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ACCEPTANCE AND POTENTIAL OF RENEWABLE ENERGY SOURCES BASED ON BIOMASS IN RURAL AREAS OF HUNGARY

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List of abbreviations

BAT – Best Available Techniques

CO^2 – Carbon dioxide

EE – Energy Efficiency

EU – European Union

GJ – Gigajoule

HIPA – Hungarian Investment Promotion Agency

HCSO – Hungarian Central Statistical Office

IREF – Integrated Renewable Energy Farm

MW – Megawatt

NIMBY – "Not In My Back Yard" phenomenon

pcs – Pieces

R&D – Research and Development

RE – Renewable Energy

RES – Renewable Energy Sources

RRR – Relative Risk Ratios

RuRes – "Renewable energy sources in a function of a rural development" project

TSO – Transmission System Operator

1. Introduction

The processes of climate change occurring worldwide nowadays motivate countries to set up special measures regarding environmental protection policy and Sustainable Energy Development Strategies. In context of EU there is the initiative of EU 2020 Climate and Energy Package which includes three main target components: greenhouse gas emission reduction (20% comparing to 1990), renewable energy sources (RES) usage rise (20% from all EU energy) and energy efficiency (EE) improvement by 20% (da Graça Carvalho, 2012). Promotion of RES and EE incentives are among the main strategic components for fulfilment of the National emission reduction targets. This covers such sectors as housing, agriculture, waste and transport. According to European Commission and following the new urban-rural typology of the regions: 66,1% of land in Hungary is predominantly rural; 47,9% of population in Hungary live in predominantly rural areas (Eurostat, JRC, EFGS, REGIO-GIS). Thus, the focus on rural area is required for the national achievement of the EU 2020 Climate and Energy goals. The expected benefits of the 2020 package and the National targets implementation include socio-economic development, stabilization of heating and power system, fossil fuels consumption decrease. Furthermore, energy is directly related to the most critical social issues that affect sustainable development: poverty, jobs, income levels, access to social services, gender disparity, population growth, agricultural production, climate change and environment quality, and economic and security issues (El Bassam, 2001). For the future decades Hungary must face severe challenges in electricity supply on the national level in a secure, economically proven, and environmentally friendly way. Currently the renewable energy supply in Hungary is lagging the EU average amount.

The proposed scenarios had been built by the national TSO (Transmission System Operator) are strongly dependent on non-domestic, foreign sources (Kiss et al., 2016). However, the potential enlargement of RE utilisation is conducted under the country's National Renewable Energy Action Plan.

Therefore, the thesis research proposes analysis on the social potential regarding RES and EE in a function of rural development in rural areas of Hungary. The study mainly focuses on RES based on local resources considering biomass, public acceptance and potential of biomass in local communities. Importance of the topic can be explained by general significant targets: reductions of fossil fuels consumption and CO^2 emissions and improvement of waste management in rural areas.

The current research raises the issue of investigation of the potential usage of RES and EE improvement in rural territories of Hungary. There are two main constituents for the 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 of acceptance regarding biomass utilisation in local communities.

The research area is the Koppány Valley located in Somogy county in Hungary. This area was selected taking into consideration the reason of already existing initiatives related to the green local society development run by Vox Vallis Development Association (Filep-Kovács et al., 2016) and supportive "Renewable energy sources in a function of a rural development" (RuRes) project. The plans to establish locally photovoltaic elements and biogas power plant station are among them. Relevance of the current research is to assess social potential of the proposed RES's usage and to investigate awareness of the rural stakeholders towards them. Koppány Valley Nature Park is the development unit consisting of 10 settlements: Fiad, Kisbárapáti, Bonnya, Somogyacsa, Somogydöröcske, Szorosad, Kára, Miklósi, Törökkoppány, Koppányszántó. The lead organisation is Vox Vallis Association in cooperation with members of the self-governments of these settlements. Koppány Valley is in one of the most underdeveloped Hungarian territories considering serious economic, social and infrastructural issues based on 290/2014. (XI. 26.). Despite this fact, there is significant potential regarding the green energy sector if considering essential amount of local raw bio-material production (Mezei et al., 2018). The estimated theoretical potential of biomass in the area is substantial, however, I assumed that 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 very poor and depressive socio-economic and demographic conditions indicated by low incomes of the local population, unemployment, high age rate and inefficient agricultural production (Titov and Kovács, 2018). Although the region has tremendous natural resources reserves provided by environment, under the actual conditions there is no opportunity to utilize it in an efficient, profitable and beneficial way for the local society. It is happening due to the lack of advanced production and energy technologies to be applied, low educated and low skilled human resources, incompetence of the local governmental decision makers (Mezei et al., 2018). Introduction of modern, efficient, and environmentally friendly energy technologies would create new economic prospects for the stakeholders, therefore arise a new breath for the life in the neighborhood.

2. Literature review

2.1 Bioeconomy and rural sustainability

The current study dedicated to the ***bioeconomy*** development field, which is also known as "biobased economy" or "knowledge-based bioeconomy". The sustainable growth of ***bioeconomy*** sector became a seriously considerable issue in the recent decade worldwide. The definition of ***bioeconomy*** comprises several multidirectional aspects such as advanced biotechnologies intended to solve global challenges, biotechnologies in life science either biomass applications to substitute fossil fuels. Biomass-based RES are supposed to provide and to maintain sustainable biomass supply for energy purposes instead of conventional fossil materials utilisation, which induces negative impacts to the environment. Expansion of ***bioeconomy*** is especially pertinent for rural areas, where the largest amount of biomass could be harvested from various farming and other agricultural activities of enterprises and local population. Furthermore, the exploitation of the bioeconomy's potential and possibilities can/could facilitate the solving of common socio-economic problems of the rural areas: low incomes, ageing population, high migration, etc. Besides, it undertakes the change in the way of handling agricultural operations. Instead of conservative and outdated path presupposing active use of chemical fertilisers and intensive tillage, ***bioeconomy*** proposes more organic approach, gentle land treatment and agroforestry technics to be applied. However, it also supposes the switch from arable lands using for plants cultivation to energy crops growing fields. This process causes discussion on the topic of challenge between bioenergy and food resources. Indeed, such land-use change may cause concern regarding negative ecological effects as soil carbon losses, GHG emissions, impacts on biodiversity. Those effects were displayed by replacement of extensively managed grasslands to intensively managed annual crops (Fargione et al., 2008). Thus, the public debate raises the issue of **acceptance** of bioenergy. In the “ideal” visualisation of the ***bioeconomy*** to be implemented, it will consider and combine environmental, social and health segments in the one system (Lewandowski, 2015). In this case, biomass will be used for food, feed and materials as well as for energy purposes (Staffas et al., 2013). The strategy of local development based on orientation to ***bioeconomy*** and to sustainable use of local natural resources is called – in this interpretation – *endogenous local development* (Bosworth et al., 2016).

The main reasons to promote ***bioeconomy*** according to McCormick and Kautto, 2013:

- Depletion of fossil fuels and their negative affects to the environment;
- Fossil fuels contribute to climate change and global warming processes;
- The substitution of fossil fuels by renewable source in case of material use is only possible via biomass (not via wind or solar energy);
- Biomass is widespread and available for rural areas;
- Utilisation of biomass on different stages offers new workplaces, therefore increases revenue opportunities for residents;
- Biomass applications contribute to potential development of innovative processes.

Although, in general I agree with the authors regarding the above statements, it is important to mention disadvantages of biomass utilization. In pursuit of the long-term climate strategic goals, the existing stock should not be incinerated. At the same time, burning biomass also increases CO^2 emissions. In this respect, it rather to emphasize the role of energy utilization of biomass for rural development purposes.

There are many studies exploring experiences of different countries in a field of energy sustainability in rural areas with various approaches and methods. In Germany the concept of an integrated renewable energy farm (IREF) (El Bassam, 1998) as a farming system model with an optimal energetic autonomy was considered for the optimization, evaluation, and implementation of integrated renewable energy sources for rural communities (El Bassam, 2001). In Scotland rural areas were considered for the social study, where the areas are regarded as lacking of continuous energy supply due to weak grid and socio-economic growth to investigate the intimate and sensitive nature of the social issues that are important in the communities when decisions are made on renewable energy supply and demand. People were interviewed according to the predefined criterion of renewable energy such as willingness to accept, changes of lifestyle, income and pay, and education and employment (Shamsuzzoha et al., 2012). In Malaysia, the potential for applying renewable sources – solar, wind and hydropower – for rural electrification was investigated, especially in the poorest States (Borhanazad et al., 2013). The project of large-scale stage-by-stage implementation of energy systems based on solar energy and other renewable energy sources (RES) in rural settlements of Russia had been worked out. Research was made based on the analysis of regional, climatic, social, economic, and technical factors, proposed complex approach to energy supply of rural buildings and predictive estimates (Shepovalova, 2015). In Bolivia, the current status of rural renewable energy was analysed. There was provided and employed an analytical framework to study the network of stakeholders that determines the adoption, absorption, and diffusion of renewable energy technology (Pansera, 2012). The current research raises attention to the development of ***bioeconomy*** in Hungary using the example of the Koppány Valley micro region as a benchmark.

2.2 National renewable energy and rural development policy measures

According to the National Renewable Energy Action plan 2010-2020, the one of the strategic goals for renewable energy policy in Hungary is recognised as “Agriculture and rural development”. First, it implies the use of biomass (as a predominant renewable source in Hungary) for energy purposes based on sustainability aspects including biodiversity and soil quality protection. Application of renewable technologies based on biomass in rural areas should contribute to the retention of working places in agricultural sector and to facilitate promotions of new jobs. The use of organic matter from livestock for biogas production can improve efficiency of waste management and to increase competitiveness of the sector. The use of sub-products, solid wastes from agriculture and forestry for local energy purposes and their transformation into the final products will support additional income for rural residents and reduce the need of fossil fuels in rural communities. In the future, renewable energy sources of agricultural and forestry origin (primarily biomass) may play a major role in the complex regional development of rural areas, the utilisation of land no longer used for food production, in addressing the environmental problems of rural settlements and increasing their population retaining capacity and in the creation of new jobs in rural areas (National Energy Strategy 2030).

National Rural Development Strategy 2020 also declares the main targets of the program, which can be contributed using renewable energy sources based on biomass:

- Maintenance of rural population, demographic balance recovering;
- Energy and food security procuring;
- Competitiveness improvement in agriculture and food industry, restoring the balance of animal and plant productions;
- Protection of biodiversity, soil, water and landscapes, environmental security improvement;
- Application of local resources and systems in energy production, increasing energy independence;
- Diversification of rural economy, quality of life increasing;
- Establishment the close connections between urban and rural areas;
- Preservation of working places and creation of new jobs in rural areas.

However, the real situation in Hungarian rural areas is not so positive. The typical socio-economic problems are unemployment, low level of income, lack of capital, ageing of population, migration of young and educated people to the big cities (Gonda, 2011). In such conditions further development is problematic. In this context, so high share of biomass in production of energy based on statistics, probably could be explained by traditional firewood usage for heating purposes of households in rural areas. The main reason for that is poverty of the local population.

The national target for energy from renewable energy sources in gross final consumption of energy in 2020 was set as 14,65%. This amount of RE was practically reached in 2015 and equaled 14,5%. But, for instance, in comparison with the targets of the neighbouring EU countries, which are the following: Austria- 34%, Slovakia- 14%, Romania- 24%, Croatia- 20%, Slovenia- 25%, Hungary is still lagging.

In this block my idea was to highlight the existing documents dealing with biomass utilization in Hungary created by the official policymakers on a country level. Some of them as National Renewable Energy Action plan 2010-2020 and the National Rural Development Strategy 2020 are in the end of their declared working period now. Unfortunately, conventional issues listed by Gonda, 2011 (unemployment, low incomes, lack of capital, ageing of population, etc.) remain in force in some rural regions of Hungary to this day. For example, Hernád Valley (Bai et al., 2016) faces with the similar disadvantageous conditions as Koppány Valley too. However, I admit that the mentioned regions are among the traditionally undeveloped areas of Hungary and their socio-economic indicators may differ from the national average.

In fact, I also referred to the National Energy Strategy 2030, which talks of longer period of time. Nevertheless, these strategies involve not only energy aspects of biomass utilization, though its role in rural and socio-economic development. I believe, this overview provides the legal framework of the research scope from the side of the Hungarian government.

2.3 Biomass as a main renewable energy source for rural development in Hungary

This overview based on relevant information and data on renewable energy sources provided by Eurostat energy statistics, the frameworks of Hungarian national development programs: National Renewable Energy Action plan 2010-2020, National Energy Strategy 2030 and National Rural Development Strategy 2020, Hungarian scientific publications in field of renewable energy, rural development and agriculture.

The Figure 1. reflects the composition of primary production of renewable energy by type in Hungary graphically.

Based on Eurostat energy statistics renewable energy sources based on biomass including solid biofuels, biogasoline, biodiesels and biogas in total have a dominant share in structure of renewable energy supply in Hungary- more than 90% in 2015.

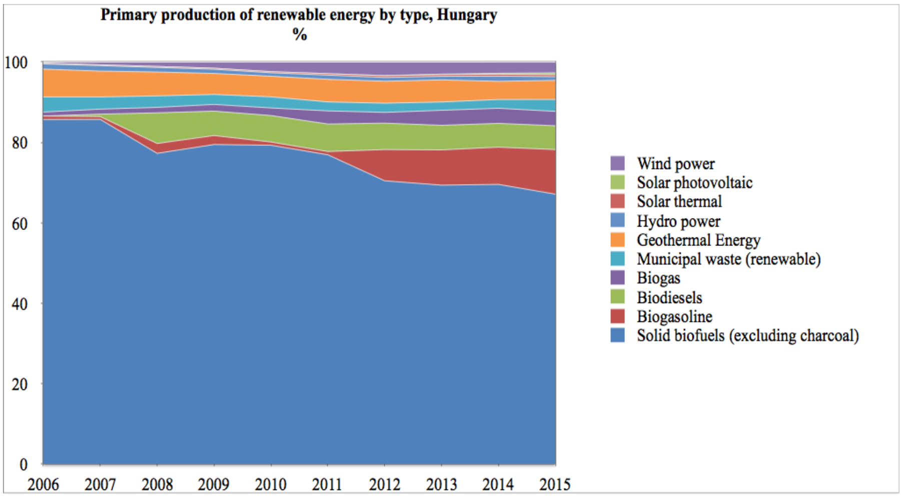


Figure 1. Primary production of renewable energy by type in Hungary
Source: own development based on Eurostat energy statistics

Thus, biomass can be recognised as the main source for the renewable energy production in Hungary almost without any competition from another renewable energy sources. This situation demonstrates, from the one hand, great potential of biomass products for energy purposes in Hungary (for instance, high improvement of biogasoline production), from the other hand insufficiency in development of the other renewables (wind, hydro and solar powers). The next part is intended to conduct deeper analysis of the actual situation considering national statistics and strategic plans and their critical reflections based on literature and reality.

Agriculture and farming remain the main role of labour engagement in rural areas, therefore the most potential of biomass energy applications comes from those sectors.

The areas of possible application of biomass for energy purposes in agriculture can be described as following (Szlavik and Csete, 2012):

- Combustion, heat production, electricity production;
- Production and sale of bio-briquettes as fuel for gas generators;
- Producing bioethanol and biodiesel;
- Burning and pyrolysis of combustible gases;
- Biogas production.

Agricultural sources of biomass for energy purposes are cereal straw, maize stalk, sunflower stalk and rape straw. These sources should be appropriate if technologies for harvesting and burning are available. Vineyard and orchard pruning residues (branch tendrils and fruit tree loppings) can be also an appropriate solution. The harvesting in bales and burning in small stokes of branch tendrils is a viable solution on the vine growing farms (Mago et al., 2009). According the study of biogas utilisation and its environmental benefits in Hungary (Fazekas et al., 2013), realisation of the local biomass potential contributes to the financial savings of companies, it diversifies resources, has a positive impact on regional development and job creation. Besides that, it helps to protect the environment, to limit fossil fuels consumption and to fight against climate change. Most raw materials using for bioenergy production in Hungary comes from agricultural waste (74% in 2012). There are several different types of such raw materials applied in Hungary: cattle slurry, cattle manure, pig slurry, poultry-litter, silage maize, sweet sorghum, green waste in settlements, swill, butchery waste/meat pulp. The number of agricultural biogas power plants reached 50 pcs by 2020 with the installed capacity more than 100 MW rapidly increasing over the time (HIPA). Figure 2. shows geographical location of Hungarian biogas power plants. Most of the facilities are situated in rural areas, perhaps, due to easy access to required raw materials.

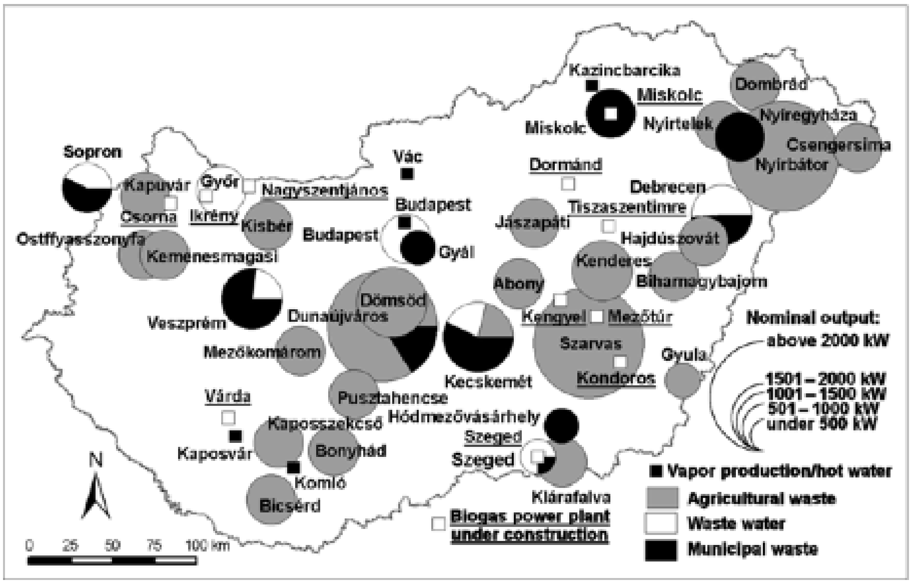


Figure 2. Biogas power and heating plants in operation or under construction in Hungary in 2012

Source: Fazekas et al., 2013

The biomass potential in the micro-region of Eger including wine-branch, cuttings of fruit trees and field crops was determined as 250000 GJ. There are 2 power plants utilising biomass. One of them, Matra power plant has installed capacity of 836 MW. Biomass was found as the most suitable source for the local development and settlements value-added increase. It contributes to the local economy by involvement of business activities: hardwood floor, woodchips and wood-pellets production (Bujdosó et al., 2012). The other aspects of biomass utilisation in regard with sustainability were also explored (Gálosi-Kovács and Bank, 2012).

Several authors have been working on the topic in Hungary. The potential for the production and uses of biomass-based energy sources in Hungary has already been considered (Garay et al., 2012). The paper gives a broad introductory part including the consideration of the national and European renewable policy aspects, particularly focusing on solid biomass and its estimated amount in Hungary. The authors provided comparison models between Hungary and other European countries in biogas and biofuel production as well. They concluded that solid biomass would continue to be the most used bioenergy source in Hungary; the amount of solid biomass that would be needed by 2020 is already available from forestry and agriculture; in Hungary the potential to produce first generation biofuel from domestically grown crops was significantly higher than in most EU Member States but the development of the sector had not met the expectations yet. A significant biomass potential has been investigated in Hernád Valley (Bai et al., 2016). Photovoltaic panels were recognised as highly accepted by the local population. The authors found that the population did not have adequate knowledge regarding RES. The lack of information sources was listed as a main reason for that fact. Seventeen settlements of Heves County were examined trough the survey in order to research the subject of public acceptance of renewable energy sources based on biomass and to explore the general knowledge, innovative attitude, acceptance and willingness of application as well as the estimation of the benefits of the use of RES within the inhabitants (Bujdosó et al., 2012). The authors found that knowledge on various bioenergy-related technologies in general was moderate. Knowledge on biogas, biodiesel and the combustion of biomass exceeded 40%. Environmental protection aspects proved to be the most relevant among the most important benefits in relation to the use of RES. The authors admitted that the society took the biomass energy into consideration and its importance and responsibility were increasing.

The issue of the energy as a local product in Hungary was investigated by Németh et al. in 2020. The authors stated the complexity of the subject and the concomitant processes, which require involvement of efforts of the public, corporations, local governments and companies dealing with RE industry. The energetical issues included import and export must be (re)interpreted locally according to the conditions of particular subregion and settlement (Németh et al., 2020).

The relevance of regional researches on RES is proved by number of projects investigated the use of RES in rural areas of Hungary as Interreg RuRES project.

2.4 Endogenous local development

It the past few decades the approach of regional development strategies shifted from exogenous character (with intense contribution of external resources) to endogenous (Stimson et al., 2011), which supposes local development based on region's reliance and the most efficient utilisation of the local resources and facilities (Bodnár, 2013). In this respect, the proposed local development strategy would have a goal to create favourable conditions for a region aiming to maximize its local resources utilization. The focus of it goes to endogenous processes such as an encouragement of collaborative and communicative advantages between the private, public and community local actors (Stimson et al., 2011). However, the changing policies and inadequate access to investment capital along with lack of cooperation of the actors of the area inhibit the implementation of these strategies and actions successfully (Mezei et al., 2018). Despite that fact, the target area has such local capital elements (Camagni, 2009) that can be utilised and fed into the development of the region (Bodnár, 2013). Use of landscape, partnership cooperation between the local actors, innovations, public activities, and local governance may serve as local development engines in the same degree with the natural resources and acceptance, trust or esteem (Camagni, 2009). Apart of the natural resources' potential, social capital and its potential including people's **knowledge** is an important infrastructural part of the endogenous local development strategy (Johansson et al., 2001).

2.5 Public acceptance of biomass and social potential

Public acceptance is a decisive factor for technology deployment in society. In the situation of *high public acceptance,* it makes much easier implementation of a technology, in reverse *low public acceptance* is a serious constrain for it. Fulfilment of renewable energy goals for governmental plans and strategies at the same time satisfying public preferences is a crucial challenge for the decision-makers. The "Not In My Back Yard" NIMBY phenomenon, when local people manifest their protest locating a technology in their habitual residence, occurred in many countries across the Europe. According to van Rijnsoever et al. (2015): "the concept of ***public acceptance*** refers to an attitude towards a technology or to a form of behaviour that supports or resists the implementation of a technology".

Lack of the social acceptability of the biomass-based power plants installation is one of the substantial limitations to spread of this technology in Europe and in other countries. The NIMBY syndrome (Not In My Back Yard) was identified as a serious public barrier to implementation of the biomass energy developments. In this respect, the main actions approached to avoid public opposition against proposed power plants construction, and to promote social acceptance were investigated (Giuliano et al., 2018). The measures promoting acceptance are the following:

- The effective use of BAT (Best Available Techniques) validation on the development phase;
- Local population involvement at all stages of plant design;
- Installation of webcams installation making images of raw material in the plant available for the viewing by the local population;
- Introduction of monitoring systems in order to verify the real impact of emissions on air quality in the neighbourhood and at the same time they are also available for the viewing and control by the local population.

The new methodology proposed by Giuliano et al. (2018) is supposed to support and promote a real *cultural change*. It provides transparent tools for the air quality monitoring systems which can reduce the NIMBY syndrome and to strengthen the **social acceptance** of biomass powered plants. By using this system local stakeholders can be notified and immersed to the sustainable development and circular economy development frameworks.

Public acceptance is directly related and frequently dependent to so-called *formation of public preferences*. Basically, people generate their preferences based on the **information** they receive and process further. In the age of existing advanced technological solutions, the procedure of collecting an information about the public preferences became more accessible. The information flow is passing via internet and new media channels disseminating information towards population, in turn sharing findings about the *public preferences*. It is also fast and efficient way to provide a general public feedback to policymakers regarding their decisions (van Rijnsoever et al., 2015).

The role of local inhabitants in co-creating knowledge, innovation and technology dedicated to implementation of renewable energy projects is increasing (van Rijnsoever et al., 2015). In this perspective, understanding mechanisms, which form *public preferences,* hence facilitate **public acceptance** is substantial. It was found by van Rijnsoever et al. using the discrete choice experiment that *labels, time, and heterogeneity* influence formation of preferences, thus contribute to **public acceptance.** It was suggested to research the group of respondents with indifferent opinion about the topic in opposite to the respondent groups expressed strong preferences. The potential intention could be the inclusion of those people with indifferent opinion to the public debate regarding renewable energy. It is especially important to emphasise the reasons of such indifference, which is possibly caused by insufficient knowledge, by low involvement or by other causes (De Best-Waldhober et al., 2009) in order to change people's attitude.

The concept of social **acceptance** is subdivided on three dimensions: *Socio-political acceptance, Market acceptance* and *Community acceptance* (Wustenhagen et al., 2007).

Socio-political acceptance implies **acceptance** of a technology from the side of politics, policy makers, key stakeholders, and the public (Rosso-Ceron and Kafarov, 2015). Political decision-makers must ensure effective regulations and policies to strengthen the *community* and *market* **acceptance** of RES. The *socio-political* **acceptance** is fundamental platform for the general ***social acceptance*** achievement.

Market acceptance implies **acceptance** of a technology or an innovation from the side of consumers, investors and intra-firm regulated by the market process.

Community acceptance implies **acceptance** of a technology from the side of the local stakeholders and the communities which are directly affected by the RES installation.

Even in case of secured *socio-political* and *market acceptance, community acceptance* represented by residents, local authorities and employees takes a priority to oppose either to support an energy project (van Rijnsoever et al., 2015).

A questionnaire survey was conducted in Colombia in order to investigate characteristics of the three scopes of the social acceptance of RES (Rosso-Ceron and Kafarov, 2015). The study aimed to determine the main barriers to **acceptance** at the community level. In scope of the community **acceptance** there were two evaluated barriers: cultural rejection to changes involving the use of RE and lack of acceptance by consumers. Cultural rejection included resistance to change, cultural reasons, unknown technologies, etc. Lack of acceptance involved lack of social acceptance for some RES, unfamiliar technologies, lack of local participation, and preference for traditional energy.

Lack of acceptance of RE showed a medium level and cultural rejection to changes demonstrated medium and high-level barriers. Authors emphasised the increased sensitivity of the public to: relatively large developments at the local level; lack of information and **knowledge** on energy projects related to RES; the perception of harm and risk in the community related to energy project placement. Among the cultural factors the level of **trust** in different institutions involved in the project was identified. Besides that, different local traditions may influence projects implementation. Novelty of a technology can have an impact on acceptance, it could be considered positively in some areas, in turn causes concern in others. According to Rosso-Ceron and Kafarov (2015), it is highly recommended to involve community, informing and making part. The suggestions made by the authors are the following:

- Creation of education campaigns on RES at the local, regional and national levels;
- Provision and dissemination of relevant information about RES;
- Participation and communication increase in decision-making;
- Coordination between state, regional and local policies.

In general, positive attitudes towards all RES were investigated. Additionally, it is important to mention the high degree of **acceptance** of biomass systems (74,5%) according to the survey's results. In consideration of adaptation process of the technologies based on biomass, it needs to deal with residents' relations and integration to the local economy and social infrastructure. The project design has a crucial role in this process.

The systematic switch from the use of conventional energy sources to renewable energy is a process characterized by a strong social orientation where individuals' perceptions obtain pivotal significance (Alam et al., 2014).

Knowledge is a factor having a trend to influence attitudes related to the acceptance (Liu and Zhang, 2012). The influence of two external variables cost and **knowledge** on residents' attitudes to use renewable energy technologies was tested by the research in Peninsular Malaysia (Kardooni et al., 2016). The study aimed to reveal the factors influencing **acceptance** of renewable energy by the local population. The results of the survey showed a high-level public awareness regarding the climate change (69,75%). There were three recommended measures how to increase social awareness of environmentally friendly practices and green technology applications:

- Introduction of environmental and technology courses at all school levels;
- Promotion of environmental and green technology campaigns in mass media and social media;
- Establishment of a one-stop center/agency to distribute information about green technologies.

Authors defined that both factors *perceived usefulness* and *perceived ease of use* are associated with the **acceptance** of renewable energy in Malaysia. An importance of factor **knowledge** regarding renewable energy was proved in the way that **knowledge** has positive influence on *perceived usefulness* to utilise RE (Kardooni et al., 2016). Nonetheless, it was found that people have a sense about to use renewable energy and it is demanding high level of efforts, which has negative impact on their behaviour in regard to RE. The lack of **knowledge** and professional skills is a possible explanation for this phenomenon. R&D spending was emphasised as a necessary tool of generating new **knowledge** to change the current paradigm.

The recommendations given above are aiming to shape better public opinion related to RE. Educational system, mass media and governmental initiatives should play a substantial role in this process.

The drivers of acceptance and intentions to protest renewable energy in Germany were analysed by Liebe and Dobers (2019). Despite generally strong public support, local opposition might limit renewable energy expansion according to the authors opinion. Authors found that protest potential opposing the construction of new power plants is rather low. The exploration of factors affecting acceptance of hypothetical power plant installation was an important part of the study. One of the considered energy sources in the analysis was biomass.

Negative population perceptions towards the introduction of low carbon sustainable energy technologies affect the viability and long-term success of the energy projects (Rosso-Ceron and Kafarov, 2015). Therefore, it is crucial point to explore the attitudes of energy consumers which are representing their behaviour (Ek, 2005).

Nuortimo and Härkönen (2018) investigated relationships between the image of energy production in social media and public acceptance of renewable energy sources, with focus on market deployment. They emphasised that the public acceptance is significant in the market deployment context. The learning machine-based media analysis methodology was applied. Comprehensive amount of social media and editorial sources came under the consideration. The data were examined in order to enhance the links of public acceptance, political decision-making and technology market deployment. The outcomes of the study showed that biomass power seems to be more unknown among the people than the solar and wind, nonetheless with a propensity to a positive acceptance.

The actors related to the development of energy technologies can use editorial media to influence public acceptance (Heras-Saizarbitoria et al., 2011). The sustained *behavioural change* can be achieved through the path of incorporated attention, comprehension, motivation, and behavioural trial (McCorkindale et al., 2013). Indeed, interaction with various stakeholders is required to solve not only local problems of the social **acceptance**, but also to use it in a way of finding new innovative solutions for the sustainable deployment of RES (Rosso-Ceron and Kafarov, 2015). The utilisation of media analysis can be used to reveal social acceptance to provide information, what can be useful for the local development project leaders and community decision-makers. Communication provides the way to affect the public aiming to establish an auspicious environment for the energy technology deployment. Perspectives of the social acceptance or non-acceptance can be seen to connect to the appropriate decision-making authorities, to the legal frameworks and development plans, which in turn links to possibility of subsidies and funding. In this way, local technology explication and project designing might get an advantage from the local media sensation (Nuortimo and Härkönen, 2018).

Despite generally high support of renewables in the society, a further expansion of renewable energy utilisation would demand support for specific energy applications at a local level. The necessity of *local* acceptance of renewable energy systems is caused by the claims of renewable energy utilisation expansion (Zoellner et al., 2008). Taking into consideration empirical studies, there were commonly identified high awareness of energy issues and sources, however it was shown that people mostly aware of wind and solar technologies, but not of biomass (Devine-Wright, 2007). Indeed, positive attitudes in regard to biomass power were also explored, notwithstanding the source of biomass has its matter; people demonstrated less commitment to forest-based bioenergy (Qu et al., 2011).

Trust was detected as a factor, which influences social acceptance by the several previous studies considered slightly different types of trust by an empirical analysis. *Trust in stakeholders* was found as influential factor to the public acceptance of technologies (Terwel et al., 2011), along with the size of the project and local history which may influence local acceptance as well (Dutschke, 2011). *Trust in organisations* related to the energy applications development can influence people's acceptance of technologies (Terwel et al., 2009). The gain of trust is happening through people's discussions and interactions, thereby influencing each other (Huijts et al., 2007). Social media play an important role to provide a platform for the human communication to support social processes of public acceptance (Nuortimo and Härkönen, 2018), it also helps to reinforce confidence and trust via manifestation on the international level (de Coninck et al., 2009).

Education is another substantial factor influencing acceptance which was discovered in the thematic researches. Education can affect social acceptance in the way to increase acceptability, therefore, to decrease opposition intentions of population. Nevertheless, an educational increase may not necessarily raise up acceptance of energy applications (Itaoka et al., 2005). *Information* performs the function which can lead to increased acceptance in certain cases (Palmgren et al., 2004).

People ***participating in community energy related activities*** provide more positive attitudes concerning renewable energy in comparison to those who are not participating. Moreover, non-members of the community energy initiatives tend to be more indifferent and uncertain but not more protesting to renewable energy technologies (Bauwens and Devine-Wright, 2018).

Considering RES projects planning and implementation in general there are several necessary parties to be involved in including expert as well as public opinions (Assefa and Frostell, 2007; Jobert et al., 2007). Cooperation is the way to solve the conflicting interests and different vision issues between them (Del Rio and Burguillo, 2009). Successful cooperation requires a few components including cohesion, elimination of personal interest, complete and correct information and representation. In a whole it is a participation of all stakeholders in the decision-making process (Del Rio and Burguillo, 2009; Zoellner et al., 2008). Economically vital and socially acceptable projects are developing under the collaboration between private and public members (Rosso-Ceron and Kafarov, 2015). According to Assefa and Frostell: "Social effects shape society as a whole and each member individually and are accompanied by social acceptance that is an important component of sustainability" (Assefa and Frostell, 2007).

Utilisation of biomass reflects to triple win for the forest-carbon-climate nexus, thereby it addresses to ecological, economic, and social goals (Malmsheimer et al., 2011; Tidwell, 2015).

The ***social acceptance*** of harvesting and utilisation of biomass taking into consideration geographic and social context-based inequalities of the area requires place-based, context-specific research to supplement regional and national social evaluations (Western et al., 2017).

The research conducted in Western Colorado, USA (Uncompahgre Plateau) aimed to recognise the interaction between local geographic and social contexts and the social acceptability of biomass harvesting and utilisation. It was revealed that, albeit achievement of forest fuel reduction and restoration goals are associated to acceptability of harvesting and utilisation of biomass, acceptance judgments are multidimensional, context specific, and conditional on other values. It should be considered by the local economic developers that **collaboration** does not always create complete harmony of **acceptance** due to the fact of existing differences in stakeholders' **acceptance** judgments (Western et al., 2017). The study demonstrated that **collaboration** could let these differences to arise, be used for consensus building and to serve for better understanding of these differences for decision-makers. It helps to managing authorities to distinguish the different stakeholder groups according to their similarities in acceptability judgments. The given approach refers to the analysis of different *MAYBE, YES, NO* **acceptance** groups conducted in this dissertation. Western et al. suggested the view on acceptability judgments as a complex system consisted from accumulated **knowledge**, experience, and evolution of value orientation.

The **acceptance** was conditioned by the basic objectives of environmental protection and improvement and living conditions and habits on the Uncompahgre Plateau. **Collaboration** was considered as an effective instrument to assert the jointly acceptable management actions from the decision-making as well as from the residents' side. Factually, efficient **collaboration** takes place in shaping the *social acceptability* of biomass when it comes to association between the national-level policies and the local place-based participation initiatives (Western et al., 2017).

Local community's acceptance of a biofuel refinery project plays a crucial role in a successful project's realisation. The outcomes of a project may cause both positive and negative consequences for the residents. Positive impacts of biorefinery facilities operation include job opportunities improvement, increased demand on local biofuel feedstocks, higher local tax revenues, local infrastructure development, strengthening flow of economic transactions via increased purchase of local goods and services. In general, these are the key indicators of a local economic development.

Aside with the positive effects, there are negative externalities possible to occur. Increased air and water pollution caused by biofuel plant and transportation related emissions, noise, traffic overload, safety concerns regarding fuel storage, potentially decreased property values due to that may lead to the local community protests against biorefineries.

Population density and **education** level have a negative association with the probability of biofuel plant location (Fortenbery et al., 2013).

Comprehensive estimation of community members attitudes towards biofuel applications and acceptance level can serve for regional developers and biorefinery investors to make relevant decisions and to avoid financial failures (Gi-Eu Lee et al., 2017).

The factors influencing local acceptance of a biorefinary based on *willingness to pay* population perceptions were investigated in Michigan, USA (Gi-Eu Lee et al., 2017). Referring to the conducted survey, 65% of the respondents stated their support for the biorefinery, 27% were against it, 8% did not decide. The main reasons to support and to oppose biofuel facility construction were identified.

Positive factors mentioned by the respondents are job creation, increased sales for local farmers, environmental benefits, plant contribution to local taxes, foreign oil dependence reduction.

Negative factors opposing the biorefinery are the following: smell and noise, long-term environmental effects, road overloading, risk of industrial accidents, no trust to economic viability of biofuels, increased food prices.
The information and data gathered by the survey are to be used by the local decision-makers for designing appropriate communication,

education, and involvement efforts to ensure community **acceptance** and support.

The number of researches on the area of the local social acceptance of biogas power plants were conducted in Switzerland. According to Soland et al. (2013) high level of public acceptance is a necessary requirement to promote the rapid increase of renewable energy in a country. The Swiss legal democratic system assuming direct relationships between the citizens and authorities could serve as good example for adaptation in other states. Inhabitants of Switzerland have a right to vote directly on political decisions, to convey their concern in relation to technological and energy introductions. It happens during the planning process on the national as well as on the local levels, therefore, fulfils the achievement of efficient collaboration and work. *Simplification* and *standardisation* of planning procedures should be addressed to responsible governmental authorities in order to ensure the raise of renewable energy successfully (Bundesamt für Energie BFE, 2012). Geissman and Huber emphasised the establishment of a new renewable-based power plants is barely possible without residents' involvement in the project debates (Geissman and Huber, 2011).

Aside with photovoltaic systems, biomass-based, biogas power plants are the most prevalent renewable energy technology in Switzerland. Research goal was to investigate attitudes of local population towards renewable energy technological applications, revealing factors influencing public acceptance locally is essential for the long-term perspective project planning. Gaining data and knowledge about social acceptance is especially promising to minimise possible local opposition initiatives (Soland et al., 2013). Primarily, such research is relevant for rural territories, where the placement of biogas plants is common due to agricultural lands proximity, thus, to facilitate raw material access. It is mainly focusing on the **social potential** of adjoining residential areas.

The flow chart (Figure 3.) was added to summarize the main groups of factors revealed in the literature review, which influence the social acceptance of RES.

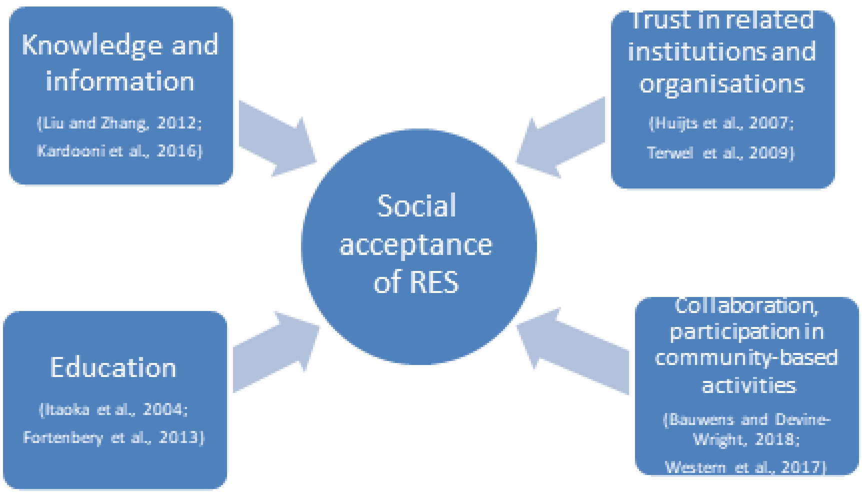


Figure 3. Factors influencing the social acceptance of RES

Source: own development

Knowledge and information; education; trust in related institutions and organisations; collaboration, participation in community-based activities were identified as the key pillars of the social acceptance.

3. Objectives of the dissertation

Koppány Valley located in one of the most underdeveloped Hungarian territories considering serious economic, social and infrastructural issues. Despite this fact, there is significant potential regarding the green energy sector if considering essential amount of local raw bio-material production. The estimated theoretical potential of biomass in the area is substantial, although however it is complicated to realise due to the social barriers such as lack of knowledge and low level of awareness regarding renewables among the local stakeholders. Community acceptance is the subject of the current research aiming to investigate the attitudes of the local stakeholders and the community members of the Koppány Valley micro region regarding introduction of RES based on biomass in their neighbourhood. Considering the factors of the social acceptance of RES revealed in the literature review objectives of the dissertation are to be set. Taking into account the key pillars of the social acceptance of RES (Figure 3.), I realised the necessity of population knowledge exploration regarding RES based on biomass. Linking between the knowledge and awareness provide the path to the social potential description regarding acceptance of RES. Investigation of the personal and specific factors influencing social acceptance of biogas power plant installation should demonstrate the detailed profile of the respondent according to reveled characteristics and patterns.

Therefore, objectives of the dissertation are the following:

• To define the level of knowledge and awareness of bio-based RES among the local stakeholders in rural area;

- To investigate the social potential of the Koppány Valley regarding acceptance of RES based on biomass;
- To explore personal and specific factors influencing social acceptance of biogas power plant installation.

4. Materials and methods

4.1 Introduction of the research area

The location of the research was 10 settlements in the Koppány Valley, in the Northern part of Somogy County. 9 of them are administrative units in the Tab District and Koppányszánto, which belongs to the other structural division (Tolna County, Tamási District). This area has primarily small villages and considered as economically underdeveloped (based on 290/2014. (XI. 26.) government regulation on the classification of the beneficiary districts).

The area is typically characterized by small villages and located far away from towns. Bigger centrums do not affect them considerably. The location of the research area is depicted by the Figure 4.

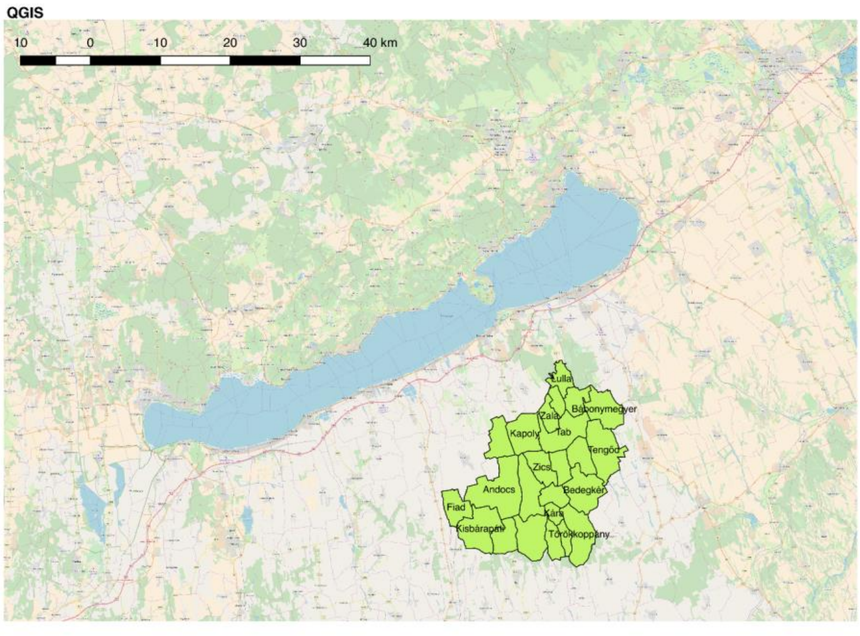


Figure 4. Geographical location of the research area

Source: Titov et al., 2018

According to the national delimitation 6 of the 10 examined settlements are described as cumulatively underdeveloped and 3 of them suffer from severe unemployment (HCSO). The small villages and the lack of towns in the area cause several serious social and economic disadvantages. 2 095 people live in the examined area in 10 small villages. All the examined settlements have a population under 500 people, 5 of them have a population under 200 people. The highest unemployment rate was indicated in Somogyacsa, Szorosad, Kisbárapáti, Bonnya and Koppányszánto. It exceeds all the benchmark averages. The settlements on the south part of the Tab District including Somogyacsa, Bonnya, Fiad, and Kisbárapáti are backward villages on the boarder of disappearing. From the view of the regional development they form a so-called internal periphery which is very hard to develop. This is the poorest part of the district. The largest problem of the area which also the most difficult to handle is the rapid decline of the social capital. The basis of the community renewal disappears because of the multifactorial contra-selection caused by the migration of young people, the moving of successful businesses into towns, the moving of elder people to relatives in towns. The situation of the remaining population is dramatic and shows a continuous decline. Based on the observed information mentioned above we may conclude that implications of the traditional rural development policy applied to the region have no positive effect on the local economic state. In this respect, it would be reasonable to consider and investigate alternative, more innovative sources for the local development. There are several possible local development strategies: FDI, circular economy, endogenous development, etc. Considering the fact, that the region is quite rich in natural bio resources (forests, agricultural lands, etc.) and favourable natural conditions (climate, soil, etc.), the local resource based *endogenous development strategy* seen as the most preferable and feasible. Realization of the natural resources' potential could provide raw materials for the further renewable energy applications based on biomass in order to generate "green" energy supply for the local stakeholders. Therefore, every opportunity including the utilization of renewable energy must be grasped in order to improve the population retaining capacity and the employment rate. That change would contribute to the energy savings, decrease natural gas dependency, employment promotion. In this way, the added-value growth of the region in general might be expected.

There are a few initiatives towards sustainable bio-resources utilization which were already implemented by the local authorities:

-Biomass storage places (mostly firewood for heating purposes);

-Green waste containers for more sustainable waste management and waste utilization;

-Agri-tourism promotions including walking tourist routes and places for leisure in nature to increase attractiveness of the area for visitors and newcomers.

In regard with environmental protection improvement and considering incentives from the local development association, the significance of the local raw bio-material production potential was explored using two different approaches: by analysing local agriculture statistics and through the local population survey.

Local population survey was conducted in frames of the RuRES project- “Renewable energy sources and energy efficiency in the function of rural development” dedicated to Hungary-Croatia Cross-border Co-operation Programme.

The examined area is among the traditionally underdeveloped areas of Hungary. The problems of the examined area are not totally new and had being analysed in previous studies. The complexity and interconnectedness of different social, economic, and environmental issues were intensively researched. Such negative aspects as intensive agricultural production, poor employment power, degradation of natural resources and depopulation – should be addressed by complex solutions (Gelencsér, 2017). In order to recognise and define the problems, moreover, to search for their solutions implementation of completely new strategic development programs on the local level is required.

4.2 Description of the Dataset

The original dataset had 309 observations collected during the survey, out of it 303 observations were considered in the actual effective Dataset after exclusion of the missing data. The final Dataset consisted of 13 independent categorical variables and 1 dependent categorical variable. The independent variables were divided into two subsets according to the common topic of the variables: **personal factors** and **specific factors**.

Personal factors (see Table 1.) represent the individual characteristics of the respondent (background, socio-demographical information) as **gender**, **age**, **residence** place, **years of living** at the same area,

education background, professional **occupation** and trust the local authorities (**trust.to.mayor**). The given subset was selected to investigate which personal factors of the local inhabitants have significant effect on the acceptance of biomass-based renewable energy at the local community level. Identification of the common personal characteristics contributes to creating *personal profiles* of the local inhabitants accepting (*YES*), not accepting (*NO*) or not sure to accept (*MAYBE*) biogas power plant in rural area.

Table 1. 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 10 settlements of the Koppány Valley were divided into three groups according to their geographical location. Western part including respondents living in Fiad, Kisbárapáti and Bonnya; Eastern part including respondents living in Törökkoppány, Koppányszántó and Szorosad; Middle part including respondents living in Somogyacsa, Somogydöröcske, Kára, and Miklósi	*WEST; EAST; MIDDLE*
years.of.living	the number of years of living at the local residence	*[<10]; [>10]*

Source: own development

education	respondent's level of 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" (including employed, self-employed, private producer respondents), "non-active, homestay" (including retired, full-time mother respondents) and "dependent" (including unemployed, student, public worker status respondents)	*ACTIVE; NON-ACTIVE, 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*

The specific subset of variables emphasizes the **knowledge** and behavioral (habitual) parameters of rural inhabitants (Table 2.). It characterizes respondent's deeper knowledge background about the specific terms as **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 (**own.plant**, **own.animal**), that may count as extra sources of bio energy. **Willingness.to.collect** biomass is essential in a sense of cooperative activities at the local community level without which operation and maintenance of biogas power station is hard to fulfil (Western et al., 2017). Identification of the common specific characteristics contributes to creating *specific profiles* of the local inhabitants accepting (*YES*), not accepting (*NO*) or not sure to accept (*MAYBE*) biogas power plant in rural area.

Table 2. 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*

Source: own development

The dependent variable - **acceptance** expresses respondent’s willingness to support biogas power plant installation (Table 3.).

Table 3. The dependent variable

Variable	Description of the variable	Groups of categorical variable
acceptance	respondent's willingness to support biogas power plant installation at the local residence place	*YES; NO; MAYBE*

Source: own development

Based on the original Dataset of 13 independent and 1 dependent variables **predicted.acceptance** variable was created (see Table 4.).

Table 4. The predicted dependent variable

Variable	Description of the variable	Groups of categorical variable
predicted.acceptance	respondent's predicted willingness to support biogas power plant installation at the local residence place	*YES; NO; MAYBE*

Source: own development

4.3 Methodology

Local population questionnaire survey was carried out in May 2018 in 10 settlements of the Koppány Valley micro region (n=310). Sampling was carried out with the help of a quota-based combined with snowball method – weighted by the settlements' population size. The questionnaire was divided into 3 general blocks: (1) *personal information* about respondents (background information); (2) *awareness about RES* in general; (3) *acceptance and potential of biomass-based RES*. Likert scale, multiple choice and open answer questions were applied to the questionnaires in the course of the survey. Descriptive statistics and cross table analysis were applied to describe the results.

The **multinomial logistic regression** methodology was selected for the data analysis, because it provides an appropriate technique to predict the probability of category membership on a dependent variable based on multiple independent variables (Starkweather and Moske, 2011; Garson, 2013). In the research the probability of the categories of **acceptance** was predicted by 13 independent categorical variables (see Table 1. and 2.).

The multinomial logistic regression is sensitive to closely related categorical variables, which induces the necessity of checking whether multicollinearity occurs (Starkweather and Moske, 2011; Garson, 2013). The multicollinearity diagnostics was implemented through the variance-inflation factors analysis. The VIF calculation formula is:

$\text{VIF}_i = \frac{1}{1 - R_i^2}$, where $R^2{}_i$ is the R^2-value obtained by regressing the i^{th} predictor on the remaining predictors.

A multinomial logit model was built under R software with the usage of R commander and "stargazer" packages, which were used to modifying the logit probability coefficients to *relative risk ratios* (RRR), that are the exponentiated values of the logit coefficients.

The dependent variable **acceptance** contains three basic categories: *YES*, *NO* and *MAYBE*. One of these categories should be selected necessarily as the basement or reference level category to run the multinomial logit model (Starkweather and Moske, 2011; Garson, 2011). In our case, category *MAYBE* was selected as a reference one. The probabilities of switching respondent's decision from *MAYBE* to *YES* or *NO* were examined. The probability of changing decision was expected to be influenced by the independent variables included in the model. It was expected to reveal the most important influencing factors of **acceptance**.

Two types of the effect plots were applied for visualization of the multinomial logit model results: *stacked areas* and *lines with confidence bands effect plots*.

Predicted probabilities of **acceptance** were calculated under R commander by the fitted values calculation, selecting the highest predicted probability of **acceptance** groups *YES; NO; MAYBE* as

predicted.acceptance. Boxplots were used for displaying the distribution of the **predicted.acceptance** groups *YES; NO; MAYBE.*

Two-way contingency table method and the *Pearson's Chi-squared test* were applied to provide a foundation for statistical inference (Munoz et al., 1997) to test the relationship between the **acceptance** and **predicted.acceptance** variables.

"Irr" package, which provides various coefficients of interrater reliability and agreement (Munoz et al., 1997) was used for the agreement statistics estimation including the *Percentage agreement* and the *Cohen's Kappa evaluations*.

5. Results and discussion

5.1 Local population survey results

The results of the local population survey are presented below accordingly to the thematic blocks of the questionnaire including characteristics of the sample (background information), awareness about RES and biomass-based energy sources knowledge and acceptance.

5.1.1 Characteristics of the sample (background information)

The first thematic block of questions includes information regarding respondents' gender, age, educational level and place of residence.

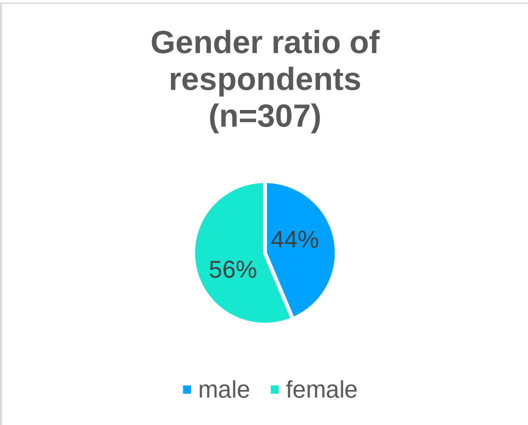


Figure 5. Respondents' gender

Source: own calculations based on population survey results (data) from RuRES, 2018

Most of the respondents are female 56% (172 people from the asked inhabitants), 44% of the respondents are male (135 people). The gender ratio of the respondents is quite balanced.

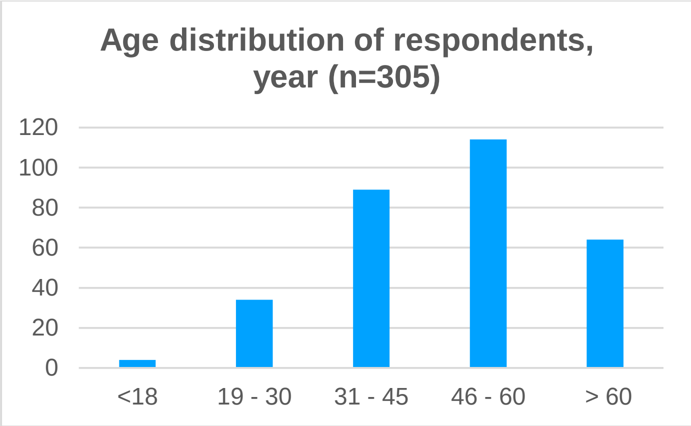


Figure 6. Respondents' age

Source: own calculations based on population survey results (data) from RuRES, 2018

In terms of age distribution, most of the respondents belong to the 46-60 age group. Figure 6. indicates that there are predominantly respondents with age higher than 30 (88% of the total).

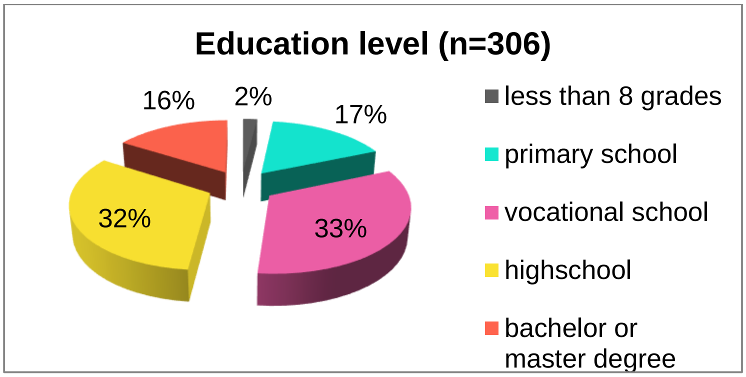


Figure 7. Respondents' education level

Source: own calculations based on population survey results (data) from RuRES, 2018

Considering the education level of respondents (Figure 7.), most of the people have vocational school or high school as the highest degree of education. Only 16% obtained to have university degree.

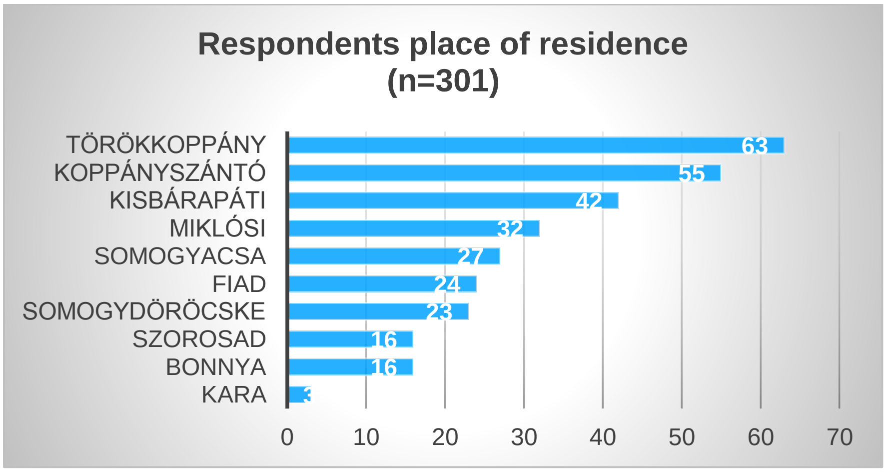


Figure 8. Respondents place of residence

Source: own calculations based on population survey results (data) from RuRES, 2018

Based on Figure 8. may be concluded that settlements with the highest number of respondents are Törökkoppány, Koppányszántó and Kisbárapáti. In opposite, Szorosad, Bonnya and Kára are villages with the least number of respondents.

5.1.2 Awareness about RES

The second thematic block of questions represents respondents' knowledge about RES and their types, knowledge about different RE technologies, acceptance of different RES, reasons to use renewable energy and information sources about RES.

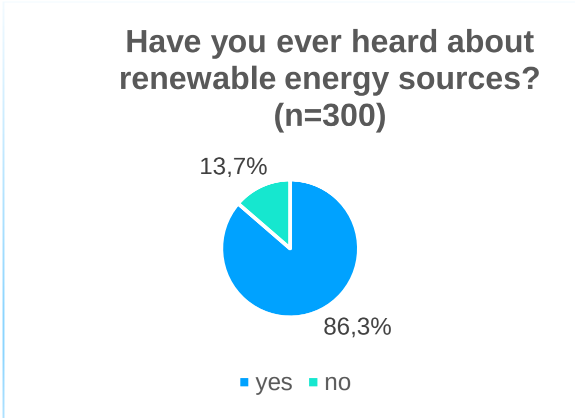


Figure 9. RES knowledge

Source: own calculations based on population survey results (data) from RuRES, 2018

Among the 300 questioned inhabitants 41 person (13.7%) have never heard about the renewable energy sources (RES), while 259 persons (86.3%) have heard about RES (Figure 9.). It shows high level of awareness about RES among stakeholders of the Koppány Valley.

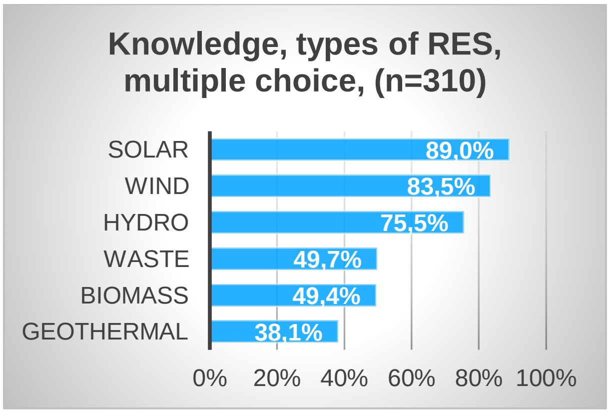


Figure 10. Knowledge, types of RES

Source: own calculations based on population survey results (data) from RuRES, 2018

Solar, wind and hydro energy are listed by respondents as the most well-known (Figure 10.).

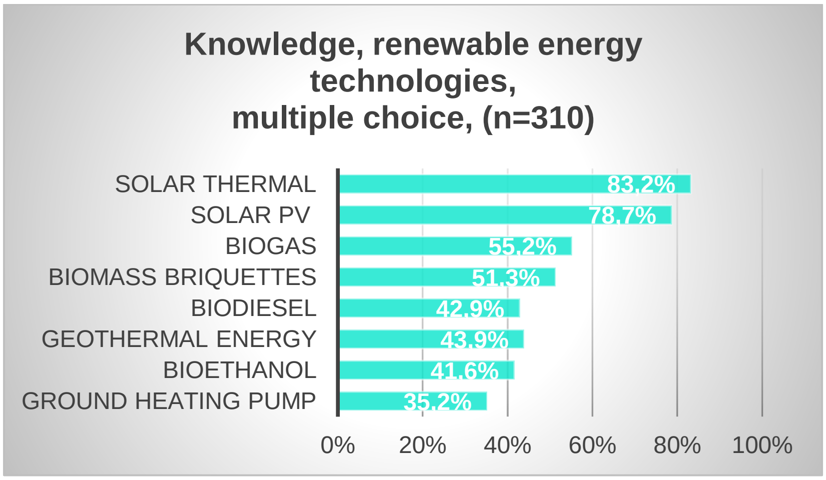


Figure 11. Knowledge about different RE technologies

Source: own calculations based on population survey results (data) from RuRES, 2018

Figure 11. confirms the results of the Figure 9. by reflecting solar-based renewable energy technologies (solar thermal and solar PV) as the most recognized and well-known among the local population, 83.2% and 78.7% respectively.

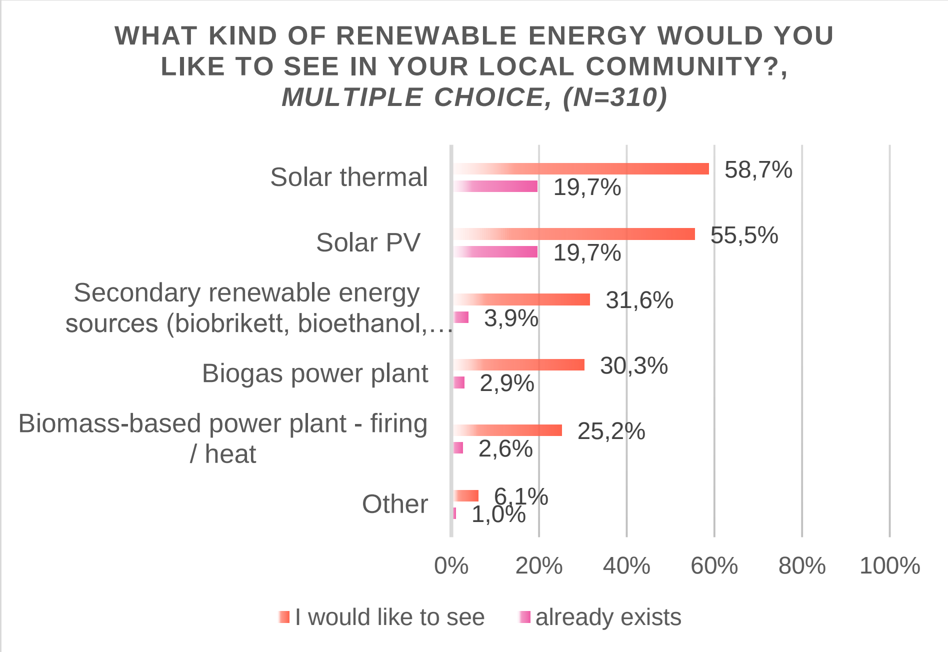


Figure 12. Acceptance of different RES

Source: own calculations based on population survey results (data) from RuRES, 2018

In accordance to Figure 10. and 11., in Figure 12. we can observe that residents of the Koppány Valley are willing to accept in their local community solar based RE at most. Only 30.3% of respondents would like to have biogas power plant.

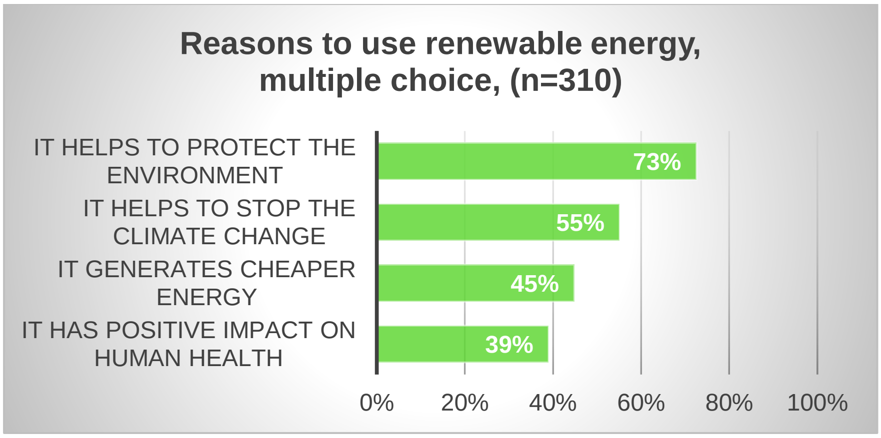


Figure 13. Reasons to use renewable energy

Source: own calculations based on population survey results (data) from RuRES, 2018

The opinion of 310 inhabitants was asked about the reasons to use RE. They could have multiple choices. Among them, 73 % (the highest) selected the option, which says "it helps to protect the environment". 55 % stated that "it helps to stop the climate change". 45 % of people chose that "it generates cheaper energy". Lastly, 39 % chose the "it has positive impact on human health" option (see above Figure 13.).

There are different sources to collect information about RE. The graph examines (see Figure 14.), which sources are the most common or less important to reach the inhabitants with the information in the given area. TV mentioned as the most common source to get information about RE, the second is internet. The least important information sources in respect to RE in the research area are local government and specialized publications.

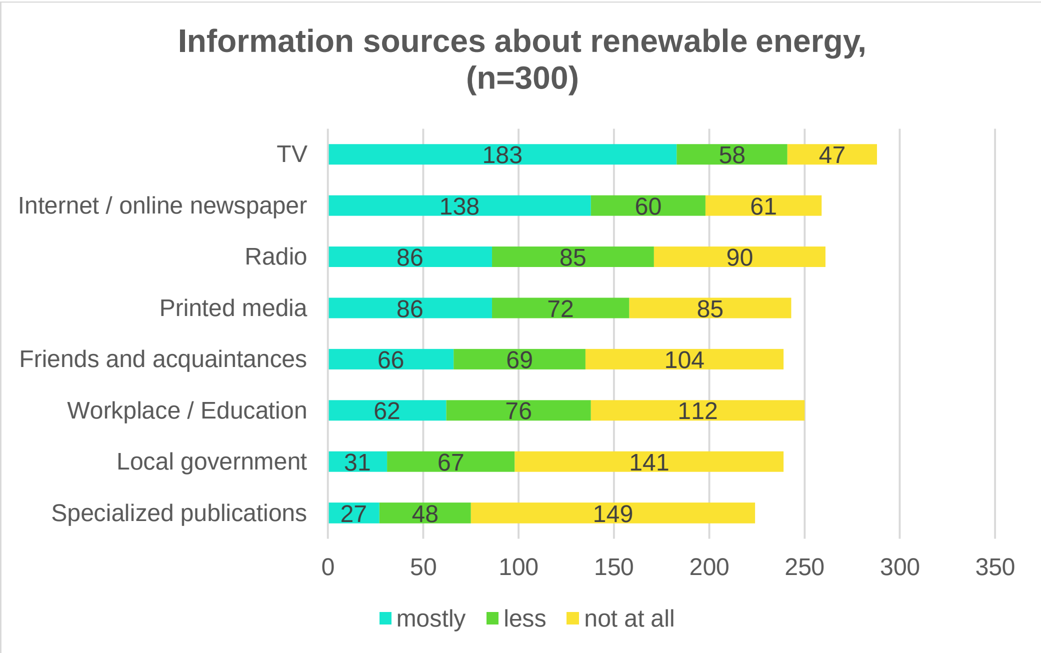


Figure 14. Information sources about RES

Source: own calculations based on population survey results (data) from RuRES, 2018

5.1.3 Biomass-based energy sources knowledge and acceptance

The third thematic block of questions reflects respondents' basic biomass and bio-based energy sources knowledge, support of a biogas plant installation, collection activities and different aspects of a biogas plant acceptance.

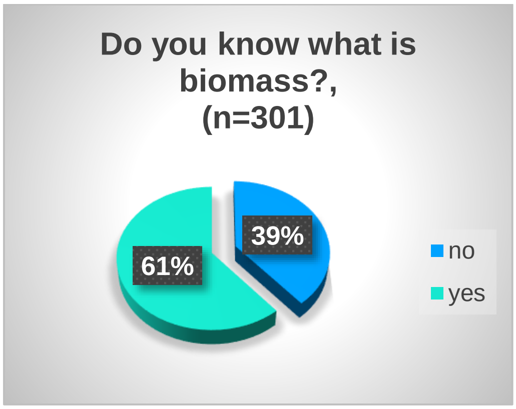


Figure 15. Basic biomass knowledge

Source: own calculations based on population survey results (data) from RuRES, 2018

61% of respondents stated their knowledge about what biomass is (Figure 15.). Among the biomass energy sources biofuel, biogas and bio briquettes were mentioned as the most known with more than 72% of awareness rate. At least 54% of the population have knowledge about energy forest, energy grass and bio pellets (Figure 16.). Thus, general knowledge about biomass definition and bio-based energy sources among inhabitants of the Koppány Valley has basically moderate level.

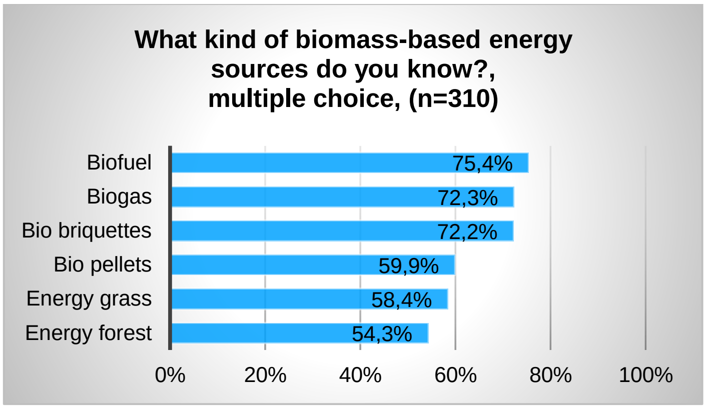


Figure 16. Bio-based energy sources knowledge

Source: own calculations based on population survey results (data) from RuRES, 2018

Then I switched to the public acceptance questions part. I asked stakeholders whether they would support installation of a biogas power plant in their local community. 35% of respondents answered "yes", 20% said "no" and the rest 45% declared "may be" (Figure 17.). It means most of the people are not quite sure about their decision regarding biogas plant installation.

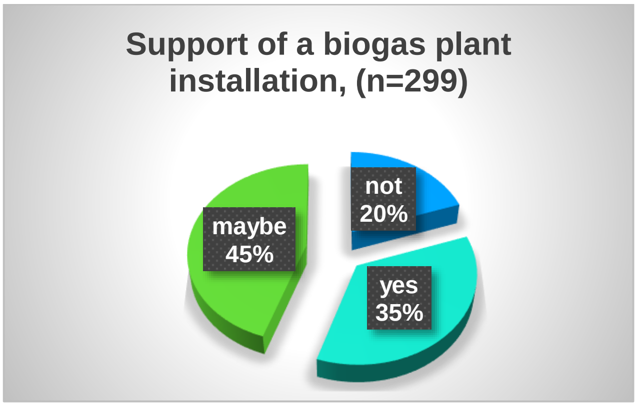


Figure 17. Support of a biogas plant installation

Source: own calculations based on population survey results (data) from RuRES, 2018

Despite this, 73% of people are ready to collect plant residues from their garden in order to get raw materials for the proposed biogas plant (Figure 18.).

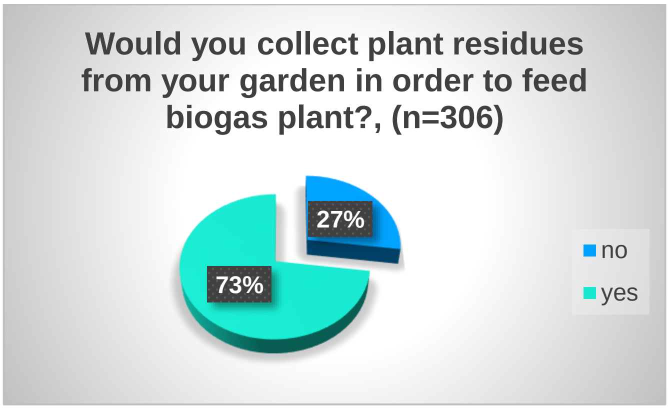


Figure 18. Collection activities

Source: own calculations based on population survey results (data) from RuRES, 2018

For the Likert scale method, I offered respondents to express their opinion about the statements using estimation scale from 1 to 5, where **1** meant “completely disagree” and **5** meant “completely agree”. The analysis of the different acceptance aspects as willingness to collect organic waste (this question was applied to the Likert scale as well), willingness to make financial contributions for the green energy utilisation and readiness to participate community activities related to biogas production is represented by the Figure 19. We can see that people are much more likely to collect organic waste (so it confirmed our results in Figure 18.) than to work together or specially to provide financial aids.

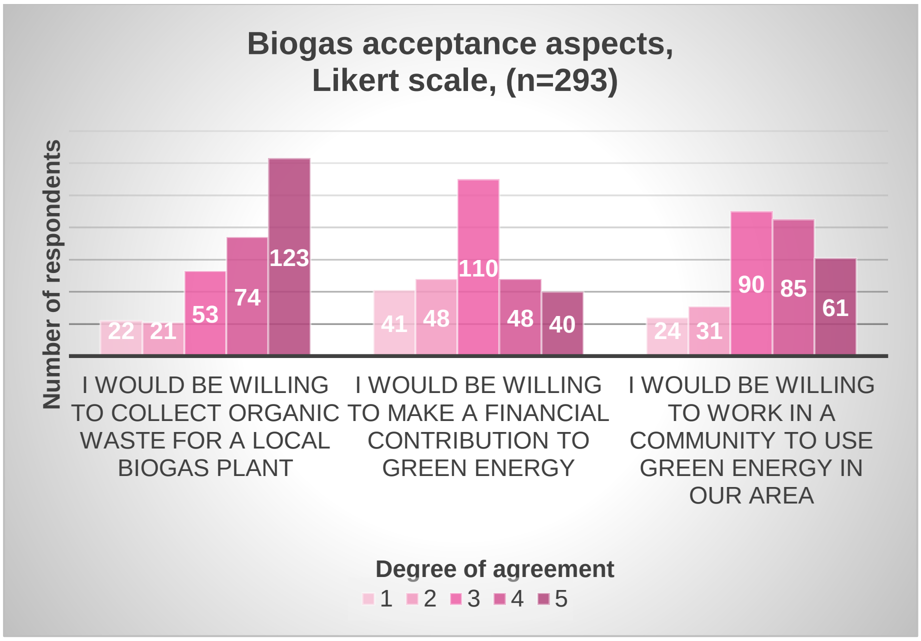


Figure 19. Different aspects of a biogas plant acceptance

Source: own calculations based on population survey results (data) from RuRES, 2018

Accumulation of raw materials is crucial issue for the operational maintenance of a biogas plant. Therefore, the fact that local population is willing to collect plant residues, organic waste and other bio sources for feeding biogas plant purpose indicates significant progress in the social potential of the area.

5.2 Research questions and hypotheses

Based on the survey results 45% of the respondents answered *MAYBE* for the question “Would you support biogas power plant installation in your local community?”, 35% said *YES*, the other 20% stated *NO*. The hidden social potential should be realized from the population group with the uncertain opinion (majority of the respondents). In this respect, exploration of factors having significant effect on the acceptance level, gains even more importance. It would be useful for the local decision-makers and local development strategy officials to know how to convince people to change their attitude in aspect of further investment to the bioenergy development infrastructure. In this respect, research has a focus on defining the common characteristics of the *MAYBE* (convincible) **acceptance** group. I suppose that uncertain population group should realise the social potential of the Koppány Valley regarding biomass-based RES acceptance.

Research questions of the dissertation:

RQ1: Which personal factors are significant to the **acceptance** of a biogas power plant installation?
RQ2: Which specific factors are significant to the **acceptance** of a biogas power plant installation?
RQ3: What are the main personal characteristics of the respondents committed to *YES; NO; MAYBE* (convincible) **acceptance** groups?
RQ4: What are the main specific characteristics of the respondents committed to *YES; NO; MAYBE* (convincible) **acceptance** groups?

Hypothesis 1: Personal factors **trust.to.mayor** and **education** are associated with the **acceptance** of a biogas power plant installation.

Hypothesis 2: Specific factors **biomass.knowledge**, **energy.crops.knowledge** and **climate.change.knowledge** are associated with the **acceptance** of a biogas power plant installation.

Hypothesis 3: The convincible group of the respondents is characterized by the lack of **knowledge**, which can be improved.

5.3 Methodological analysis results

The data of 13 independent personal and specific variables and one result variable were chosen to define the multinomial logistic regression model of local population acceptance of biogas power plant installation. Multicollinearity was testing through the variance-inflation factors analysis.

The results of the variance-inflation factors analysis are shown by Tables 5. and 6.

Table 5. 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

Source: own development

Table 6. 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

Source: own development

The VIF values of the variables in both subsets did not exceed the critical point 10 and remained slightly low according to the Tables 5. and 6. Thus, there was no concern to expect multicollinearity of the independent variables. The multinomial logit model could be run properly.

The results of the multinomial logistic regression of the 7 personal variables are demonstrated by Table 7.

Table 7. Multinomial logistic regression model for the Independent variables' subset 1- "Personal factors"

Personal factors	Coefficients		RRR		Std. Error	z value	Pr(>|z|)
	Dependent variable:		Dependent variable:				
	no	yes	no	yes			
age[< 30]	-0.560	-1.263**	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**	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	1.011	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.mayor[no]	2.804***	-0.062	16.510***	0.940	0.51946	4.319	1.56E-05 ***
trust.to.mayor[yes]	0.518	2.904***	1.678	18.241***	0.30316	7.058	1.69E-12 ***
years.of.living[> 10]	0.474	-0.038	1.606	0.963	0.39313	0.234	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						

Source: own development

Based on the results (Table 7.), the interpretation of RRR is (keeping all other variables constant):

- dependent variable **acceptance** is 0.57 times more likely to take on value *NO* compared to *MAYBE* if independent variable **age** takes group *[<30] (p>0.05)*. The dependent variable **acceptance** is 0.28 times more likely to take on value *YES* compared to *MAYBE* if **age** takes group *[<30] (p< 0.05)*.

In case of **acceptance** category *NO*:

Age *[<30]*– This is the relative risk ratio for a one unit increase in age under 30 score for preferring *NO* to *MAYBE*, given that the other variables in the model are held constant. If a subject were to increase the respondent's age under 30 score by one unit, the relative risk for preferring *NO* to *MAYBE* would be expected to decrease by a factor of 0.57 given the other variables in the model are held constant. So, given a one unit increase in age under 30, the relative risk of being in the *NO* group would be 0.57 times more likely when the other variables in the model are held constant. More generally, we can say that if a subject were to increase the respondent's age under 30 score, we would expect the respondent to be more likely to prefer *MAYBE* over *NO*.

In case of **acceptance** category *YES*:

Age [<30]– This is the relative risk ratio for a one unit increase in age under 30 score for preferring *YES* to *MAYBE*, given that the other variables in the model are held constant. If a subject were to increase the respondent's age under 30 score by one unit, the relative risk for preferring *YES* to *MAYBE* would be expected to decrease by a factor of 0.28 given the other variables in the model are held constant. So, given a one unit increase in age under 30, the relative risk of being in the *YES* group would be 0.28 times more likely when the other variables in the model are held constant. More generally, we can say that if a subject were to increase the respondent's age under 30 score, we would expect the respondent to be more likely to prefer *MAYBE* over *YES*.

- dependent variable **acceptance** is 0.57 times more likely to take on value *NO* compared to *MAYBE* if independent variable **age** takes group *[<30]* $(p>0.05)$. The dependent variable **acceptance** is 0.28 times more likely to take on value *YES* compared to *MAYBE* if **age** takes group *[<30]* $(p< 0.05)$.

- dependent variable **acceptance** is 1.3 times more likely to take on value *NO* compared to *MAYBE* if independent variable **age** takes group *[>60]* ($p>0.05$). The dependent variable **acceptance** is 1.08 times more likely to take on value *YES* compared to *MAYBE* if **age** takes group *[>60]* ($p>0.05$).
- dependent variable **acceptance** is 0.89 times more likely to take on value *NO* compared to *MAYBE* if independent variable **education** takes group *PRIMARY* ($p>0.05$). The dependent variable **acceptance** is 0.37 times more likely to take on value *YES* compared to *MAYBE* if **education** takes group *PRIMARY* ($p< 0.05$).
- dependent variable **acceptance** is 1.33 times more likely to take on value *NO* compared to *MAYBE* if independent variable **education** takes group *UNIVERSITY DEGREE* ($p>0.05$). The dependent variable **acceptance** is 0.57 times more likely to take on value *YES* compared to *MAYBE* if **education** takes group *UNIVERSITY DEGREE* ($p>0.05$).
- dependent variable **acceptance** is 1.53 times more likely to take on value *NO* compared to *MAYBE* if independent variable **gender** takes group *MALE* ($p>0.05$). The dependent variable **acceptance** is 0.96 times more likely to take on value *YES* compared to *MAYBE* if **gender** takes group *MALE* ($p>0.05$).
- dependent variable **acceptance** is 0.58 times more likely to take on value *NO* compared to *MAYBE* if independent variable **occupation** takes group *DEPENDENT* ($p>0.05$). The dependent variable **acceptance** is 1.01 times more likely to take on value *YES* compared to *MAYBE* if **occupation** takes group *DEPENDENT* ($p>0.05$).

- dependent variable **acceptance** is 0.4 times more likely to take on value *NO* compared to *MAYBE* if independent variable **occupation** takes group *NON-ACTIVE, HOMESTAY ($p>0.05$)*. The dependent variable **acceptance** is 0.52 times more likely to take on value *YES* compared to *MAYBE* if **occupation** takes group *NON-ACTIVE, HOMESTAY ($p>0.05$)*.
- dependent variable **acceptance** is 0.33 times more likely to take on value *NO* compared to *MAYBE* if independent variable **residence** takes group *MIDDLE ($p<0.05$)*. The dependent variable **acceptance** is 0.88 times more likely to take on value *YES* compared to *MAYBE* if **residence** takes group *MIDDLE ($p>0.05$)*.
- dependent variable **acceptance** is 1.09 times more likely to take on value *NO* compared to *MAYBE* if independent variable **residence** takes group *WEST ($p>0.05$)*. The dependent variable **acceptance** is 0.77 times more likely to take on value *YES* compared to *MAYBE* if **residence** takes group *WEST ($p>0.05$)*.
- dependent variable **acceptance** is 16.51 times more likely to take on value *NO* compared to *MAYBE* if independent variable **trust.to.mayor** takes group *NO ($p<0.01$)*. The dependent variable **acceptance** is 0.94 times more likely to take on value *YES* compared to *MAYBE* if **trust.to.mayor** takes group *NO ($p>0.05$)*.
- dependent variable **acceptance** is 1.68 times more likely to take on value *NO* compared to *MAYBE* if independent variable **trust.to.mayor** takes group *YES ($p>0.05$)*. The dependent variable **acceptance** is 18.24 times more likely to take on value

YES compared to *MAYBE* if **trust.to.mayor** takes group *YES (p<0.01).*

- dependent variable **acceptance** is 1.61 times more likely to take on value *NO* compared to *MAYBE* if independent variable **years.of.living** takes group *[>10] (p>0.05).* The dependent variable **acceptance** is 0.96 times more likely to take on value *YES* compared to *MAYBE* if **years.of.living** takes group *[>10] (p>0.05).*

Based on multinomial logistic regression model for the Independent variables' subset 1- "Personal factors", considering the significance level (p-value), parameters with high effect on the dependent variable **acceptance** were determined. Effect plots provide graphical visualization of the significant components of Table 7.

Acceptance is significantly influenced by the following personal variables (*age, education, residence, trust.to.mayor*):

1. **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 20. shows the **age** effect on probability of **acceptance**.

2. **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 21. shows the **education** effect on probability of **acceptance**.

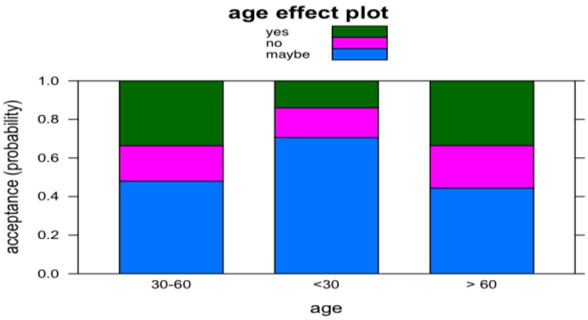
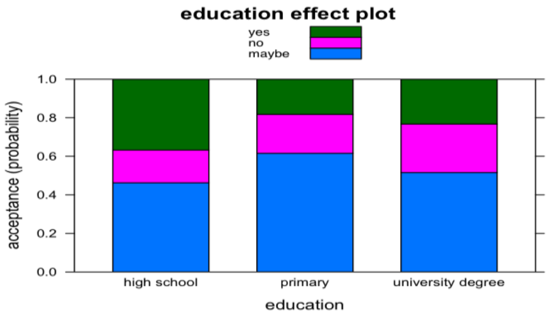


Figure 20. Age effect plot (stacked areas)

Source: own



development

Figure 21. Education effect plot (stacked areas)

Source: own development

According to the results shown on Figure 20. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **age** *[30-60]***.**
The group of respondents committed to *NO* **acceptance** group is characterized by **age** *[>60]***.**
The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **age** *[<30]***.**

According to the results shown on Figure 21. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **education** *HIGH SCHOOL***.**
The group of respondents committed to *NO* **acceptance** group is characterized by **education** *UNIVERSITY DEGREE***.**
The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **education** *PRIMARY***.**

3. **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 22. shows the **residence** effect on probability of **acceptance**.

4. **trust.to.mayor**. 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** takes group *YES* (p<0.01).
The likelihood to choose **acceptance** category *NO* increases by 16.51 times (the risk or odds is 1551% higher) in comparison to category

MAYBE, if respondent's **trust.to.mayor** takes group *NO* (p<0.01). Figure 23 shows the **trust** effect on probability of **acceptance**.

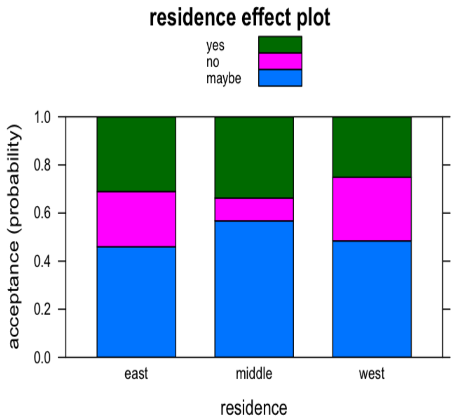


Figure 22. Residence effect plot (stacked areas)

Source: own development

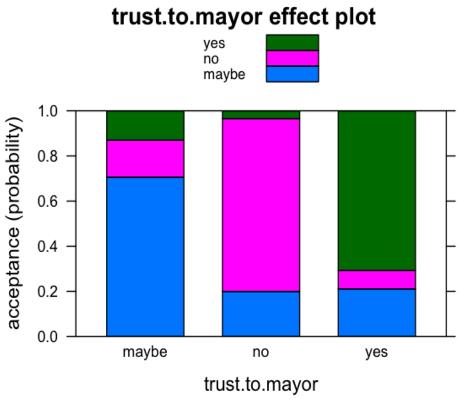


Figure 23. Trust to mayor's decision effect plot (stacked areas)

Source: own development

According to the results shown on Figure 22. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **residence** *EAST***.**

The group of respondents committed to *NO* **acceptance** group is characterized by **residence** *WEST*.

The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **residence** *MIDDLE***.**

According to the results shown on Figure 23. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **trust.to.mayor** *YES***.**

The group of respondents committed to *NO* **acceptance** group is characterized by **trust.to.mayor** *NO*.

The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **trust.to.mayor** *MAYBE***.**

Based on Table 7. the personal profiles of the respondents committed to *YES; NO; MAYBE* (convincible) **acceptance** groups were complied. Personal profiles of the different **acceptance** groups of biogas power plant in rural area are characterized by the following personal features represented by Table 8.

Table 8. 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*	*NON-ACTIVE, HOMESTAY*
trust.to.mayor	*YES*	*NO*	*MAYBE*

*did not provide significance (p>0.1)

Source: own development

Predicted.acceptance variable was created based on the predicted probabilities of the **acceptance** groups *YES; NO; MAYBE.* Distribution of the different **predicted.acceptance** groups dedicated to "Personal factors" is represented by the boxplot (Figure 24.).

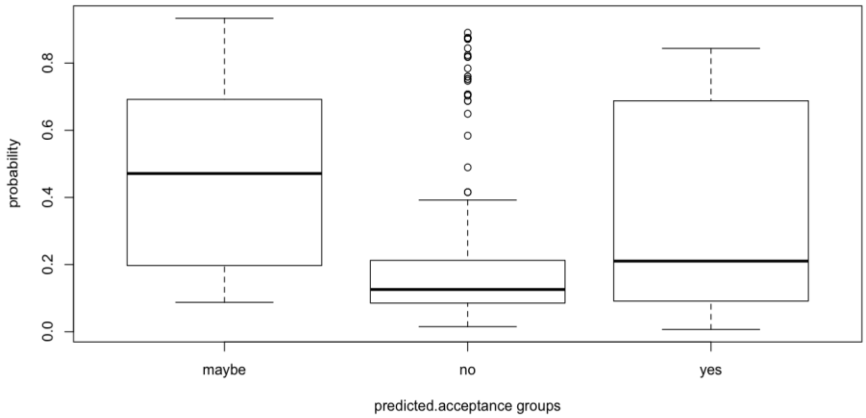


Figure 24. Predicted acceptance boxplot ("Personal factors")

Source: own development

Two-way contingency table reflects on relationship between the **acceptance** and **predicted.acceptance** dependent variables (row percentages) based on the Independent variables subset 1- "Personal factors" (Table 9.).

Table 9. Contingency table of acceptance and predicted acceptance ("Personal factors")

acceptance	predicted.acceptance		
	MAYBE	***NO***	***YES***
MAYBE	77.9	2.9	19.1
NO	44.1	37.3	18.6
YES	20.4	0.9	78.7
Pearson's Chi-squared test			
X-squared = 167.99	df = 4	p-value <2.2e-16	

Source: own development

The model is fitted according to the Pearson's Chi-squared test ($p<0.05$) (Table 9.).

Agreement statistics were used to validate the results of the predicted probabilities model (Tables 10. and 11.).

Table 10. Percentage agreement of acceptance and predicted acceptance ("Personal factors")

Percentage agreement (Tolerance=0)
Subjects = 303

Raters = 2
%-agree = 70.3

Source: own development

According to Table 10., the percentage of agreement between the two raters **acceptance** and **predicted.acceptance** is 70.3%.

Table 11. Cohen's Kappa estimation (”Personal factors”)

Cohen's Kappa for 2 Raters (Weights: unweighted)
Subjects = 303
Raters = 2
Kappa = 0.514
z = 12
p-value = 0

Source: own development

According to Table 11. the Cohen's Kappa value of the two raters **acceptance** and **predicted.acceptance** is 0.514 ($p<0.05$). It indicates moderate interrater reliability.

The results of the multinomial logistic regression of the 6 specific variables are demonstrated by Table 12.

Table 12. Multinomial logistic regression model for the Independent variables subset 2- "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.animal[yes]	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						

Source: own development

According to the above presented results (Table 12.), the interpretation of RRR is (keeping all other variables constant):

- dependent variable **acceptance** is 0.84 times more likely to take on value *NO* compared to *MAYBE* if independent variable **biomass.knowledge** takes *YES* instead of *NO ($p>0.05$)*. The dependent variable **acceptance** is 1.74 times more likely to take on value *YES* compared to *MAYBE* if **biomass.knowledge** takes *YES* instead of *NO ($p<0.1$)*.

In case of **acceptance** category *NO*:

Biomass.knowledge *YES* – This is the relative risk ratio for a one unit increase in biomass knowledge score for preferring *NO* to *MAYBE*, given that the other variables in the model are held constant. If a subject were to increase the respondent's biomass knowledge score by one unit, the relative risk for preferring *NO* to *MAYBE* would be expected to decrease by a factor of 0.84 given the other variables in the model are held constant. So, given a one unit increase in biomass knowledge, the relative risk of being in the *NO* group would be 0.84 times more likely when the other variables in the model are held constant. More generally, we can say that if a subject were to increase the respondent's biomass knowledge score, we would expect the respondent to be more likely to prefer *MAYBE* over *NO*.

In case of **acceptance** category *YES*:

Biomass.knowledge *YES* – This is the relative risk ratio for a one unit increase in biomass knowledge score for preferring *YES* to *MAYBE*, given that the other variables in the model are held constant. If a subject were to increase the respondent's biomass knowledge score by one unit, the relative risk for preferring *YES* to *MAYBE* would be expected to increase by a factor of 1.74 given the other variables in the model are held constant. So, given a one unit increase in biomass knowledge, the relative risk of being in the *YES* group would be 1.74 times more likely when the other variables in the model are held constant. More generally, we can say that if a subject were to increase the respondent's biomass knowledge score, we would expect the respondent to be more likely to prefer *YES* over *MAYBE*.

- dependent variable **acceptance** is 0.39 times more likely to take on value *NO* compared to *MAYBE* if independent variable **climate.change.knowledge** takes *YES* instead of *NO* $(p<0.1)$. The dependent variable **acceptance** is 1.009 times more likely to take on value *YES* compared to *MAYBE* if **climate.change.knowledge** takes *YES* instead of *NO* $(p>0.05)$.
- dependent variable **acceptance** is 1.14 times more likely to take on value *NO* compared to *MAYBE* if independent variable **energy.crops.knowledge** takes *YES* instead of *NO* $(p>0.05)$. The dependent variable **acceptance** is 3.39 times more likely to take on value *YES* compared to *MAYBE* if **energy.crops.knowledge** takes *YES* instead of *NO* $(p<0.01)$.
- dependent variable **acceptance** is 1.35 times more likely to take on value *NO* compared to *MAYBE* if independent variable **own.animal** takes *YES* instead of *NO* $(p>0.05)$. The dependent variable **acceptance** is 0.89 times more likely to take on value *YES* compared to *MAYBE* if **own.animal** takes *YES* instead of *NO* $(p>0.05)$.
- dependent variable **acceptance** is 1.16 times more likely to take on value *NO* compared to *MAYBE* if independent variable **own.plant** takes *YES* instead of *NO* $(p>0.05)$. The dependent variable **acceptance** is 2.39 times more likely to take on value

YES compared to *MAYBE* if **own. plant** takes *YES* instead of *NO (p<0.05).*

- dependent variable **acceptance** is 1.68 times more likely to take on value *NO* compared to *MAYBE* if independent variable **willingness.to.collect** takes *YES* instead of *NO (p>0.05)*. The dependent variable **acceptance** is 2.94 times more likely to take on value *YES* compared to *MAYBE* if **willingness.to.collect** takes *YES* instead of *NO (p<0.01).*

Based on multinomial logistic regression model for the Independent variables subset 2- ”Specific factors”, taking into account the significance level (p-value), parameters with high effect on the dependent variable **acceptance** were determined. Effect plots provide graphical visualization of the significant components of Table 12.

acceptance is significantly influenced by the following specific variables (*biomass.knowledge, climate.change.knowledge, energy.crops.knowledge, own.plant, willingness.to.collect*)::

1. **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 25. shows the **biomass.knowledge** effect on probability of **acceptance**.

2. **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 26. shows the **biomass.knowledge** effect on probability of **acceptance**.

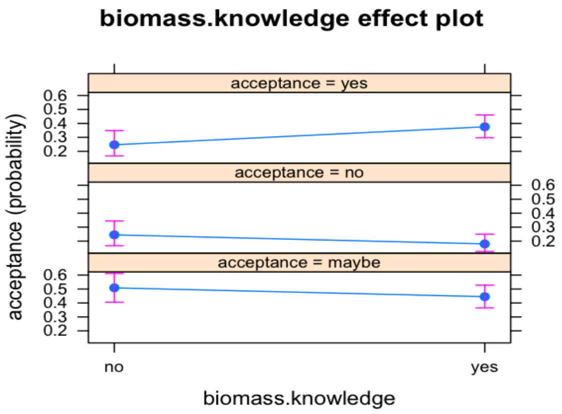


Figure 25.

Biomass.knowledge effect plot (lines with confidence bands)

Source: own development

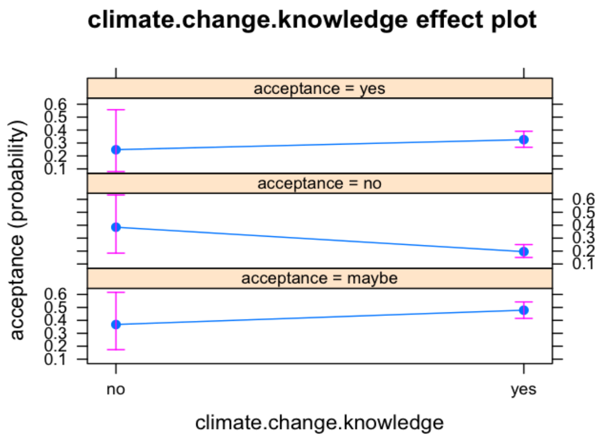


Figure 26. Climate.change.knowledge effect plot (lines with confidence bands)

Source: own development

According to the results shown on Figure 25. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **biomass.knowledge** *YES***.**

The group of respondents committed to *NO* **acceptance** group is characterized by **biomass.knowledge** *NO.*

The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **biomass.knowledge** *NO***.**

According to the results shown on Figure 26. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **climate.change.knowledge** *YES***.**

The group of respondents committed to *NO* **acceptance** group is characterized by **climate.change.knowledge** *NO.*

The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **climate.change.knowledge** *YES***.**

3. **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 27. shows the **energy.crops.knowledge** effect on probability of **acceptance**.

4. **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 28. shows the **own. plant** effect on probability of **acceptance**.

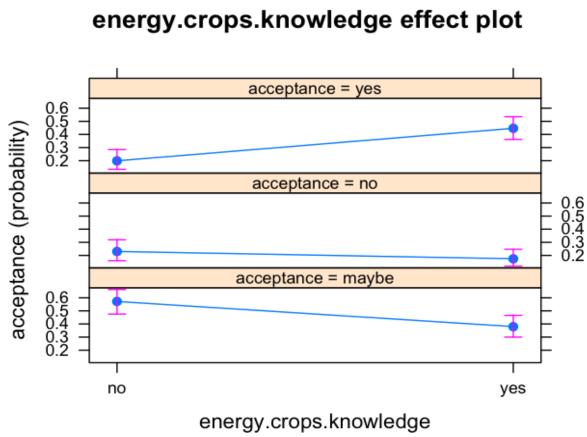


Figure 27. Energy.crops.knowledge effect plot (lines with confidence bands)

Source: own development

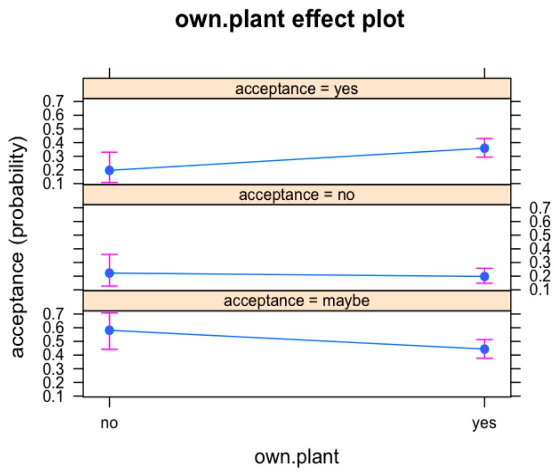


Figure 28. Own.plant effect plot (lines with confidence bands)
Source: own development

According to the results shown on Figure 27. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **energy.crops.knowledge** *YES***.**
The group of respondents committed to *NO* **acceptance** group is characterized by **energy.crops.knowledge** *NO.*
The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **energy.crops.knowledge** *NO***.**

According to the results shown on Figure 28. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **own. plant** *YES***.**
The group of respondents committed to *NO* **acceptance** group is characterized by **own. plant** *NO.*
The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **own. plant** *NO***.**

5. **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 29. shows the **willingness.to.collect** effect on probability of **acceptance**.

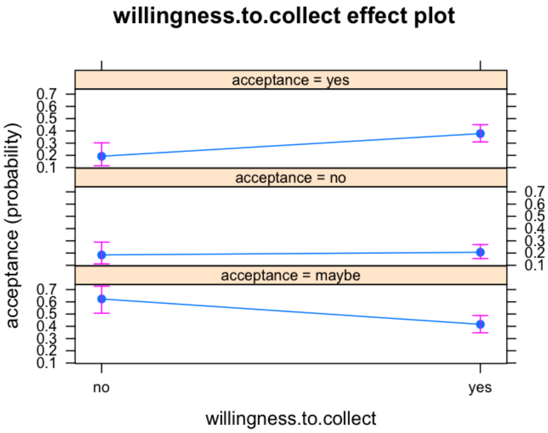


Figure 29.

Willingness.to.collect effect plot (lines with confidence bands)

Source: own development

According to the results shown on Figure 29. can be concluded:

The group of respondents committed to *YES* **acceptance** group is characterized by **willingness.to.collect**. *YES***.**

The group of respondents committed to *NO* **acceptance** group is characterized by **willingness.to.collect**. *YES.*

The group of respondents committed to *MAYBE* (convincible) **acceptance** group is characterized by **willingness.to.collect**. *NO***.**

Based on Table 12. the specific profiles of the respondents committed to *YES; NO; MAYBE* (convincible) **acceptance** groups were complied. Specific profiles of the different **acceptance** groups of biogas power plant in rural area are characterized by the following specific features represented by Table 13.

Table 13. Specific profiles of the different acceptance groups

Specific factors	**acceptance group**		
	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*

*did not provide significance (p>0.1)

Source: own development

Predicted.acceptance variable was created based on the predicted probabilities of the **acceptance** groups *YES; NO; MAYBE*. Distribution of the different **predicted.acceptance** groups dedicated to "Specific factors" is represented by the boxplot (Figure 30.).

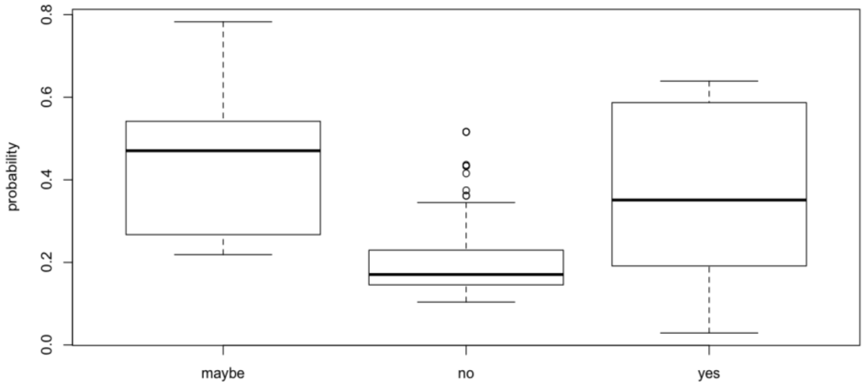


Figure 30. Predicted acceptance boxplot (“Specific factors”)
Source: own development

Two-way contingency table reflects on relationship between the **acceptance** and **predicted.acceptance** dependent variables (row percentages) based on the Independent variables subset 2- “Specific factors” (Table 14.).

Table 14. Contingency table of acceptance and predicted acceptance (“Specific factors”)

acceptance	**predicted.acceptance**		
	MAYBE	***NO***	***YES***
MAYBE	72.1	1.5	26.5
NO	64.4	5.1	30.5
YES	34.3	0.0	65.7
Pearson’s Chi-squared test			
X-squared = 46.33	df = 4	p-value = 0.000000002103	

Source: own development

The model is fitted according to the Pearson's Chi-squared test ($p<0.05$) (Table 14.).

Agreement statistics were used to validate the results of the predicted probabilities model (Tables 15. and 16.).

Table 15. Percentage agreement of acceptance and predicted acceptance ("Specific factors")

Percentage agreement (Tolerance=0)
Subjects = 303
Raters = 2
%-agree = 56.8

Source: own development

According to Table 15., the percentage of agreement between the two raters **acceptance** and **predicted.acceptance** is 56.8%.

Table 16. Cohen's Kappa estimation ("Specific factors")

Cohen's Kappa for 2 Raters (Weights: unweighted)
Subjects = 303
Raters = 2
Kappa = 0.272
z = 6.32
p-value = 2.55e-10

Source: own development

According to Table 16. the Cohen’s Kappa value of the two raters **acceptance** and **predicted.acceptance** is 0.272 ($p<0.05$). It indicates fair interrater reliability.

6. Conclusions and recommendations

Summarizing the results of the personal factors influencing **acceptance** analysis, the Hypothesis 1 was proved by the following findings:

1. **Trust.to.mayor** demonstrated high level of association with the **acceptance** ($p<0.01$) (Table 7.).
2. **Education** associated with the acceptance in the way to having high school diploma provides higher **acceptance** (Figure 21.).

The highest effect was indicated in case of the **trust.to.mayor** variable (this variable expresses respondent's willingness to support local mayor's decision to install biogas power plant). The likelihood to accept power plant increases by 18 times if respondent is willing to support local mayor's decision (Table 7.). Despite it was not analyzed (neither in current research nor by other authors), the reason behind can be explained by the loyalty of rural population to the local authorities in the one hand and by reluctance to take self-responsibility for the decision making in the other hand. In my opinion, the area of the further research activities may cover investigation of the relationships between the trust to the local mayor's decision to install biogas power plant and the social acceptance of biogas power plant installation. Based on my own findings, it was not totally clear why so strong relationships between the variables occurred.

Regarding the sociodemographic variables, in Liebe and Dobers research (2019), there was found the trend that higher educated people demonstrate higher acceptance towards renewable energy, that support my own findings.

The personal profile of the *MAYBE* (convincible) **acceptance** group is the following (Table 7.):

FEMALE, [<30] years old, living in the *MIDDLE* part of the Koppány Valley (including Somogyacsa, Somogydöröcske, Kára, and Miklósi), for *[<10]* years, possesses *PRIMARY* **education**, having *NON-ACTIVE, HOMESTAY* occupational status and not sure in **trust.to.mayor** (*MAYBE)*.

Based on the above profile, can be assumed: these are young people, primarily educated, without active professional either social position. Probably, they are not really involved in activities dedicated to the local community life. The goal for the decision-makers is to raise their interest by innovative approaches of local development oriented to the population group with such personal features.

There are three different types of individuals in the population from the *Collective Action* point of view: "free riders", unconditional cooperators, and conditional cooperators (Fischbacher et al., 2001; Gachter, 2007; Ostrom, 2000).

Under the meaning of ***"free riders"*** we understand people who contribute nothing, do *not* accept renewable energy power plants in their vicinity, biogas power plant in rural area in our context (**acceptance** group *NO*), but benefit from the provision of the good, consume electricity from biogas and receive lower emissions, for instance.

Unconditional cooperation implies 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, c***onditional cooperation*** means contribution of individuals to a specific public good, in our case biogas power plant considered as a public good, 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 that others do the same the same. *Conditional cooperation* leads to less acceptance of renewable energy.

An important message for political decision-makers is the following: "political campaigning can help to provide information to the general public about the "true" costs and benefits of different energy sources and so provide tailor-made information. This might alter attitudes and, in turn, acceptance and protest motivations".

In the context of possible changing opinion 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 (Rosso-Ceron and Kafarov, 2015).

Based on the specific factors model's results, the Hypotheses 2 and 3 proved due to the following findings:

1. **acceptance** is significantly influenced by the specific variables **biomass.knowledge**, **energy.crops.knowledge**, **climate.change.knowledge** (Figures 25., 26. and 27.).

2. Convincible group of the respondents is characterized by the lack of **knowledge** about the terms **biomass** and **energy crops** (Table 13.).

Specific knowledge about the terms **biomass**, **climate change** and **energy crops** indicate person's deeper immersion into the subject of the survey. Understanding what biomass is and what is used for as well as **climate change** and **energy crops** exegesis ensure the path of accepting biogas plant (Figures 25., 26. and 27.).

Cultivation of **own plants** and involvement in other agricultural activities force householders to face with the problem of utilization of organic waste and plant residues, which lead to higher **acceptance** of biogas plant installation ($p<0.05$) (Figure 28.). Albeit, keeping **own animals** did not show any influence on the **acceptance** ($p>0.05$) (Table 8.). Probably, it is not a concern for the respondents where to expose animal waste, either they do not know how to utilize animal waste in aspect of biogas.

It was also proved (Table 8.), that the **willingness.to.collect** biomass is an essential indicator of the **acceptance**. If a person is ready to make his own contribution to operation of biogas power plant and to participate in the collective activities, it specifies his proactive position in a community-based involvement. In that way, **acceptance** is going to be increased (Figure 29.). The community-based approach is one of the most common practices of endogenous local development (Rodriguez et al., 2019) procuring adoption and maintenance of renewable energy applications.

The specific profile of the *MAYBE* (convincible) **acceptance** group is the following (Table 9.):
people, which are not involved in farming activities such as plant cultivation or animal keeping (**own.plant** and **own.animal** both *NO*), do not know the terms **biomass** and **energy crops** (both *NO*), but aware of climate change (**climate.change.knowledge** *YES*). They are not willing to collect biomass (**willing.to.collect** *NO*).

The specific profile complements the personal profile and confirms the inactive personal image. The promising fact is high awareness of the **climate change**, which could show the path for linkage the **climate change** term with the other terms of **biomass** and **energy crops**. Local decision-makers should provide an appropriate basic information about that. Then, the better understanding of the basic terms, might influence to willingness to collect biomass and to participation in other activities at the local community level.

According to the results of the regression model made by Liebe and Dobers (2019), climate change concern has positive effect on the acceptance of wind power plants and solar fields but not on the acceptance of biogas plants, in contradiction to my own results, where **climate.change.knowledge** has statistically significant positive influence on the **acceptance**. This discrepancy might be caused due to inequality of the examined expressions of climate change concern and **climate.change.knowledge**, although these terms are both closely related to people's attitude regarding the climate change.

My selection of variables was based on the factors I revealed in the literature review. Though, I propose the further direction of the research with inclusion and consideration of more influencing factors on the acceptance of biogas power plant.

7. New scientific results

During 16 months of my research the most important social, economic and biomass production data of the examined settlements were collected primarily as well as secondary statistical data. Three hundred and ten questionnaires were distributed in 10 rural settlements of the tested micro region. It was concentrated to three main parts of questions: general information about respondents (background information), awareness regarding renewable energy and different types of sources and a separate block considered biomass data specifically. In the questionnaire mostly Likert scale and multiple-choice questions were applied. The study of social and natural opportunities for the renewable energy utilization helps to determine local economic circumstances by describing the social environment of the Koppány Valley. The main factors affecting public behavior towards local sustainable energy improvement were investigated. Based on the conducted survey and results obtained I provide the acceptance and awareness regarding biomass use for energy purposes, what could be considerable for the decision makers in order to invest capital to the local economy. Relying on statistical evidence, I believe that my results contribute to the implementation of regional development projects aimed to improve energy efficiency of households and to maximize the added value of the Koppány Valley. In this way, these measures may serve as possible solution to get out from the current difficult economic situation and to give impetus for the further rural and regional development.

Therefore, I would like to highlight the ***new scientific results*** as the main outcomes of my dissertation:

1. I proved that educational level of a respondent (high school diploma obtained) associated to higher acceptance of the biogas power plant installation focusing on the research area.
2. I created the personal and the specific profiles of the convincible population group with the uncertain opinion regarding to **acceptance** biomass-based power plant in the Koppány Valley rural area of Hungary.
3. I proved that social acceptance of the biogas power plant installation is associated with the respondent's knowledge regarding biomass, energy crops and climate change focusing on the research area.
4. I found that the convincible group of the respondents is characterized by insufficient **knowledge** about the terms **biomass** and **energy crops**.

8. Summary

The thesis started with the introductory part explaining motivation of the research. The research topic of "Acceptance and potential of RES based on biomass in rural areas of Hungary" is supportive for the EU 2020 Climate and Energy Package and Hungarian national emission reduction targets. The special focus on rural scope justified by Hungary as predominately rural country and the socio-economic disadvantages of rural areas. The literature review consisted of several chapters providing the theoretical basement and scientific context of the study. Bioeconomy and rural sustainability; national renewable energy and rural development policy measures; biomass as a main renewable energy source for rural development in Hungary; endogenous local development and public acceptance of biomass and social potential topics were considered. Based on the literature review the objectives of the dissertation were set up including definition of knowledge and awareness of bio-based RES among the local rural population; investigation of the social potential of the Koppány Valley research area related to acceptance of RES and exploration of personal and specific factors influencing social acceptance of biogas power plant installation. The following Materials and methods chapter included the introduction of the Koppány Valley research area, it's territorial structure and development circumstances. Description of the created Dataset consisted from 13 independent and 1 dependent categorical variables was provided. The methodological procedures included local population survey and its statistical analysis via multinomial logistic regression. The Results and discussion chapter firstly demonstrated results of the local population survey divided to a few parts. There were Characteristics of the sample (background information); Awareness about RES and Biomass-based energy sources knowledge and acceptance subchapters. Based on the survey results, research questions and hypotheses were posed. Methodological analysis results showed the outcomes of the statistical analysis according to multinomial logistic regression modeling. Statistical interpretation of the model was conducted and significant factors influencing acceptance were identified. Personal and specific profiles of the respondents – which belong to the different acceptance groups and predicted probabilities of acceptance – were carried out. The final part of the thesis reports about Conclusions and recommendations. The Hypotheses were proved, there were found associations between the variables **trust.to.mayor**; **education** and the dependent variable **acceptance**. It was also proved, the respondent group with the uncertain opinion is characterized by the lack of **knowledge** about the terms **biomass** and **energy crops.**

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12. Curriculum vitae

Alexander Titov was born on 30th of August in 1991 in Ryazan, Russia. He graduated from Ryazan State Agritechnological University in 2013 with the specialist degree in Economics and Management of an Agricultural Enterprise (English BA). After completed his BA, he continued his study in Kaposvár University and he received his degree majoring in Regional and Environmental Economics MSc in 2016. During his mater period, he was granted by Erasmus+ program to be an exchange student and intern in Rhodes, Greece and Osijek, Croatia. He was the first international student to participate the Hungarian National Contest of scientific works OTDK. He accomplished some research projects with the team from the university as a junior researcher, including RuRES, Agroforestry and Intelligent specialization programme research projects. From 2016 up to now, he is a PhD student of Szent István University - Kaposvár Campus, and he taught Environmental Economics and Regional Analytic Methods for international bachelor and master students.

13. Appendix

This questionnaire was developed in English and translated to Hungarian for the local population in order to help the better understanding in the course of the survey.

General information

* Required

1. Gender *

Mark only one oval.

- Male
- Female

2. Age *

Mark only one oval.

- <18
- 18-30
- 31-45
- 45-60
- >60

3. Residence *

Mark only one oval.

- Törökkoppány
- Fiad
- Kisbárapáti
- Bonnya
- Somogyacsa
- Somogydöröcske
- Szorosad
- Kára
- Miklósi
- Koppányszántó
- Other: ____________________

4. The years of residence in the settlement *

Mark only one oval.

- 1-5
- 5-10
- 10-20
- >20

5. Level of education *

Mark only one oval.

- ◯ No finished education
- ◯ Primary school
- ◯ Secondary school
- ◯ High school
- ◯ Graduate and above
- ◯ Phd
- ◯ Other: ____________________

6. Occupation *

Mark only one oval.

- ◯ Student
- ◯ Employed
- ◯ Unemployed
- ◯ Retired

7. Main source of income *

Mark only one oval.

- ◯ Scholarship
- ◯ Salary
- ◯ Private enterprise
- ◯ Pension payments
- ◯ Social aid payments
- ◯ Other: ____________________

8. The number of people in household *

Mark only one oval.

- 1
- 2
- 3
- 4
- 5 or more

9. Please, select if you have it in your backyard *

Check all that apply.

	I have it	I don't have it	Specify size or number (if available)
Grass (square m)	☐	☐	☐
Orchard (number of trees)	☐	☐	☐
Vineyard (numer OR square m??)	☐	☐	☐
Vegetable beds (square m)	☐	☐	☐
Cattle (head)	☐	☐	☐
Pigs (head)	☐	☐	☐
Poultry (head)	☐	☐	☐
Sheep or goat (head)	☐	☐	☐
Horse (head)	☐	☐	☐
Field for hay production (meadow) (square m)	☐	☐	☐
Own forest (hectares)	☐	☐	☐
Crop field (hectares)	☐	☐	☐
None of the above	☐	☐	☐
Other. Please specify here:_______________	☐	☐	☐

10. Please, specify the types of growing crops (If any).

Awareness regarding renewable energy sources

11. Have you ever heard about renewable energy sources? *

Mark only one oval.

- Yes
- No

12. What kind of renewable energy sources (RES) do you know? *

Check all that apply.

- [ ] Wind energy
- [ ] Hydro energy
- [ ] Geothermal energy
- [ ] Solar energy
- [ ] Biomass (short-rotation forests, fuel grass, etc.)
- [ ] Waste (biowaste, household waste, industry by products)
- [ ] None

13. What kind of renewable energy technologies or secondary sources do you know? *

Check all that apply.

- [ ] Solar thermal
- [ ] Photovoltaic
- [ ] Biomass combustion
- [ ] Biobriquette
- [ ] Biogas
- [ ] Biodiesel
- [ ] Bioethanol
- [ ] None
- [ ] other, please specify: ____________________

14. What are the main sources you get information about RES? *

Mark only one oval per row.

	Never from this source	Less from this source	Mostly from this source
Radio	⬭	⬭	⬭
TV	⬭	⬭	⬭
Internet	⬭	⬭	⬭
Newspapers and journals	⬭	⬭	⬭
Local municipality	⬭	⬭	⬭
Social network (friends, colleagues, etc.)	⬭	⬭	⬭
Other: ____________________________	⬭	⬭	⬭

15. Have you ever heard about climate change? *

Mark only one oval.

- Yes
- No

16. What are, in your opinion, the effects of climate change in your local area? (If any).

17. What are the main reasons to use RES instead of conventional ones? (Select maximum 3 answers). *

Check all that apply.

- [ ] It helps to protect the environment
- [ ] It helps to stop climate change
- [ ] It reduces use of fossil fuels
- [ ] It creates cheap energy
- [ ] It contributes to the country's energy independence
- [ ] It produces less CO2 emission
- [ ] It has positive effect on human's health

18. What kind of renewable technology would you wish to have in your local area? (Select maximum 3 answers). *

Check all that apply.

- [ ] Solar thermal
- [ ] Photovoltaic panels
- [ ] Wind turbines
- [ ] Biomass-based power plant
- [ ] Wood based heating
- [ ] Geothermal (?)
- [ ] Passive houses (terminology?)
- [ ] Technologies that use secondary RES (biobriquett, biogas, bioethanol, etc)

19. Would you like to contribute to RES production in your local area if there are any? *

Mark only one oval.

- ◯ Yes
- ◯ No

20. Please, specify the possible contributions.

Mark only one oval per row.

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
I am willinng to collect residues from my garden in order to feed biogas power plant	◯	◯	◯	◯	◯
I am willing to pay additional fee to produce clean energy in my local community	◯	◯	◯	◯	◯
I am willing to spend extra time for the community based activities	◯	◯	◯	◯	◯

Biomass related questions

21. Do you know what biomass is? *

Mark only one oval.

- ( ) Yes
- ( ) No

Biomass

Biomass is plant matter that can be converted to an energy source. It includes agricultural materials, tree residue from managed forests and wood waste from urban ares.

22. Which forms of energy-related utilisation of biomass do you know? *

Check all that apply.

- [ ] Direct heating of foil mats
- [ ] Electricity generation (lighting / network replenished)
- [ ] Energy production: heating and cooling (the house for example)
- [ ] Transport (bioethanol)
- [ ] Heating with wood burning
- [ ] None

23. What bio-energy resources do you know? *

Check all that apply.

- [ ] Energy forest
- [ ] Energy grass
- [ ] Bio-briquette
- [ ] Pellets
- [ ] Bio-gas
- [ ] Bio-fuels
- [ ] None

24. What kind of energy source do you use for heating in your residence? *

Check all that apply.

- [ ] Petroleum
- [ ] Natural gas
- [ ] Wood
- [ ] Electricity

Other: [ ] ____________________

25. Please, specify the amount of petroleum/natural gas/wood etc. what you use for heating on a monthly basis (If any).

____
____
____
____
____

Biowaste

Biowaste is a form of biomass. It is waste material capable of decomposing under anaerobic or aerobic conditions. Commercial sources of biowaste include forestry and agricultural residues, animal. waste and manure, sewage sludge and commercial food waste.

26. Do you use bio waste for heating in your residence? (garden plants, tree cuts, etc.) *

Mark only one oval.

- ( ) Yes
- ( ) No
- ( ) Partly

27. How do you utilise plant residues from your garden? Ranking (1-most) *

Check all that apply.

- [ ] Do not utilise, just burning
- [ ] Feeding animals
- [ ] Composting
- [ ] Leaving in garden
- [ ] Put it in a waste bin

28. Do you cook for your family by yourself or buy ready food? *

Mark only one oval.

- Cook by myself
- Buy ready food
- Both

Biogas

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste.

29. Would you like to have biogas power plant in your settlement? *

Mark only one oval.

- Yes
- No
- Can't decide

30. What would be, in your opinion, benefits to have biomass-based power plant in your settlement? *

31. What would be, in your opinion, disadvantages to have biomass-based power plant in your settlement? *

32. Are you familiar with the term energy crops? *

Mark only one oval.

- Yes
- No

Energy crop

An energy crop is a plant grown as a low-cost and low-maintenance harvest used to make biofuels, such as bioethanol, or combusted for its energy content to generate electricity or heat.

33. Would you like to grow energy crops in your garden/field instead of traditional plants if there is market for it? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't decide

34. Please, indicate the degree of agreement with the statements.

Mark only one oval per row.

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
RES reduce the use of fossil fuels	◯	◯	◯	◯	◯
RES produce cheap energy	◯	◯	◯	◯	◯
RES help Hungary to be less dependent on imported energy	◯	◯	◯	◯	◯
The investment cost of RES application is high	◯	◯	◯	◯	◯
RES results in less carbon dioxide (CO2) emissions	◯	◯	◯	◯	◯
Biogas power plant helps to save climate	◯	◯	◯	◯	◯
I am aware of possible smell immited from biogas plant	◯	◯	◯	◯	◯
Biogas power plant is beneficial for local nature (environment)	◯	◯	◯	◯	◯
Biomass energy consumption has a positive effect on Human's health	◯	◯	◯	◯	◯
Energy sources based on biomass in local area have positive influence on standards of life	◯	◯	◯	◯	◯
Energy sources based on biomass in local area help to create new job places and reduce unemployment	◯	◯	◯	◯	◯
The maintainance of biomass based power plant causes	◯	◯	◯	◯	◯

high pressure on transportation system					
Application of RES based on biomass helps to improve local infrastructure	⬭	⬭	⬭	⬭	⬭

35. If the mayor of your village would decide to build biogas power plant, would you support his decision? *

Mark only one oval.

- ⬭ Yes
- ⬭ No
- ⬭ Can't decide