Acceptance and Potential of Renewable Energy Sources Based on Biomass in Rural Areas of Hungary

Alexander Titov 1, György Kövér 2, Katalin Tóth 2, Géza Gelencsér 3 and Bernadett Horváthné Kovács 1,*

Abstract: The main focus of the paper is the investigation of the social potential of local renewable energy utilization in a rural peripheral region in Hungary. Public acceptance of biomass-based renewable energy sources can be crucial for rural communities in realization of their sustainable development strategy. The research area was Koppany Valley Natur Park 2000, a microrregion of 10 settlements located in the South Transdanubian region. This microrregion is characterized by poor and depressive socioeconomic and demographical conditions, despite its significant natural resources. The microrregion’s complex development strategy includes the utilization of local resources of renewable energy. Local population survey (n = 310) was conducted (in May 2018) on local biomass potential, knowledge, and attitudes of the local stakeholders in the microrregion. Multinomial logistic regression model estimates the acceptance of population, explanatory variables are categorical demographical (personal) factors and specific factors (based on answers of respondents). Trust in local authorities, knowledge on biomass in general and on specific technologies, as well as the education level of rural inhabitants are significant factors in supporting biomass plant establishment. Further, the group and characteristics of acceptance groups that the local development strategy may consider were defined.

Keywords: renewable energy; biomass; social acceptance; rural development; strategy

1. Introduction

Through national energy and climate plans, EU member states commit to meeting a voluntary share of renewable energy by 2030, and, between 2020 and 2030, to follow a national trajectory [1]. Promotion of renewable energy sources (RES) and energy efficiency (EE) incentives are among the main strategic components for the fulfillment of the emission reduction targets [2].

Regional alternative energy [3] sources of renewable energy production is available locally, thus may contribute to lessening the rural dependence on the national grid [4]. Authors also concluded that public acceptance is one of the main factors influencing local utilization of renewable energy. Low awareness and lack of acceptance [5] are prohibiting bioeconomy transitions. The role of local inhabitants in cocreating knowledge, innovation, and technology dedicated to the implementation of renewable energy projects is increasing. Differentiation among respondent groups could potentially include people with indifferent opinion to the public debate regarding renewable energy, thus can be a means to [6] change people’s attitude. Sharing findings on local perceptions is a fast and efficient way to provide general public feedback to policymakers regarding their decisions [7]. Interaction with various stakeholders is required not only to solve local problems of social acceptance, but also to find new innovative solutions for the sustainable deployment of RES [8].
The underlying factors of attitudes related to acceptance are studied broadly in RES context; among them knowledge [9], trust in stakeholders [10,11] or organizations [12], education [13], and information [14]. Moreover, participation in energy related community activities ensures more positive attitudes to renewable energy in comparison to where there is no participation. Nonmembers of the community energy initiatives tend to be more indifferent and uncertain but not more opposed to renewable energy technologies [15]. Considering the planning and implementation of RES projects in general, cooperation of experts, public, and other stakeholders is important [8,16–18], also is making them involved in the decision-making process [18,19]. Through a survey of inhabitants on public acceptance of biomass-based RES the general knowledge, innovative attitude, acceptance and willingness of application, as well as the estimation of benefits of RES had been explored. Adequate knowledge on RES, lack of information sources knowledge on various bioenergy-related technologies in general and on specific technologies (biogas, biodiesel, combustion of biomass exceeded) were found as weaknesses [20]. Environmental protection aspects proved to be the most relevant benefits concerning the use of RES. Willingness to collect biomass is essential in a sense of cooperative activities at the local community level without operation and maintenance of biogas power stations is hard to fulfil [21].

The potential for the production and use of biomass-based energy sources has already been considered [22] as the most exploited bioenergy source in Hungary; the amount of solid biomass needed is already available from forestry and agriculture. Biomass potential had been also investigated in 17 settlements of a Northern Hungarian micro-region (Hernad Valley) [23]. Rural development can lean on local biomass, although the common residue from the maintenance of orchards, vineyards, etc., is often overlooked by the energy sector [24]. Agricultural waste [25] and livestock waste [26] are also covered in recent models of rural economic developments as well as the regional potential of combination of agricultural residues and forestry biomass [27].

In this respect, the exploration of factors having a significant effect on the acceptance level gains importance [28]. The research being presented has a focus on defining characteristics of acceptance groups, including the convincible acceptance group. We suppose the uncertain population group is to realize the social potential of the Koppany Valley regarding biomass-based RES acceptance.

The present study focuses on local biomass as local resource and public acceptance and potential of biomass in a specific rural community. Two main constituents were considered for deep research at a local level: 1. Public acceptance of renewable energy sources based on biomass in rural communities; 2. Assessment of the social potential regarding biomass in local communities.

2. Materials and Methods

2.1. Research Area

The research area is the Koppany Valley located in Somogy county in Hungary (Figure 1). Koppany Valley Nature Park is a microregion consisting of 10 settlements along the Creek of Koppany. The lead organization is Vox Vallis Association co-operating with members of self-governments of these settlements. This area was chosen by taking into consideration already existing initiatives related to the green local society development run by Vox Vallis Development Association [29]. The plans to locally establish photovoltaic elements and biogas power plant stations are among them. The relevance of the current research is to assess the social potential of the proposed RES’s usage and to investigate awareness of the rural stakeholders on RES. The area is in one of the most underdeveloped Hungarian territories of serious economic, social, and infrastructural issues [30]. Despite this fact, there is significant potential regarding the green energy sector if considering the essential amount of local raw biomaterial production [31].
Despite this fact, there is significant potential regarding the green energy sector if considering the essential amount of local raw biomaterial production [31].

The potential of biomass in the area is substantial, however, we hypothesized it is complicated to utilize it due to the social barriers such as lack of knowledge and low level of awareness regarding renewables among the local stakeholders. This region is characterized by poor and depressive socioeconomic and demographical conditions indicated by low incomes of the local population, low educated and low skilled human resources, barriers of the local governments’ decision makers [32], unemployment, high age of population, and intensive agricultural production [31,33]. The managers of the microregion pursue a complex, integrated development action. A biogas plant is planned to be built in the center of the microregion and to utilize 500 ha of surrounding cropland with alternative crop production. This land size is expected to satisfy the local complex demand for extractable protein for chicken feed and the 1 KW biogas plant by the remains (fiber) of the multiannual crops. With this community owned investment (owners will be the municipalities and the local development NGO) the aim is to serve an integrated, complex development that relies on the families’ human resources and lands nearby, in which way the alternative cultivation can restore the soil conditions and avoid further chemical burden of the Koppany Creek [33].

2.2. Survey

An on-site visitor questionnaire survey targeting the local population was carried out in May 2018 in 10 settlements of the Koppany Valley microregion (n = 310). The sample for interviews was selected on a population quota base (10% of population, with no regard to the age, education, gender ratio), and is considered representative for the population of the settlements. Snowball method was applied, when finding the next respondent. The answers were registered by panelists and were recorded electronically later on. The panelists were junior researchers and PhD students and had been trained for the interviewing technique by a specialist. The questionnaire had been pretested and was divided into three general blocks: personal information about respondents (background information); awareness about RES in general; acceptance and potential of biomass-based RES. Likert scale, multiple choice, and open questions were applied.
2.3. Dataset and Variables

The original dataset had 310 observations collected during the survey, out of it 303 observations were considered in the actual effective dataset after exclusion of the missing data. The current research covers part of the full dataset; the relevant parts of the survey questions consist of 13 categorical variables and one dependent categorical variable (for the detailed information of the categories see tables Tables A1 and A2 in Appendix A). The explanatory variables were divided into two subsets: personal factors and specific factors.

Personal factors represent the individual characteristics of the respondent (gender, age, residence, years of living in the same area, education background, professional occupation, and trust in local authorities). The specific subset of variables emphasizes the knowledge and behavioral (habitual) parameters of rural inhabitants. It characterizes the respondents’ deeper knowledge on specific terms (biomass, energy crops, and climate change). It provides additional lifestyle information about the rural personality: whether householders are involved or not in certain farming activities such as plant cultivation or animal keeping, that may count as biomass.

The hypothesis was that the category variables of ‘personal’ and ‘specific characteristics’ (or combination of them) have a significant effect on the category outcome variable of ‘acceptance of biomass-based renewable energy’ at the local community level. We defined three groups of outcome variable: accepting (YES), not accepting (NO), or not sure to accept (MAYBE) the establishment of a biogas power plant in the rural area.

2.4. Statistical Method

Multinomial logistic regression (MLR) was applied, because it provides an appropriate technique to predict the probability of category membership on a dependent variable based on multiple independent variables [34,35].

In order to understand factors beyond uncertainty, the probabilities of switching a respondent’s decision from MAYBE (as reference category) to YES or NO were predicted by 13 categorical variables. As the managers of the development strategy of the microregion mostly benefit from understanding the uncertain group, in the end we summarized the main characteristics of this (MAYBE) group and formulated some recommendations that rely on the group’s (personal and specific) features. Multicollinearity was tested through variance-inflation factors analysis (VIF). Diagnostics was done in R software, numerical diagnostics (For results output see Appendix C). The VIF calculation formula is:

$$VIF_i = \frac{1}{1 - R^2_i}$$

where $R^2_i$ is the $R^2$-value obtained by regressing the $i$th predictor on the remaining predictors.

Stacked areas and lines with confidence bands effect plots were applied for visualization of the multinomial logit model results.

3. Results

Altogether, 13 personal and specific variables model local population acceptance groups of biogas power plant installation. Following the brief introduction of the sample characteristics, the results are presented in two respective subsections. Prior test was applied (variance-inflation factor analyses (VIF)) to prove no concern to expect multicollinearity of the independent variables. None of the VIF values of the variables in either subset exceeded the critical point 10 and were low (see Table A1). The multinomial logit model could be run properly.

3.1. Characteristics of the Sample

The ratio of female and male respondents in the sample (n = 310) was 56%, 43%, respectively, and the majority (29% and 37%) of the respondents belonged to the age groups 31–45 years and 46–60 years. The third most frequent age group was above 60 years. This
structure represents the age structure of the rural settlements visited in the course of the survey. The highest share of people in the sample live in the central settlement (20%) of the microregion, moderate ratios (10; 14; 18%) were only in case of three further settlements, most settlements (6 out of 10) were represented in the sample with an individual a share lower than 10%. Most people of the sample have lived in the area for more than 10 years (82%) out of this category, 62% has been settled for more than 20 years. One third of the sample obtained a vocational school degree and the other third a high school degree. Both higher education degree and primary education represent 16–16% of the sample size. More than half of the people asked are employed or self-employed, another 20% is pensioners, some of them still in school (5%) or at home with children (3%), while than unemployed or public employed ratio exceeds 10% in the sample. Almost all respondents (93%) reported their engagement with plant or crop production, while around half of them (57%) keep livestock too. Appendix B contains detailed information about the sample characteristics and the specific variables too.

Based on the survey results 42% of the respondents were uncertain (MAYBE) about supporting a biogas plant (35% YES, 20% NO). (Comparably, a polish study determined [36] 56% of the respondents were supportive of biomass power plant construction.) According to the model results, we define the characteristics of each group.

3.2. Personal Profiles

The results of the multinomial logistic regression of seven personal variables are demonstrated in Table 1.

| Personal Factors        | Coefficients | RRR | Dependent Variable: | Dependent Variable: | Std. Error | z Value | Pr (>|z|) |
|-------------------------|--------------|-----|---------------------|---------------------|------------|---------|---------|
| age [<30]               | –0.560       | –2.126 ** | No                   | Yes                 | 0.571      | 0.283 ** | 0.45410 | −2.307 | 0.0211 * |
| age [>60]               | 0.260        | 0.077  | 1.297               | 1.080               | 0.44174    | 0.286   | 0.7749  |
| education [primary]     | –0.112       | –0.988 ** | No                   | Yes                 | 0.894      | 0.372 ** | 0.38585 | −1.274 | 0.2026  |
| education [university degree] | 0.286       | 0.567  | 1.330               | 0.567               | 0.39466    | 0.578   | 0.5631  |
| gender [male]           | 0.425        | 0.037  | 1.529               | 0.964               | 0.27922    | 0.618   | 0.5366  |
| occupation [dependent]  | –0.538       | 0.011  | 0.584               | 1.101               | 0.41094    | −0.535  | 0.5930  |
| occupation [non-active, homestay] | –0.907       | −0.662 | 0.404               | 0.516               | 0.42773    | −1.777  | 0.0756  |
| residence [middle]      | –1.095 **    | –0.125 | 0.334 **            | 0.882               | 0.33068    | −1.504  | 0.1327  |
| residence [west]        | 0.090        | –0.263 | 1.094               | 0.769               | 0.33842    | −0.239  | 0.8112  |
| trust.to.major [no]     | 2.804 ***    | –0.062 | 16.510 ***          | 0.940               | 0.51946    | 4.319   | 1.56 × 10−5 *** |
| trust.to.major [yes]    | 0.518        | 2.904 ** | 1.678               | 18.241 ***          | 0.30316    | 7.058   | 1.69 × 10−12 *** |
| years.of.living [>10]   | 0.474        | –0.038 | 1.606               | 0.963               | 0.39315    | 0.254   | 0.8147  |
| Constant                | –1.471 **    | −0.971 * | 0.230 **            | 0.379 *             | –          | –       | –       |
| Akaike Inf. Crit.       | 514.320      | 514.320 | 514.320             | 514.320             | –          | –       | –       |

Note: * p < 0.1; ** p < 0.05; *** p < 0.01; Log likelihood = −231.1598; Pseudo R2 = 0.2705480.

The results in Table 1 presents the likelihood to choose ‘YES’ for acceptance of biogas plant (result variable) (compared to MAYBE) if the respondent’s answer on the personal question is YES or NO (compared to MAYBE). Detailed explanations for only significant results are supported by figures too: Figures 2–5.

Considering the significance level (MLR: p-value), parameters with high effect on the dependent variable were determined. Effect plots (Figures 2–5) provide a graphical visualization of the significant components of Table 1.

According to the output of the applied multinomial logistic regression model, acceptance is significantly influenced by the following personal variables:

- Age. The likelihood to choose acceptance category YES decreases by 0.28 times (the risk or odds is 72% lower) in comparison to category MAYBE, if respondent’s age group is [<30] (p < 0.05). Figure 2 shows the age effect on probability of acceptance.
The group of respondents committed to YES acceptance group is characterized by age [30–60], while NO acceptance group by age [>60]. The respondents in ‘convincible’ acceptance group (MAYBE) is characterized by age [<30].

![Age effect plot](image-url)

**Figure 2.** Age effect plot (stacked areas).

Education. The likelihood to choose acceptance category YES decreases by 0.37 times (the risk or odds is 63% lower) in comparison to category MAYBE, if respondent’s education group is PRIMARY ($p < 0.05$). Figure 3 shows the education effect on the probability of acceptance.

The group of respondents committed to YES acceptance group is characterized by education category High School, while in group NO by University Degree. The respondents in the ‘convincible’ acceptance group is characterized by the category Primary.

![Education effect plot](image-url)

**Figure 3.** Education effect plot (stacked areas).

Residence. The likelihood to choose acceptance category NO decreases by 0.33 times (the risk or odds is 67% lower) in comparison to category MAYBE, if respondent’s residence group is MIDDLE ($p < 0.05$). Figure 4 shows the residence effect on the probability of acceptance.

The group of respondents committed to YES acceptance group is characterized by residence place EAST (i.e., settlements on the eastern part of the microregion). The respondents in group NO live either in the western part (WEST) or the eastern settlements (EAST). The MIDDLE settlements’ inhabitants are less sure (more of them belong to MAYBE group).
Residence. The likelihood to choose acceptance category NO decreases by 0.33 times (the risk or odds is 67% lower) in comparison to category MAYBE, if respondent’s residence group is MIDDLE ($p < 0.05$). Figure 4 shows the residence effect on the probability of acceptance.

The group of respondents committed to YES acceptance group is characterized by residence place EAST (i.e., settlements on the eastern part of the microregion). The respondents in group NO live either in the western part (WEST) or the eastern settlements (EAST). The MIDDLE settlements’ inhabitants are less sure (more of them belong to MAYBE group).

Figure 4. Residence effect plot.

Trust. The likelihood to choose acceptance category YES increases by 18.24 times (the risk or odds is 1724% higher) in comparison to category MAYBE, if respondent’s trust.to.mayor variable takes group YES ($p < 0.01$). The likelihood to choose acceptance category NO increases by 16.51 times (the risk or odds is 1651% higher) in comparison to category MAYBE, if respondent’s trust.to.mayor variable takes group NO ($p < 0.01$). Figure 5 shows the trust effect on the probability of acceptance.

The most obvious differences between the acceptance groups can be seen in case of Trust. The respondents committed to YES acceptance group are characterized by YES category of the variable trust.to.mayor. In the group of NO trust, the high probability is seen for the support of biogas (YES group of outcome variable).

Figure 5. Trust in mayor’s decision.

Based on the membership (Table 1) in predicted acceptance groups, the personal characteristics of inhabitants can be defined according to Table 2.

According to the results, MAYBE group is younger, has up to 10 years of residence, basically primary educated, who are not sure about their trust in local authorities. The NO group is elderly, they live on the western part of the microregion, typically diploma holders, and have critical opinions on local authorities.
Table 2. Personal profiles of the different acceptance groups.

| Personal Factors | Acceptance Group |
|------------------|------------------|
|                  | YES              | NO              | MAYBE (Convincible) |
| gender           | FEMALE           | MALE            | FEMALE             |
| age *            | [30–60]          | >60             | <30               |
| residence *      | EAST             | WEST            | MIDDLE            |
| years.of.living *| [<10]            | >10             | [<10]             |
| education *      | HIGH SCHOOL      | UNIVERSITY DEGREE | PRIMARY |
| occupation       | ACTIVE           | DEPENDENT       | NONACTIVE, HOMESTAY |
| trust.to.mayor * | YES              | NO              | MAYBE             |

*p significance (p ≤ 0.1) The p-values are presenting the significance level of the effect of the categorical variables in the multinomial logistic regression model.

3.3. Specific Profiles

The results of the multinomial logistic regression of six specific variables are demonstrated in Table 3.

The results in Table 3 present the likelihood to choose ‘YES’ for acceptance of biogas plant (result variable) (compared to MAYBE) if the respondent’s answer on the specific question is YES or NO (compared to MAYBE). Detailed explanations for only significant results are supported by figures too: Figures 6–10.

Considering the significance level (MLR: *p*-value), parameters with high effect on the dependent variable were determined. Effect plots (Figures 6–10) provide a graphical visualization of the significant components of Table 3.

Table 3. Multinomial logistic regression model for the “specific factors”.

| Specific Factors                  | Coefficients | RRR | Std. Error | z Value | Pr (>|z|) |
|----------------------------------|--------------|-----|------------|---------|-------|
|                                  | Dependent Variable: | Dependent Variable: |            |         |       |
|                                  | No           | Yes | No         | Yes     |       |       |
| biomass.knowledge [yes]         | −0.177       | 0.554 * | 0.838      | 1.741 * | 0.28287 | 0.826 | 0.40883 |
| climate.change.knowledge [yes]  | −0.940 *     | 0.009 | 0.391 *    | 1.009   | 0.53796 | −1.205 | 0.22834 |
| energy.crops.knowledge [yes]    | 0.130        | 1.222 *** | 1.139      | 3.393 *** | 0.28136 | 2.768 | 0.00563 ** |
| own.animals                    | 0.297        | −0.125 | 1.346      | 0.882   | 0.25778 | 0.136 | 0.89217 |
| own.plant [yes]                | 0.151        | 0.872 ** | 1.163      | 2.393 ** | 0.31974 | 1.623 | 0.10468 |
| willingness.to.collect [yes]    | 0.517        | 1.079 *** | 1.678      | 2.943 *** | 0.28237 | 2.912 | 0.00359 ** |
| Constant                        | −0.587       | −2.826 *** | 0.556      | 0.059 *** | –      | –     | –      |
| Akaike Inf. Crit.              | 600.270      | 600.270 | 600.270    | 600.270 | –      | –     | –      |

Note: * p < 0.1; ** p < 0.05; *** p < 0.01; Log likelihood = −286.1351; Pseudo R2 = 0.09706682.

According to the applied multinomial regression model, acceptance is significantly influenced by the following specific variables:

Biomass.knowledge. The likelihood to choose acceptance category YES increases by 1.74 times (the risk or odds is 74% higher) in comparison to category MAYBE, if respondent’s biomass.knowledge is YES (p < 0.1). Figure 6 shows the biomass.knowledge effect on the probability of acceptance.

The probability of belonging to YES acceptance group is higher in case of reported knowledge of biomass. There is a slightly higher chance to belong to NO acceptance group if the respondent reported NO knowledge on biomass. The convincible group of respondents either support (YES) or deny (NO) biogas plant establishment (acceptance groups).
Figure 6. Biomass knowledge effect plot (lines with confidence bands).

Climate.change.knowledge. The likelihood to choose acceptance category NO decreases by 0.39 times (the risk or odds is 61% lower) in comparison to category MAYBE, if respondent’s climate.change.knowledge is YES ($p < 0.1$). Figure 7 shows the biomass.knowledge effect on the probability of acceptance.

In case of respondents reporting NO knowledge on climate change the range of probability of belonging to the NO acceptance group is very large. Those, however, reported that their knowledge on climate change more definitely belongs to the YES acceptance category and less belongs to the NO acceptance group. The probability of belonging to convincible group is still higher if they reported climate change knowledge.

Figure 7. Climate change knowledge effect plot (lines with confidence bands).

Energy.crops.knowledge. The likelihood to choose acceptance category YES increases by 3.39 times (the risk or odds is 239% higher) in comparison to category MAYBE, if respondent’s energy.crops.knowledge is YES ($p < 0.01$). Figure 8 shows the energy.crops.knowledge effect on the probability of acceptance.

A similar pattern for the knowledge of energy crops is seen to knowledge of biomass. Yes acceptance group membership has higher probability if the respondent knows energy crops and lower if not. In the group of convincible people, NO knowledge on energy crops has a higher probability.
if respondent’s energy.crops.knowledge is YES (\( p < 0.01 \)). Figure 8 shows the energy.crops.knowledge effect on the probability of acceptance.

A similar pattern for the knowledge of energy crops is seen to knowledge of biomass. Yes acceptance group membership has higher probability if the respondent knows energy crops and lower if not. In the group of convincible people, NO knowledge on energy crops has a higher probability.

Figure 8. Energy crops knowledge effect plot (lines with confidence bands).

Own.plant. The likelihood to choose acceptance category YES increases by 2.39 times (the risk or odds is 139% higher) in comparison to category MAYBE, if respondent’s own.plant is YES (\( p < 0.05 \)). Figure 9 shows the own.plant effect on the probability of acceptance.

In acceptance group YES, the probability is higher if respondent has crops or plants, and opposite tendency is seen in the group of convincible people (MAYBE acceptance group).

Willingness.to.collect. The likelihood to choose acceptance category YES increases by 2.94 times (the risk or odds is 194% higher) in comparison to category MAYBE, if respondent’s willingness.to.collect is YES (\( p < 0.01 \)). Figure 10 shows the willingness.to.collect effect on the probability of acceptance.

In acceptance group YES, the probability is higher if respondent’s reported willingness to collect biomass, and the opposite tendency is seen in the group of convincible people (MAYBE acceptance group).

Figure 9. Own plant effect plot (lines with confidence bands).
Based on the membership (Table 3) in predicted acceptance groups, the specific characteristics of inhabitants can be defined according to Table 4.

Table 4. Specific profiles of the different acceptance groups.

| Specific Factors            | YES | NO | MAYBE (Convincible) |
|----------------------------|-----|----|---------------------|
| own.plant *                | YES | NO | NO                  |
| own.animal                 | NO  | YES| NO                  |
| biomass.knowledge *        | YES | NO | NO                  |
| willingness.to.collect *   | YES | YES| NO                  |
| energy.crops.knowledge *   | YES | NO | NO                  |
| climate.change.knowledge * | YES | NO | YES                 |

* significance ($p \leq 0.1$) The $p$-values are presenting the significance level of the effect of categorical variables in the multinomial logistic regression model.

According to the results, MAYBE group is aware of climate change threats, but they do not have an active knowledge on, nor take part in, biomass production. The absolute supportive YES group is inhabitants with a good understanding of biomass and climate change challenges and think of themselves as active participants in the biobased economy.

4. Discussion

The highest effect was indicated in case of the trust.to.mayor variable. The likelihood to accept a power plant increases by 18 times if a respondent is willing to support the local mayor’s decision (Table 1). Although it has not been yet analyzed (neither in current research nor by other authors according to our knowledge), the reason behind it can be explained by the loyalty of rural population to the local authorities on the one hand and by a reluctance to take self-responsibility for the decision making on the other hand.

We found that knowledge of biomass and knowledge on energy crops correlate with the supportive personality features towards biogas plant establishment. However, the evidence of such knowledge is moderate [20]. It was also found earlier that environmental protection aspects proved to be the most relevant in relation to the use of RES which corresponds with our findings on the significance of climate change issues.

Although an increase in educational level may not necessarily increase acceptance of energy applications [11], regarding the sociodemographic variables, in Liebe and Dobers’s research [37], the trend was found that higher educated people demonstrate higher acceptance towards renewable energy that supports our own findings. There are three different types of individuals in the population from the Collective Action point of view: “free riders”, unconditional cooperators, and conditional cooperators [38–40]. “Free riders” are people who...
contribute nothing, do not accept renewable energy power plants in their vicinity, biogas power plant in a rural area in our context (acceptance group NO), but benefit from the provision of the goods, consume electricity from biogas, and receive lower emissions, for instance. Unconditional cooperation implies the cooperation of individuals making decisions regarding public goods independently of third parties’ expectations and actions (biogas power plant acceptance group YES). In counter to that, conditional cooperation means the contribution of individuals to a specific public good, in our case biogas power plant considered as a public good, is merely occurring if they are convinced that others are also doing so (convincible acceptance group MAYBE). In the context of renewable energy, conditional cooperation means that individuals only support new sites if they believe others are doing the same. Conditional cooperation leads to less acceptance of renewable energy. In the context of the target population group (convincible acceptance group MAYBE in our case) negative preconceptions and skepticism are among the most challenging factors of such education process [8].

According to the results of the regression model of Liebe and Dobers [37], climate change concern has a positive effect on the acceptance of wind power plants and solar fields but not on the acceptance of biogas plants, in contradiction to our own results, where climate.change.knowledge has a statistically significant positive influence on the acceptance. This discrepancy might be caused due to the inequality of the examined expressions of climate change concern and climate.change.knowledge, although these are similar by their terms.

A similar survey methodology was applied in Poland in peripheral regions [4]. The authors also concluded public acceptance as a major factor influencing local utilization of renewable energy. In accordance with the quantitative methodology we applied, they admitted that investigation of the relationship between the specific factors and attitudes is a necessity to facilitate the educating process about RE.

5. Conclusions

Awareness of, and partaking in, bioeconomy and trust in local authorities proved to be significant factors when considering a biomass-based complex development strategy and its support by local people. Although or findings are limited to specific conditions of the given rural microregion, many of them were supported by similar research from both in Hungary and Europe. We wanted to discover specific factors determining the social acceptance of the analyzed microregion’s complex development strategy especially its concerns on renewable energy utilization. We defined three ‘acceptance’ groups by having applied a multinomial regression model.

It can be assumed that the inner structure of the microregion analyzed has a definite impact on how people feel about their engagement in the local area; but more importantly, it was recovered that the younger generation is the key population group that can be convinced about bioeconomy benefits. A positive result was to see they are already aware of climate change issues. Obviously limited by their conditions of living, but local people think themselves active participants of climate change fight and understand potentials of biomass as they reported their household residuals as bioresources.

Local decision makers have the solid base of trust which is not without understanding the options bioeconomy offers for rural communities. Formal and nonformal education and inclusion of the young generation is certainly a way for strengthening this community and implementing their complex, biobased development strategy.

Limitations of the survey was the spectrum of the socioeconomic characteristics we included; therefore, further questions to be asked related to our model are whether an extended factor list (family size and income, housing circumstances of household, monthly utility bills, etc.) would improve the model. Given the chosen — specific — area we targeted for the research, also the findings cannot be generalized (e.g., at country level) but the methodology can be applied in further similar cases.
Further policy implications of the proposed methodology could be socioenvironmental systems (SES) modeling [41–44] to address complex and strategic issues of energy and climate change in a function of rural development at the local level. In rural development policy and planning, especially to reveal community preferences, AHP can have a crucial role [45]. The modeling process of SES contains wide discussion platforming among the stakeholders, possible scenarios and opportunities determination, which give place to priority based decision making. Thus, thorough policy and strategy formulation to accelerate the mechanism of public awareness and education to environmental challenges can be achieved.

**Author Contributions:** Conceptualization, A.T.; Methodology, G.K.; Supervision, G.G.; writing—original draft, B.H.K.; writing—review and editing, K.T. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by European Union and the European Social Fund EFOP-3.6.2-16-2017-00018 “Let’s produce together with nature—Agroforestry as a new breakthrough opportunity”; Article publishing charge was covered EFOP-3.6.1-16-2016-00007 “Intelligent specialization programme at Kaposvar University” research projects to provide opportunities for the data collection and analysis support.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy concerns.

**Acknowledgments:** The authors are thankful to mayors of the settlements and the management and colleagues of the Vox Vallis Association.

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

**Appendix A**

**Table A1.** Independent variables subset 1 “personal factors”.

| Variable        | Description of the Variable | Groups of Categorical Variable                          |
|-----------------|------------------------------|--------------------------------------------------------|
| gender          | Respondent’s gender          | MALE; FEMALE                                           |
| age             | Respondent’s age             | [<30]; [30–60]; [>60]                                   |
| residence       | Respondent’s place of residence | WEST; EAST; MIDDLE                                      |
| years.of.living | The number of years of living at the local residence | [<10]; [>10]                                           |
| education       | “Primary” (finished primary school at least), “high school” (obtained high school diploma), “university degree” (obtained higher education diploma) | PRIMARY; HIGH SCHOOL; UNIVERSITY DEGREE                   |
| occupation      | Respondent’s occupation type | ACTIVE; NONACTIVE, HOMESTAY; DEPENDENT                     |
| trust.to.mayor  | Respondent’s willingness to support local mayor’s decision to install biogas power plant at the local residence place | YES; NO; MAYBE                                          |
Table A2. Independent variables subset 2 “specific factors”.

| Variable         | Description of the Variable                                                                 | Groups of Categorical Variable |
|------------------|---------------------------------------------------------------------------------------------|--------------------------------|
| own.plant        | Existence of respondent’s own or rented land with plant origin on it (at least one of these: orchard, vineyard, forest, vegetable beds, grassland, cropland) | YES; NO                        |
| own.animal       | Existence of respondent’s own or rented livestock animals (at least one of these: cattle, pig, poultry, sheep, horse, rabbit) | YES; NO                        |
| biomass.knowledge | Stated knowledge of respondent about the term “biomass”                                    | YES; NO                        |
| willingness.to.collect | Stated respondent’s willingness to collect plant residues at the local residence place in order to feed proposed biogas power plant | YES; NO                        |
| energy.crops.knowledge | Stated knowledge of respondent about the term “energy crops”                          | YES; NO                        |
| climate.change.knowledge | Stated knowledge of respondent about the term “climate change”                      | YES; NO                        |

Appendix B. Categories of Explanatory Variables and Distribution of Respondents

| Category | Q 8. Have You Heard about Climate Change Before? % (n) |
|----------|------------------------------------------------------|
| 0        | 5% (17)                                              |
| 1        | 93% (287)                                            |
| n.a.     | 2% (6)                                               |
| Total    | 100% (310)                                           |

| Category | Q 18. Do You Know What Biomass Is? % (n) |
|----------|----------------------------------------|
| 0        | 38% (117)                               |
| 1        | 60% (184)                               |
| n.a.     | 2% (8)                                  |
| Total    | 100% (309)                              |

| Category | Q 26. Would You Like to Have a Biogas Plant Installed in Your Microregion? % (n) |
|----------|------------------------------------------------------------------------------|
| n.a.     | 4% (11)                                                                      |
| 0—NO     | 19% (58)                                                                     |
| 1—YES    | 34% (106)                                                                    |
| 2—MAYBE  | 43% (133)                                                                    |
| Total    | 100% (308)                                                                   |

| Category | Q17. Would You Pay for Green Energy? (Agreement: 1 Least–5 Most) % (n) |
|----------|------------------------------------------------------------------------|
| 1        | 15% (42)                                                               |
| 2        | 15% (48)                                                               |
| 3        | 35% (110)                                                              |
| 4        | 15% (48)                                                               |
| 5        | 13% (40)                                                               |
| n.a.     | 7% (22)                                                                |
| Total    | 100% (310)                                                             |
| mean     | 2.98                                                                   |
| median   | 3                                                                       |
| mode     | 3                                                                       |
| st. dev. | 1.22                                                                   |
| Category | Q 29. Do You Know the Term Energy Crops? % (n) |
|----------|-----------------------------------------------|
| 0—NO     | 44% (136)                                     |
| 1—YES    | 54% (168)                                     |
| n.a.     | 2% (6)                                        |
| Total    | 100% (310)                                    |

| Category | Q 32. If the Mayor of Your Village Decides to Build a Biogas Plant, Would it Support Your Decision? % (n) |
|----------|-----------------------------------------------------------------------------------------------------|
| 0—NO     | 9% (29)                                                                                           |
| 1—YES    | 41% (127)                                                                                         |
| 2—MAYBE  | 42% (129)                                                                                         |
| n.a.     | 8% (25)                                                                                           |
| Total    | 100% (310)                                                                                       |

| Category | Gender % (n) | Gender % (n) |
|----------|--------------|--------------|
| 1—male   | 43% (134)    |              |
| 2—female | 56% (173)    |              |
| n.a.     | 1% (3)       |              |
| Total    | 100% (310)   |              |

| Category | Age % (n) | Age % (n) |
|----------|-----------|-----------|
| <18      | 1% (4)    |           |
| 19–30    | 11% (34)  |           |
| 31–45    | 29% (89)  |           |
| 46–60    | 37% (114) |           |
| >60      | 21% (64)  |           |
| n.a.     | 1% (5)    |           |
| Total    | 100% (310) |           |

| Category | Settlement % (n) | Settlement % (n) |
|----------|------------------|------------------|
| Törökkoppány | 20% (63)         |                 |
| Fiad      | 8% (24)          |                 |
| Kisdárapáti | 14% (42)         |                 |
| Bonnya    | 5% (16)          |                 |
| Somogyacsa | 9% (27)          |                 |
| Somogydöröcske | 7% (23)     |                 |
| Szorosad  | 5% (16)          |                 |
| Kara      | 1% (3)           |                 |
| Miklósi   | 10% (32)         |                 |
| Koppányszántó | 18% (55)      |                 |
| n.a.     | 3% (9)           |                 |
| Total    | 100% (310)       |                 |

| Category | Living Years % (n) | Living Years % (n) |
|----------|--------------------|--------------------|
| 1–5      | 6% (19)            |                   |
| 6–10     | 9% (28)            |                   |
| 11–20    | 20% (63)           |                   |
| >20      | 62% (191)          |                   |
| n.a.     | 3% (9)             |                   |
| Total    | 100% (310)         |                   |
### Table A3. Variance-inflation factors for the independent variables subset 1 “personal factors”.

| Personal Factors | VIF  |
|------------------|------|
| age              | 2.109581 |
| education        | 1.290215 |
| gender           | 1.040686 |
| occupation       | 2.058305 |
| residence        | 1.129471 |
| trust.to.mayor   | 1.164983 |
| years.of.living  | 1.124966 |

Note: *p < 0.1.

### Table A4. Variance-inflation factors for the independent variables’ subset 2 “specific factors”.

| Specific Factors            | VIF  |
|-----------------------------|------|
| biomass.knowledge           | 1.300715 |
| climate.change.knowledge    | 1.070524 |
| energy.crops.knowledge      | 1.333261 |
| own.animal *                | 1.106201 |
| own.plant                   | 1.088000 |
| willingness.to.collect      | 1.050231 |
| biomass.knowledge           | 1.300715 |

Note: *p < 0.1.
References

1. European Commission. A Clean Planet for All. A European Strategic Long-Term Vision for a Prosperous, Modern, Competitive and Climate Neutral Economy; European Commission: Brussels, Belgium, 2018.

2. Ministry for Innovation and Technology Hungary. National Energy and Climate Plan; Ministry for Innovation and Technology Hungary: Budapest, Hungary, 2020. (In Hungarian)

3. Pehlklen, A.; Wulf, K.; Grecksch, K.; Klenke, T.; Tsydenova, N. More Sustainable Bioenergy by Making Use of Regional Alternative Biomass? Sustainability 2020, 12, 7849. [CrossRef]

4. Kaya, O.; Florkowski, W.J.; Us, A.; Klepaca, A.M. Renewable Energy Perception by Rural Residents of a Peripheral EU Region. Sustainability 2019, 11, 2075. [CrossRef]

5. Göttinger, A.; Ladu, L.; Quitzow, R. Studying the Transition towards a Circular Bioeconomy—Systematic Literature Review on Transition Studies and Existing Barriers. Sustainability 2020, 12, 8990. [CrossRef]

6. Berényi, L.; Birkner, Z.; Deutsch, N. A Multidimensional Evaluation of Renewable and Nuclear Energy among Higher Education Students. Sustainability 2020, 12, 1449. [CrossRef]

7. Van Rijnsoever, F.J.; Van Mossel, A.; Broecks, K.P. Public acceptance of energy technologies: The effects of labeling, time, and heterogeneity in a discrete choice experiment. Renew. Sustain. Energy Rev. 2015, 45, 817–829. [CrossRef]

8. Rosso-Cérón, A.M.; Kafarov, V. Barriers to social acceptance of renewable energy systems in Colombia. Curr. Opin. Chem. Eng. 2015, 10, 103–110. [CrossRef]

9. Liu, B.; Zhang, L. A Survey of Opinion Mining and Sentiment Analysis. In Mining Text Data; Aggarwal, C., Zhai, C., Eds.; Springer: Boston, MA, USA, 2012. [CrossRef]

10. Terwel, B.W.; Harinck, F.; Ellemers, N.; Daamen, D.D. Going beyond the properties of CO₂ capture and storage (CCS) technology: How trust in stakeholders affects public acceptance of CCS. Int. J. Greenh. Gas Control 2011, 5, 181–188. [CrossRef]

11. Dütschke, E. What drives local public acceptance—Comparing two cases from Germany. Energy Procedia 2011, 4, 6234–6240. [CrossRef]

12. Fouché, E.; Brent, A. Explore, design and act for sustainability: A participatory planning approach for local energy sustainability. Sustainability 2020, 12, 862. [CrossRef]

13. Segreto, M.; Principe, L.; Desormeaux, A.; Torre, M.; Tomassetti, L.; Tratzi, P.; Paolini, V.; Petracchini, F. Trends in social acceptance of renewable energy across Europe—A literature review. Int. J. Environ. Res. Public Health 2020, 17, 9161. [CrossRef] [PubMed]

14. Kardooni, R.; Yusoff, S.B.; Kari, F.B. Renewable energy technology acceptance in Peninsular Malaysia. Energy Policy 2016, 88, 1–10. [CrossRef]

15. Bauwens, T.; Devine-Wright, P. Positive energies? An empirical study of community energy participation and attitudes to renewable energy. Energy Policy 2018, 136, 612–625. [CrossRef]

16. Shahzalal, M.; Hassan, A. Communicating sustainability: Using community media to influence rural people’s intention to adopt sustainable behaviour. Sustainability 2019, 11, 812. [CrossRef]

17. van der Waal, E.C.; van der Windt, H.J.; van Oost, E.C.J. How local energy initiatives develop technological innovations: Growing an actor network. Sustainability 2018, 10, 4577. [CrossRef]

18. Gutiérrez-Pedrero, M.J.; Ruiz-Fuensanta, M.J.; Tarancón, M.Á. Regional factors driving the deployment of wind energy in Spain. Energies 2020, 13, 3590. [CrossRef]

19. Giuliani, A.; Gioiella, F.; Sofia, D.; Lotrechtiano, N. A novel methodology and technology to promote the social acceptance of biomass power plants avoiding nimbysm syndrome. Chem. Eng. Trans. 2018, 67, 307–312. [CrossRef]

20. Bujsdos, Z.; Patkós, C.; Kovács, T.; Radics, Z. Theoretical approach of a possible value-added chain in the biomass industry in rural areas giving the example of a Hungarian Microregion. Int. J. Agric. Manag. Dev. (IJAMAD) 2013, 3, 65–71.

21. Western, J.M.; Cheng, A.S.; Anderson, N.M.; Motley, P. Examining the social acceptability of forest biomass harvesting and utilization from collaborative forest landscape restoration: A case study from western Colorado, USA. J. For. 2017, 115, 530–539. [CrossRef]

22. Németh, K.; Birkner, Z.; Katona, A.; Göllény-Kovács, N.; Bái, A.; Balogh, P.; Gabinai, Z.; Péter, E. Can Energy be a “Local Product” Again? Hungarian Case Study. Sustainability 2020, 12, 1118. [CrossRef]

23. Bái, A.; Durkó, E.; Tar, K.; Tóth, J.B.; Lázár, I.; Kapocska, L.; Kircsi, A.; Bartók, B.; Vass, R.; Pénzes, J.; et al. Social and economic possibilities for the energy utilization of fitomass in the valley of the river Hernád. Renew. Energy 2016, 85, 777–789. [CrossRef]

24. Kulisić, B.; Radić, T.; Njavor, M. Agro-Pruning for Energy as a Link between Rural Development and Clean Energy Policies. Sustainability 2020, 12, 4240. [CrossRef]

25. Muradin, M.; Foltynowicz, Z. Potential for Producing Biogas from Agricultural Waste in Rural Plants in Poland. Sustainability 2014, 6, 5065–5074. [CrossRef]

26. Filiano, P.; Gurnari, L. A Field Experiment on Wave Forces on an Energy-Absorbing Breakwater. Energies 2020, 13, 1563. [CrossRef]

27. Soltero, V.M.; Chacartegui, R.; Ortiz, C.; Lizana, J.; Quirosa, G. Biomass District Heating Systems Based on Agriculture Residues. Appl. Sci. 2018, 8, 476. [CrossRef]

28. Makki, A.A.; Mosly, I. Factors Affecting Public Willingness to Adopt Renewable Energy Technologies: An Exploratory Analysis. Sustainability 2020, 12, 845. [CrossRef]
29. Filep-Kovács, K.; Sallay, Á.; Mikházi, Z.; Jombach, S.; Szilvácska, Z.; Valánszki, I.; Gelencsér, G. Green infrastructure in rural development, case study in Hungary. In Proceedings of the Fábián Conference on Landscape and Greenway Planning, Budapest, Hungary, 30 June–1 July 2016; Volume 5, p. 42.

30. Government Decree on the Classification of Beneficiary Districts. Available online: https://net.jogtar.hu/ (accessed on 6 December 2020). (In Hungarian)

31. Weiperth, A. Faunistic (Aquatic Macroinvertebrates, Fish and Herpetology) and Water Quality Monitoring Studies in the Köppányölgyi Habitat Rehabilitation Experimental Area; Research Report; HSA Ecological Research Centre: Budapest, Hungary, 2018; p. 53. Available online: https://koppanyolgy.files.wordpress.com/2018/06/weiperth-andrc3a1s_kutatc3a1si-jelentc3a9s_zc3b6id-forrc3a1s-program_ptkf-657-2017.pdf (accessed on 16 March 2019). (In Hungarian)

32. Mezei, C.; Horváthné Kovács, B.; Barna, R.; Csonka, A.; Szabol, K.; Nagy, M.; Csizmadia, A.; Topić, D.; Šljivac, D.; Gelencsér, G. Economic and ecological factors of territorial capital in Köppany Valley micro region. In Socio-Economic, Environmental and Regional Aspects of a Circular Economy, Proceedings of the 2018 International Conference for the 75th Anniversary of DTI, Pécs, Hungary, 19–20 April 2018; MTA KRTK RKI Transdanubian Research Department: Pécs, Hungary, 2018; p. 53.

33. Titov, A.; Szabó, K.; Horváthné Kovács, B. Social and Natural Opportunities for the Renewable Energy Utilization in the Köppany Valley Development Area. In MİC 2018: Managing Global Diversities; Proceedings of the Joint International Conference, Bled, Slovenia, 30 May–2 June 2018; University of Primorska Press: Koper, Izola, 2018.

34. Haan, P.; Uhlenendorf, A. Estimation of multinomial logit models with unobserved heterogeneity using maximum simulated likelihood. *Stata J.* 2006, 6, 229–245. [CrossRef]

35. Garson, G.D. Fundamentals of Hierarchical Linear and Multilevel Modelling. Hierarchical Linear Modelling: Guide and Applications. 2013, pp. 3–25. Available online: https://searchworks.stanford.edu/view/9656489 (accessed on 26 March 2019).

36. Liebe, U.; Dobers, G.M. Measurement of Fairness Perceptions in Energy Transition Research: A Factorial Survey Approach. *Sustainability* 2020, 12, 8084. [CrossRef]

37. Liebe, U.; Dobers, G.M. Decomposing public support for energy policy: What drives acceptance of and intentions to protest against renewable energy expansion in Germany? *Energy Res. Soc. Sci.* 2019, 47, 247–260. [CrossRef]

38. Fischbacher, U.; Gächter, S.; Fehr, E. Are people conditionally cooperative? Evidence from a public goods experiment. *Econ. Lett.* 2001, 71, 397–404. [CrossRef]

39. Gächter, S.; Johnson, E.J.; Herrmann, A. Individual-Level Loss Aversion in Riskless and Risky Choices; Discussion Paper; IZA: Bonn, Germany, 2007.

40. Ostrom, E. Collective action and the evolution of social norms. *J. Econ. Perspect.* 2000, 14, 137–158. [CrossRef]

41. Rodriguez, M.; Sanchez, L.M.; Cejudo, E.; Camacho, J.A. Variety in local development strategies and employment: LEADER programme in Andalusia. *Agric. Econ.* 2019, 65, 43–50. [CrossRef]

42. Elsawah, S.; Hamilton, S.; Jakeman, T.; Rothman, D.; Schweizer, V.; Trutnevyte, E.; Carlsen, H.; Drakes, C.; Frame, B.; Fu, B.; et al. Scenario processes for socio-environmental systems analysis of futures: A review of recent efforts and a salient research agenda for supporting decision making. *Sci. Total Environ.* 2020, 729, 138393. [CrossRef] [PubMed]

43. Nikas, A.; Gambhir, A.; Trutnevyte, E.; Koasidis, K.; Lund, H.; Thellufsen, J.Z.; Mayer, D.; Zachmann, G.; Miguel, L.J.; Ferreras-Alonso, N.; et al. Perspective of comprehensive and comprehensible multi-model energy and climate science in Europe. *Energy* 2020, 215, 119153. [CrossRef]

44. Oddsreshed, A.; Arias, A.; Cancino, H. Rural development decision support using the Analytic Hierarchy Process. *Math. Comput. Model.* 2007, 46, 1107–1114. [CrossRef]