. Overall, county residents displayed both positive and distrusting attitudes towards renewable energy. Interestingly, the study was conducted after the residents successfully opposed the construction of a wind energy farm. One of the conclusions from the study suggests the continuing need for educating the public about renewable energy because the lack of full, verifiable, and accurate information will help change attitudes.

An example of a program explicitly aiming at increasing environmental consciousness by providing financial incentives is the program Prosument. It was made possible after the regulatory changes allowed individuals to buy and operate one or more installations utilizing renewable energy that leads not only to energy cost savings, but also to sell surplus energy to the grid [Maziarz 2014]. Public funds can be applied towards the purchase and installation of photovoltaics, small wind turbines, heat pumps, solar collectors, small biogas generators, and biomass burning furnaces.

Materials and methods

Survey organization and data collection

The questionnaire was drafted with a study focusing on individual behavior and its direct and indirect effects on the environment and behaviors reflecting environmental consciousness. The intent of the authors was to address several issues that were not necessarily connected; for example, knowledge of renewable energy sources, which is the focus of this study, and preferences for recreation, which in its broad sense, involves the environment.

Printed copies of survey instruments were delivered to randomly selected residents (a convenience sample) in thirteen villages in Biała Podlaska, Tomaszów Lubelski, and Zamość districts of Lubelskie Province, including Rakowiska, Janów Podlaski, Rossosz, Łomazy, Terespol, Wisznice (all in Biała Podlaska district), Krynice (Tomaszów district), Komarów-Osada, Śniatycze, Dub, Janówka Zachodnia, and Zubowice oraz Antoniówka (all in Zamość district). All villages are located in the northern and southern part of the region, which receives the highest amount of solar radiation in the country.

Questionnaires were left in each household, that agreed to participate in the survey. The questionnaire was self-administered by a respondent, and collected by an enumerator within a few days. The main criteria for selecting a household was its location within the boundaries of one of the villages. The survey begun on July 1 and ended on August 12, 2013. The questionnaire probed respondents for their general knowledge about renewable energy sources as well as other issues. Additionally, a set of questions asked the respondent to share information about themselves and their households to provide socio-economic and demographic information used later in the specified empirical relationship. A total of 200 completed questionnaires were collected.

Descriptive statistics

The question probing respondents about renewable energy types applied a Likert-type scale offering five choices ranging from 1, meaning a respondent knew very little, 3 implying respondent chose the option describing knowledge of the renewable energy source as „neither good, nor bad”, to 5, stating that a respondent knew a lot. The average score of knowledge about five renewable energy sources was: 3.64 regarding hydro, 3.83 regarding wind, 3.34 regarding biogas, 3.97 regarding solar, and 3.29 regarding biofuels. The highest scores for wind and solar energy are not a surprise because both types are often mentioned in mass media reports about issues related to renewable energy. An earlier study also reported that these two renewable energy types were best known by the public in Poland [Co wiemy... 2014], while Us et al. [2014] in their study based on responses from Biała Podlaska district also indicated the highest level of familiarity of respondents with solar and wind energy. The highest self-assessed level of knowledge consistently indicated solar and wind energy suggesting that knowledge of these two sources of renewable energy is familiar to large segments of population [Mroczek 2011, Co wiemy... 2014, Us et al. 2014].

In terms of respondent and household characteristics, the average respondent was over 42 years old and about one in four had a university degree (Tab. 1). An average household has 3.7 persons and 73% of respondents were married. Respondents indicated a category of income and the average score was 3.17, an income between 2,001 PLN and 2,500 PLN. Nearly one half of respondents (46%) was employed full time and another 29% were farmers. When asked if renewable energy was an important topic, each respondent could rank the importance on a ten point scale; the average ranking was 7.57, but none of the participants ranked the topic lower than three.

Estimation approach

The empirical relationships defined the dependent variables as self-assessed knowledge about each type of renewable energy, i.e., wind, hydro, solar, biogas, and biofuels. The dependent variable assumed the value of 0 if a respondent self-assessed his knowledge about the specific source of energy as very low and the value ranging from 1 to 4 when a respondent indicated his knowledge ranging

Table 1. Descriptive statistics of selected demographic, socioeconomic and location characteristics

Tabela 1. Statystyka opisowa wybranych cech demograficznych, socjoekonomicznych i miejsca zamieszkania

Variable name/ Nazwa zmiennej	Units/Jedn.	Mean/ Średnia*	Std. deviation/ Odchylenie standardowe	Min./ Wartość minimalna	Max/ Wartość maksymalna
Gender/Płeć	1 = man/mężczyzna, 0 = woman/kobieta	0.48	0.50	0	1
Age/Wiek	years/lata	42.53	10.74	23	82
Education/Wykształcenie	1 = university degree/ wyższe, 0 = otherwise/ inne	0.255	0.437	0	1
Marital status/Stan cywilny	1 = married/zamężna – żonaty, 0 = other/inne	0.73	0.45	0	1
Household size/Wielkość gospodarstw domowych	number of household members/liczba osób w gospodarstwie domowym	3.71	1.06	1	5
Employment status/ Zatrudnienie	1 = fully employed/pełny etat, 00 = other/inne	0.46	0.50	0	1
Farmer/Rolnik	1 = farmer/rolnik, 0 = other/inne	0.29	0.45	0	1
Income/Dochód**	income category/ kategoria dochodu	3.17	1.13	1	5
Survey subject importance/ Ważność przedmiotu ankiety	Scale from 1 to 10/ Skala od 1 do 10	7.57	1.68	3***	10

* in case of binary variables the reported figure is a share/w przypadku zmiennej binarnej liczba oznacza udział,

** income categories are/kategorie dochodu: 1 = up to 1500 PLN, 2 = 1501-2000 PLN, 3 = 2001-2500 PLN, 4 = 2501-3000 PLN, 5 = 3001 PLN or more/lub więcej. *** none of respondents ranked the subject matter below 3/żaden respondent nie uznał ważności tematu poniżej 3

Source: own study

Źródło: opracowanie własne

from low to very good including the neutral level of „neither good nor bad”. Because knowledge or lack thereof of one renewable energy source is likely to be associated with another source, error terms may be correlated across the equations. If such a presumption is justified, the appropriate estimation technique is the multivariate ordered probit [Greene 2008, p. 826-831]. Estimation results confirmed that indeed this approach was preferred as indicated by statistically significant values of rho (rho values are across equation correlations and are statistically significant; therefore, the estimation of the multivariate probit is preferred to the estimation of five separate ordered probit equations), a measure that the selection of multivariate ordered probit was appropriate.

The estimated coefficients are not directly interpretable and serve as the basis for the calculation of effects (in the case of binary variables) and marginal effects (in the case of continuous variables). The commonly applied procedure was applied in the current study [see for example Mullahy 2011].

Results

The statistically significant variables in each equation regarding the level of knowledge about renewable energy type are: income, household size, being a farmer, and opinion about the importance of the survey regarding hydroenergy; income, being a farmer, and opinion about the importance of the survey regarding wind energy; having full time employment and being a farmer regarding biogas; being a farmer and opinion about the importance of the survey regarding solar energy; no distinct effects were identified in the equation regarding biofuels. Because the explana-

tory variables were limited to stable respondent characteristics reflected in socio-economic and demographic factors, it is plausible that a differentiating effect could be discerned by constructs based on opinions of a respondent regarding specific features of renewable energy sources. Opinions, however, are difficult to obtain and measure, and may change rapidly with incoming information and are less likely to be stable predictors of respondent level of knowledge.

Table 2 shows the change in the probability of a respondent falling into one of five knowledge categories about renewable energy sources in response to a specific change in an explanatory variable. Overall, the changes can be expected to be relatively small, but still provide rare insights useful in, for example, targeting education campaigns about renewable energy if the EU imposed a „green energy” mandate. Most often the high probability of not self-reporting as having knowledge about renewable energy sources was associated with being a farmer. Farmers had, for example, a nearly 19% lower probability of having good knowledge of wind energy as compared to non-farmer respondents. Farmers also had a lower probability of knowing about hydroenergy (7.5%), biogas (4%), and solar energy (5.1%). The higher the income, the higher the probability a respondent self-assessed his knowledge as low and the lower the probability of the self-assessment being high in the case of hydroenergy and wind energy. For example, higher income increased the probability of having low knowledge of wind energy by 5.9% and decreased the probability of having good knowledge by 5.1%. A similar directional effect was associated with full-time employment, but the opposite effects on probabilities resulted from the increased number of household members and marital status.

Table 2. Effects of binary variable and marginal effects of continuous variables on the probability of respondent choosing one of the five levels of knowledge about four renewable energy sources as compared to the “very low” knowledge level

Tabela 2. Efekt zmiany zmiennej binarnej i efekt krańcowy zmiennej ciągłej na prawdopodobieństwo, że respondent wybierze jeden spośród pięciu poziomów wiedzy o czterech rodzajach OZE w porównaniu do bardzo niskiej wiedzy

Variable name/ <i>Nazwa zmiennej</i>	Very low/ <i>Bardzo niski</i>	Low/ <i>Niski</i>	Neither low nor high/ <i>Ani niski, ani wysoki</i>	High/ <i>Wysoki</i>	Very high/ <i>Bardzo wysoki</i>
<i>Hydroenergy/Energia wodna</i>					
Household size/ <i>Liczba osób w gospodarstwie domowym</i>	-0.020	-0.0072	1.06	0.052	NA
Farmer/ <i>Rolnik</i>	0.037	0.134	0.022	-0.96	NA
Income/ <i>Dochód</i>	0.013	0.047	-0.034	-0.027	NA
Survey subject importance/ <i>Ważność przedmiotu ankiety</i>	-0.015	-0.532	-0.53	0.038	NA
<i>Wind Energy/Energia wiatrowa</i>					
Farmer/ <i>Rolnik</i>	0.024	0.216	-0.052	-0.188	NA
Income/ <i>Dochód</i>	0.007	0.059	-0.014	-0.051	NA
Survey subject importance/ <i>Ważność przedmiotu ankiety</i>	-0.007	-0.063	-0.015	0.055	NA
<i>Biogas/Biogaz</i>					
Marital status/ <i>Stan cywilny</i>	-0.092	-0.072	0.137	0.028	NA
Employment status/ <i>Zatrudnienie</i>	0.090	0.070	-0.133	-0.028	NA
Farmer/ <i>Rolnik</i>	0.132	0.103	-0.194	-0.040	NA
<i>Solar Energy/Energia słoneczna</i>					
Farmer/ <i>Rolnik</i>	0.018	0.195	-0.005	-0.157	-0.052
Survey subject importance/ <i>Ważność przedmiotu ankiety</i>	-0.006	-0.064	0.002	0.052	0.017

NA = not available, none of respondents admitted knowing a lot about this energy type/*brak danych, żaden z respondentów nie wybrał wysokiego poziomu wiedzy o tym rodzaju OZE*

Source: own calculations

Źródło: obliczenia własne

Respondents who valued the subject matter of the survey were less likely to exhibit very low knowledge, or especially low knowledge; in the case of wind or solar energy, the probability that such respondents fell into the latter category was 6.3% and 6.4%, respectively.

Conclusions

This study examines factors associated with self-assessed knowledge about renewable energy sources among rural residents of Województwo Lubelskie. Earlier studies showed that wind and solar energy are most likely to be named as renewable energies, while other sources are mentioned considerably less often. In the current study, knowledge about renewable energy is assumed to be linked to possible acceptance of appropriate equipment installation to meet the „green energy” mandate imposed on Poland by the EU.

Factors influencing the degree of knowledge about renewables were identified by employing the multivariate ordered probit technique and the calculation of changes in probability associated with knowledge level in response to a changes in an explanatory variable. Two factors most often influenced knowledge, namely being a farmer was associated with different degrees of lack of knowledge, while considering renewable energy a worthwhile subject of the survey had the opposite effect. Farmers in Lubelskie Province are potential benefactors of programs subsidizing home installation of renewable energy equipment (e.g., solar panels, small biogas facilities), yet their self-assessed knowledge level was low. It appears that additional measures are needed to enhance such knowledge in rural areas to encourage use of renewable energy generated by households. Individual efforts through the utilization of solar, wind, or biogas energy can make a substantial contribution and increase the share of „green energy” in total energy use.

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Streszczenie

Zidentyfikowano czynniki wpływające na wiedzę o OZE wśród 200 mieszkańców 13 wsi województwa lubelskiego na podstawie badań ankietowych przeprowadzonych w 2013 roku. Wyniki ankiety wskazują, że spośród 5 źródeł energii odnawialnej wymienionych w ankiecie wśród badanych osób najpopularniejsza była wiedza o energii wiatrowej i słonecznej, natomiast najrzadziej jako OZE wymieniano biopaliwa. Czynniki związane z różnym poziomem wiedzy o OZE zidentyfikowano za pomocą zmodyfikowanej metody probitowej. Największe prawdopodobieństwo, że respondent zostanie zakwalifikowany do określonej kategorii poziomu wiedzy nt. OZE występowało wtedy, gdy ankietowana osoba była rolnikiem miała wysoki dochód, pochodziła z wieloosobowego gospodarstwa domowego oraz pozostawała w związku małżeńskim.

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