DETERMINANTS OF THE WILLINGNESS TO PAY OF INHABITANTS FOR EXTERNALITIES RELATED TO THE PRESENCE OF AGRICULTURAL BIOGAS STATIONS NEAR THEIR HOMES

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Abstract

The agricultural biogas stations (BGS) are built to produce renewable energy. Their functioning is linked with certain positives, but also negatives. The loss of welfare shall be reflected in evaluation of the project before the BGS is build. The best way of incorporation of the social aspects in projects evaluation is Cost-Benefit Analysis (CBA) that assess them in monetary terms. A primary survey used contingent valuation method and found the price which the inhabitants would be willing to pay (WTP) for the reduction of negative externalities related to the BGS nearby. The aim of the paper is to find the determinants of this WTP. There were 1001 respondents, but only the determinants of non-zero WTP (239 cases) were examined. Average WTP was 50 CZK. Tested determinants in regression models were respondent's gender, age, number of members of household in total and economically active, job of the family member with maximal income, income category of the household, the highest obtained education, time living in house, and distance of the home from the BGS. However, only age, education, no. of economically active and no. of years living in the house appears to be statistically significant determinant of the WTP.

Key words: agricultural biogas stations, externalities, WTP

JEL Code: H23, H43, C20

Introduction

The agricultural biogas stations (BGS) are built to produce renewable energy and help to combat the climate change. Their advantage is that they utilize waste from agriculture and help to improve the economy of the agricultural holding.

BGS produces clean energy and should not cause air pollution. "A cogeneration unit combusting biogas produces emissions, but the quantity of emissions is negligible, in the majority of cases." (Lapčík and Lapčíková, 2011). Despite that the GBS have certain positive

effects, they should not bother the local inhabitants. Building of agricultural BGS and clean energy is supported from public sources and therefore shall bring benefits to the tax payers. Therefore, it is important to examine whether it is true.

Sometimes BGS functioning is also linked with certain disadvantages. Odour that occurs in older stations which is assessed as one of the most disputable environmental impacts in biogas stations. Another discomfort is caused by noise from transportation in relation with the construction and later operation (cogeneration unit itself is situated in a soundproof, insulated engine hall).

In the broader sense, the agricultural biogas stations have an increasing influence on the structure of crops in the Czech Republic (Dvořák et al., 2014) that can have negative consequences for the climate. Martinát et al. (2013) proved that "increased shares of sowing areas of corn maize together with increased intensities of cattle breeding partially correlate with areas where higher amount of agricultural anaerobic digestion plants occurs".

Life of the local inhabitants might be negatively influenced by the presence of the agricultural BGS. The loss of welfare due to the presence of BGS shall be reflected in evaluation of the project before the BGS is build. The best way of incorporation of the social aspects into the valuation of the projects is Cost-Benefit Analysis (CBA). It was used for example by Dobraja, Barisa and Rosa (2016) in Latvia to assess the waste to energy concept in public transport. It requires the social impacts – externalities – to be evaluated in monetary terms. CBA analysis of the investment to BGS was elaborated e.g. by Menind and Olt (2009). However, they focus mainly on financial costs and benefits.

1 Theoretical background

The opinion of population on renewable energy in Shandong, China was examined by Liu, Wang and Mol (2013). Their paper assessed rural social acceptance of renewable energy. "The results show that rural residents are generally supportive renewable energy development given its positive impacts on environment." (Liu, Wang and Mol, 2013). Respondents' stated willingness to pay more for renewable electricity increased with household income, individual knowledge level and belief about costs of renewable energy use but decreased with age. Pechrová and Lohr (2016) derived the monetary value of externalities related to the biogas stations from the value of real estate sold nearby. They found a negative effect of the presence from biogas station on the flat prices - its presence lowers the price by 0.15% based on linear regression model, or by 0.40% based on log-linear form of the model.

In order to assess the overall impact of the BGS on the local inhabitants (and tax payers in general), it is important to evaluate the negatives and positives by CBA. It is necessary to understand which disadvantages and advantages are perceived and how strongly, and what factors influence the willingness to pay of inhabitants for the reduction of negatives related to the presence and operation of agricultural BGS.

2 Data and Methods

The aim of the paper is to assess the determinants of the willingness to pay (WTP) for the reduction of the drawbacks that are linked to the presence of the agricultural BGS. Examined determinants were: characteristics of the respondent's background such as gender (variable named GENDER was included as dummy variable: 0 – male, 1 – female), age (variable AGE), number of members of household in total and economically active (ECONACTIV), job of the member of family with maximal income (JOB: 1 – employee, 0 – other), net income category of the household (INCOME: 0 – up to and equal to 40 000, 1 – over 40 000), the highest obtained education (EDU1: 0 – other, 1 – basic school, EDU2: 0 – other, 1 – high school without leaving exam, EDU3: 0 – other, 1 – high school with leaving exam, EDU4: 0 – other, 1 – college, EDU5: 0 – other, 1 – university), number of years living in house (LIVING), and distance of home from the BGS (DISTANCE). Variable EDU5 was omitted meaning that all types of education were compared to it.

There are currently over 350 agricultural biogas stations (BGS) with the total installed power 365 MW are in operation mainly due to positive policy towards renewable energy resources. (Slaboch and Hálová, 2017). For the purpose of the research from total 1001 questionnaires gained from respondents living near to 10 BGS, only 860 were valid (i.e. there were no zero values in the answers). However, mostly the price that the people were WTP for the externalities, was zero. Therefore, we selected only those observations where the WTP was non-zero (239 in total). Descriptive statistics of the sample are presented in Tab. 1.and Tab. 2.

People that are exposed to negative externalities the most, i. e. people that live up to 1 km far from BGS were asked in a questionnaire. Average distance from BGS was 498 m. The closest house was 59 meters far from BGS Lhota pod Libčany and the furthest 957 meters from Kněževes. There were 122 males and 117 females. Age ranged between 18 (the lowest possible) and 68. Average respondent was 41.7 years old and lived in a house 22.7 years on average, 71 years maximally. Four people lived in the house less than one year. Average WTP price was 49.8 CZK ranging from 1 CZK to 500 CZK. Median was 30 and modus 50 CZK.

Tab. 1: Statistical description of the respondents' sample

	Distance from BGS	Age in years	No. of years living in house	WTP
Average	498 m	41.8	22.7	49.8 CZK
Minimum	59 m	18.0	0.0	1.0 CZK
Maximum	957 m	68.0	71.0	500.0 CZK

Source: own elaboration

There were 16 people living alone. Mostly (73) people lived in the household of 2, then in the household of 4, 49 people in the house of 3 and 36 in household with 5 members. From these households, mostly 2 members were economically active (187 cases, 78.2%) and then only one (34) or 3 members (18). A member of household with the highest income was mostly employee (78.7%), only in 50 cases they were self-employed. Mainly because there were mostly 2 working members in the household, the net monthly income of the household was in 32.9% cases between 40 to 50 thous. CZK. Then in 29.4% cases, the income of the household was between 30 to 40 thous. CZK.

Tab. 2: Statistical description of the respondents' sample - continuation

No. of members of the household			A member of household with the highest income is		The highest finished education		Net monthly income of the household	
	total	economically active						
1	16	34	employee	188	basic	4	≤ 40 000 CZK	118
2	73	187	self-employed	50	high school without leaving exam	77	> 40 000 CZK	121
3	49	18	unemployed	0	high school with leaving exam	87		
4	63	0	student	0	college	28		
≥ 5	38	0	other	1	university	43		

Source: own elaboration

First, a check for multicolinearity was done. As price is continuous quantity, classical linear regression model was constructed and estimated by ordinary least square method. Originally, all explanatory variables were included into the model and then they were discarded in iteration process of forward stepwise selection in order to leave only those that were statistically significant. Calculations were done in software Statgraphics Centurion XVI.

3 Results

First, the correlation among explanatory variables was checked using Pearson correlation coefficient. There were only four correlation coefficients higher than 0.5 (or lower than -0.5) pointing on middle or strong dependence. Correlation between age of the person (AGE) and the number of years living in the house (LIVING) was middle strong and statistically significant at

$\alpha = 0.01$ (0.5513^{***}) as same as correlations between high school education with leaving exam (EDU3) and basic education (EDU1; Pearson correlation coef. = -0.5417^{***}) and high school without leaving exam (EDU2; Pearson correlation coef. = -0.5216^{***}). In later two cases, the relation was negative. Nevertheless, only excessive relation was noted between EDU1 and EDU2 (Pearson correlation coef. = 0.9629^{***}), but it did not cause a significant problem, as EDU2 was not included into the final solution of the model (see below). Hence, there was no multicollinearity (excessive dependence between explanatory variables) found.

Model itself was estimated in many forms until the optimal solution was reached. A stepwise regression method was used. The iteration process included forward selection where p- value to enter and remove was 0,05. Only significant variables were AGE, LIVING, ECONACTIV and EDU1. Nevertheless, the fit of the model was not high – only 44.87% of variability of explained variable was explained by the variability or explanatory variables. Using R^2 adjusted for the number of degrees of freedom, the fit was only 44.17%. Hence, there are other important determinants of the WTP that were not observed in the questionnaire in primary research and included into the model. Nevertheless, since the p-value in the ANOVA table is less than 0,05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The equation of the fitted model is PRICE = -0.56284 ∗ LIVING + 1.1537 ∗ AGE + 11.6559 ∗ ECONACTIV – 26.2028 ∗ EDU1. It means that when the age of a person increases by 1 year, the WTP increases by 1.15 CZK, so the intensity is not that significant. Regarding the length of living in the house near BGS, it can be seen that WTP is decreasing the longer the person lives there. Inhabitants get probably used to the presence of agricultural BGS as they live longer near it. It was expected that if there were more people economically active in a household, they would be more willing to pay higher price for elimination of negative externalities related to the BGS. It was proved as when there is one person economically active more, the WTP increases by 11.7 CZK. Having only basic education decreases the WTP by 26.2 CZK in comparison with higher education. Results are displayed in Tab. 3.

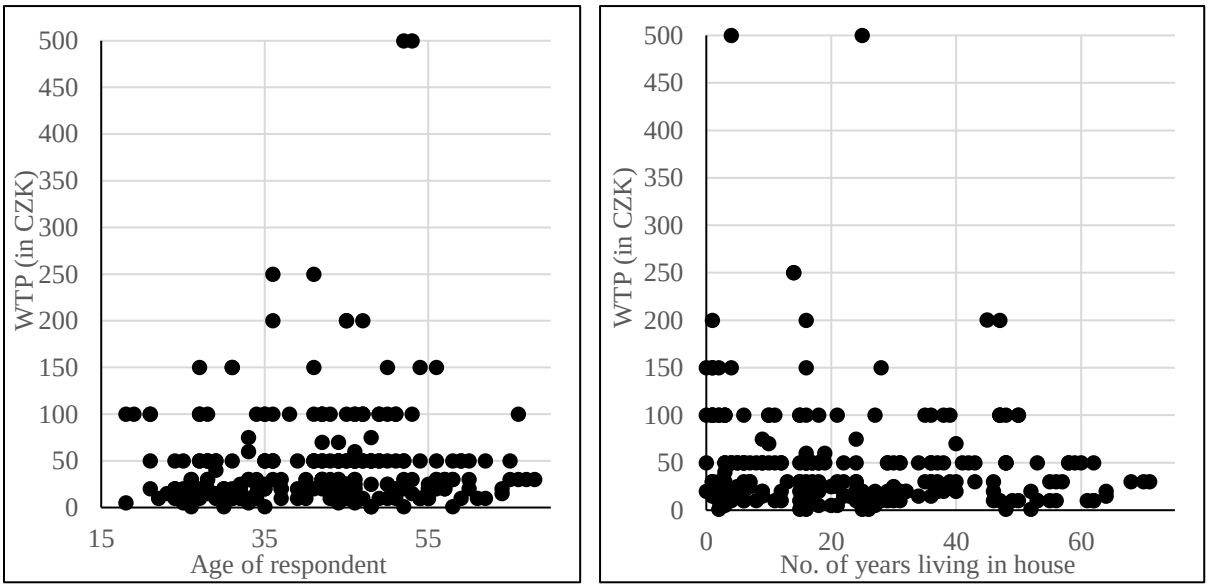
Tab. 3: Statistically significant determinants of the WTP

Parameter	Estimate	Standard error	t-statistic	p-value
AGE	1.1537	0.3115	3.7039	0.0003
LIVING	-0.5628	0.2466	-2.2820	0.0234
ECONACTIV	11.6559	5.6619	2.0586	0.0406
EDU1	-26.2028	8.1083	-3.2316	0.0014

Source: own elaboration

When the person is 41.7 years old (sample average), lives in a house for 22.7 years (sample average), is an employee and has only basic school, a WTP is 20.8 CZK. When the person is 41.7 years old (sample average), lives in a house for 22.7 years (sample average), there is one economically active person and has only basic school, a WTP is 20.8 CZK. If the length of living increases by 1%, the WTP decreases by 0.6%. When the person gets older by 1%, the WTP increases by 2.3%. When the person has again characteristics of sample average, but has other education than basic school, a WTP is higher (47.0 CZK). In this cases, the elasticity is lower, 1% increase of the number of years living in the municipality cause decrease of WTP by 0.3%, and increase of age by 1% cause increase of WTP by 1.02%. The relation between price and two the most important determinants – age and number of years living in the municipality can be seen also from Fig. 1.

Fig. 1: Relation between WTP and respondent's age (left) and no. of years living in the house (right)



Source: own elaboration

4 Discussion

From results, it can be seen that inhabitants living near 10 examined BGS are not willing to pay high prices for minimizing the negative externalities of their operation. Average WTP was 50 CZK. Naturally, households with more economically active members are willing to pay more. However, the maximum was only 500 CZK. People are probably used to and accept some inconveniences related to them such as noise or odour. It was proved also by our model, that when the person is living longer in the house near BGS, his or her WTP is lower.

Another motivation for such low WTP can be the fact that local people understand the importance of the BGS. As was proclaimed by Liu, Wang and Mol (2013) "enhancive knowledge and understanding about renewable energy (for instance, the cost) would be conducive to win public acceptance of renewable energy deployment". It also corresponds to the finding that people with only basic education are WTP less than with higher education.

Herbes, Braun and Rube (2016) found out that WTP of German consumers indicates that there are significant opportunities for providers of renewable heating to collect higher prices for products with preferential features such as the climate protection or the use of waste as a biogas substrate. This result can be relevant beyond the German energy market – for example for the Czech Republic. The situation in the Czech Republic is specific, as BGS are not according to the survey of (Dvořák et al., 2014) perceived much as "green energy source", but rather as "money source". "It can be stated that agricultural biogas stations have an increasing influence on the structure of crops in the Czech Republic and are considered by the public and farmers themselves to be an alternative source of income rather than contribution to environmental protection, reduction of greenhouse gas production and climate change." (Dvořák et al., 2014) The profitability of agricultural BGS was proved by Iotti and Bonazzi (2016) for the case of Italy. "The research shows that profitability and cash generation in the biogas plant industry are high, even if the generation of cash flow is less than the return on equity, and there are firm cases of having difficulty in financial debt repayment, even in the presence of positive economic margins," (Iotti and Bonazzi, 2016). Hence, the challenge for the future research is to examine the motivation for BGS construction and put it into the relation of the approach of the local inhabitants towards BGS. If they perceive the role of BGS positively, naturally they do not perceive the negatives so strongly and are not willing to pay high prices for their reduction. This factor limits the usage of the results of research on the overall assessment of BGS projects by CBA. WTP is too low to capture monetary value of all possible negatives (e.g. change of the structure of crop rotation and diversity). Hence, for evaluation of all externalities of BGS other valuation methods shall be used.

Conclusion

The aim of the paper was to examine the determinant that influence the price that are local inhabitants willing to pay for the externalities related to the BGS stations. WTP was found in primary research where originally 1001 respondents were asked. However, only in 239 cases, the WTP had non-zero value. Average WTP was 50 CZK. Tested determinants in regression

models were respondent's gender, age, number of members of household in total and economically active, job of the family member with maximal income, income category of the household, the highest obtained education, time living in house, and distance of the home from the BGS. However, only age, education, no. of economically active and no. of years living in the house appears to be statistically significant determinant of the WTP. The older is the person and the more economically active persons are in the household, the higher is the WTP. On the other hand, the longer the inhabitants live in the locality, the lower is the WTP as they probably got used to the presence of the BGS. Also, lower education decreases the WTP, because the people might not be that aware about the positive role of the BGS in the production of renewable energy.

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