Which Factors Influence Investments of Ukrainian Agroholdings in Biogas?

Dmytro Romets[1], Klaus Menrad[1]

[1]University of Applied Sciences Weihenstephan-Triesdorf, Straubing Center of Sciences

Correspondence: d.romets@wz-straubing.de

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Dmytro Romets[1], Klaus Menrad[1]

[1]University of Applied Sciences Weihenstephan-Triesdorf, Straubing Center of Sciences

Petersgasse 18 94315 Straubing, Germany; d.romets@wz-straubing.de

Abstract

Investments in biogas technologies are regarded with increasing interest as an effective instrument for natural gas substitution, accelerating the recovery from the recent financial crisis in Ukraine. Yet, despite economic, environmental and social advantages of biogas and regulations implemented to support it, biogas investments remain below expectations. Therefore, it is necessary to understand the investment behaviour of Ukrainian agricultural companies regarding biogas and their reactions to the support measures. This paper aims to empirically analyse the willingness-to-invest in biogas of large Ukrainian agroholdings. Top-managers of 68 agroholdings in Ukraine were interviewed personally. We proposed and tested a conceptual model that examines the institutional and individual factors affecting the investment behaviour of agricultural companies in the context of biogas. Our findings reveal that, confirming a rational evaluation of investment opportunities, primarily financial factors affect the willingness-to-invest in biogas in Ukraine. The investment behaviour of interviewed companies is mainly influenced by payback period, investment costs and subjective perception of relative advantages of biogas. Furthermore, other decision relevant parameters like feed-in tariff and natural gas price seem to play only minor roles. However, there are systemic problems which hamper biogas investments, such as lack of capital, geopolitical uncertainty and non-reliable legislative framework for biogas production. Our results shed new light on impact of institutional and individual factors on biogas investments in the agricultural sector of Ukraine and have meaningful implications for policy actions.

Key words: Investment behaviour, agricultural sector, biogas technologies

1 Introduction

Globally biogas together with other Renewable energies can play an important role in the reduction of fossil fuels consumption. While Ukraine could export own generated Renewable energy, thereby contributing to the global climate goals, the need of reliable domestic energy supply becomes a more important political issue in this country (International Finance Corporation (IFC) 2015; Arzinger 2009). Ukraine has limited fossil fuel resources and is depending on imported natural gas, which has made the country reliant on its neighbouring states (European Bank for Reconstruction and Development (EBRD) 2014). During recent years imported gas has accounted up to 70 % of its total consumption in Ukraine (Cabinet of Ministers of Ukraine 2014). Additionally, natural gas is a main energy source in the country total energy supply and is one of the reasons of Ukraine´s current energy-security problems (International Renewable Energy Agency (IRENA) 2015). Moreover, energy density of Ukraine´s economy is three to four times higher than that of the developed countries (Ukraine Sustainable Renewable Energy Lending Facility (USELF) 2014; Kirchner, Zachmann 2009; Naumenko et al. 2012; Radeke 2012; Kirchner 2013; International Finance Corporation (IFC) 2010). Needless to say, this situation is particularly challenging in the context of the economic slowdown and geopolitical uncertainty Ukraine is currently challenging.

Given Ukraine´s natural and climate resources, biogas represents a strong opportunity for improving the country energy supply (International Finance Corporation (IFC) 2015). Potential of biogas and other Renewable energies in Ukraine can be deployed to decrease the dependency on imported natural gas. Recent studies suggest that biomass has the greatest energy potential among all other types of Renewables, because of Ukraine´s high agricultural output (Organisation for Economic Development and Cooperation (OECD) 2012). Agricultural residues and waste, i.e. manure, account for close to 60 % of the biomass potential (International Renewable Energy Agency (IRENA) 2015). In this respect biogas is a key technology for biomass utilization in the agricultural sector of Ukraine.

Regarding the economic efficiency of biogas production, manure collection is a central issue to be addressed. Additionally, economies of scale may favour high number of livestock, resulting in better biogas profitability (Ukraine Sustainable Renewable Energy Lending Facility (USELF) 2011). Therefore, large-scale agricultural companies, called in Ukraine "agroholdings", represent high potential for biogas production.

Agroholdings are a relatively new type of enterprises in the agricultural sector of Ukraine. They emerged over the last 20 years during transformation processes. So far, scholars have provided only a general definition of "agroholding" as a vertical incorporation of several enterprises in the agricultural value chain (Wandel 2011). The phenomenon of agroholdings has not been widely investigated and needs further research. Ukrainian Agribusiness Club (UCAB) estimated the overall amount of agroholdings at 112 units in 2014 in Ukraine. The utilized agricultural area (UAA) of agroholdings was approximately 5.64 Mil ha, equalled to 26 % of UAA of all agricultural producers in 2014 in Ukraine (Ukrainian Agribusiness Club (UCAB) 2015). Determining the gross production of agroholdings, crops remained its long-term leadership with 63 % in the gross output of agroholdings, while animal husbandry had the share of 37 %, indicating the key business activity of agroholdings as arable farming. Current development of agroholdings is negatively influenced by the uncertain geopolitical situation in Ukraine. Considering this and unpredictable energy prices agroholdings might look for options of reliable and independent energy supply. One option may be energy generation from biogas. However, the application of biogas in the agricultural sector is not limited to be only an additional source of power generation. Biogas creates a synergy effect, including economic, environmental and social advantages (Geletukha, G., et al. 2013d). Economic advantages are connected to stable energy generation during the year. Positive environmental aspects of biogas are associated with prevention of methane emissions from agricultural waste. The social component of biogas includes improving relationships with local communities and new jobs creation in rural areas. Despite the attractiveness of biogas for agroholdings, biogas is reliant on governmental support (Masini, Menichetti 2013).

To stimulate investments in the biogas sector, the Government of Ukraine has implemented a set of economic incentives. Among the stimuli for biogas, guaranteed by the Government, are: setting of a preferential feed-in tariff (called "green tariff" in Ukraine) for electricity generated from biogas, tax benefits and obligating the Wholesale Electricity Market of Ukraine to purchase the entire electricity from biogas (Energy Charter Secretariat 2013; Arzinger 2011). Despite this promising outlook, biogas potential in Ukraine is far from being exploited (Figure 1).

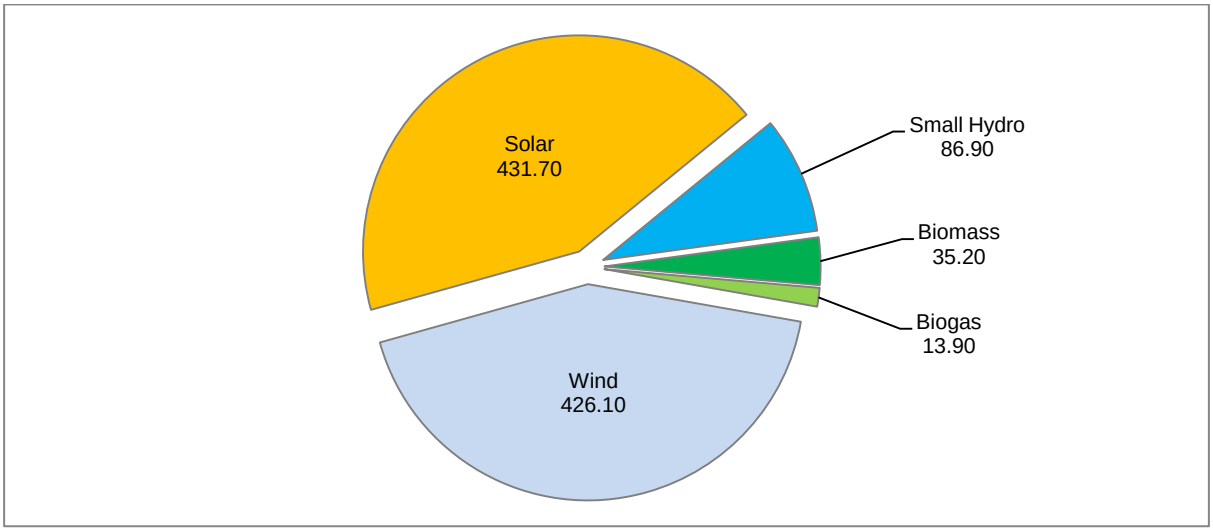

Figure 1: Structure of Renewable energy capacities in Ukraine, MWel, 2015
(Author´s representation based on National Energy and Utilities Regulatory Commission 2016, pp. 48–50; State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE) 2016, pp. 1–4)

Notwithstanding many advantages of biogas for agricultural companies only a few Ukrainian agroholdings have so far invested in biogas projects (Matveev 2013; Kucheruk 2013). The total amount of installed biogas capacity as of 1.04.2015 in Ukraine equalled to 13.9 MW_{el}, (Figure 1), whereas the amount of all Renewables accounted for 993.8 MW_{el} (National Energy and Utilities Regulatory Commission 2016).

The aim of this paper is to analyse the willingness-to-invest in biogas of Ukrainian agroholdings and to contribute to the understanding of their decision-making behaviour in the context of biogas investments. Taking into account the fact that biogas investments are often characterised by high up-front costs (Reise et al. 2012) this study focuses on large agroholdings, considered as being capable of financing such projects. Top-managers of agroholdings were selected as an appropriate informational source to study the willingness-to-invest in biogas for their leading role in the investment decision-making and their responsibility for the company development strategy. To this end, we have conducted a survey in which top-managers were interviewed personally about their willingness-to-invest in biogas, actual investment performance and attitudes towards biogas technologies. Based on a literature review and identified research gaps, the present paper incorporates organisational and adoption theories in the analysis of factors, influencing the willingness-to-invest in biogas. For these purposes, we developed and empirically tested a model using primary data collected from a sample of large Ukrainian agroholdings.

The paper is structured as follows: section 2 provides a review of relevant literature and presents the theoretical foundations of the empirical work. In section 3 the methodology is described in detail. Section 4 illustrates the survey results. Finally, in section 5 the main conclusions and practical implications of the present work will be provided. The paper ends with limitations of the study.

2 Literature Review and Theoretical Background

Literature analysis and a series of exploratory interviews with Renewable energy experts (ch. 3.1) have emphasised several important aspects. First, it has highlighted that decision-making regarding investments in innovative agricultural technologies is affected by different factors. Scholars divided the decision-relevant aspects into technological, organisational and environmental dimensions (Gadenne et al. 2009; Jungklaus 2010; Hertel 2014; Etzion 2007; Gonzalez-Benito, Gonzalez-Benito 2006). Other researchers explained decision-making as a combination of farmer motivation, external factors and farm organisational characteristics (Lynne et al. 1995; Jacobsen et al. 1994; La Due et al. 1991; Solano et al. 2003; Olsen, Lund 2011). Despite the abundant literature on this topic, little empirical study has analysed simultaneous impacts of all three dimensions. Additionally, the magnitude and direction of impact of the decision-relevant factors have not been thoroughly assessed in literature. Second, decision-making research in agriculture has been basically focused on small farms, where single persons make investment decisions (Groenwald 1987; Willock, J., et al. 1999). Contrary, agroholdings are business organisations, where decisions are made and influenced by different employee groups. In neoclassical organisational theories decision-makers identify and implement optimal solutions which are based on profit maximisation (Cyert, March 1992). Modern behavioral theories of the firm assume that organisations choose an optimal solution from available alternatives rather than try to find the best imaginable profitable one. Here, a group of organisational characterstics are decision-relevant. Additionally, numerous individuals are involved in the decision process, which mutually impact the end decision. Third, it has emphasised that cognitive factors impact the decision to invest in new agricultural technologies. While numerous scholars have applied behavioral theories to explain farmer´s decisions (Carr, Tait 1991; Wilson 1997; Austin et al. 1998a; Austin et al. 2005; Willock et al. 1999; Beedell, J. D. C. and Rehman, T. 1999), several studies have been issued on behavioral factors affecting Renewable energy investments (West et al. 2010; Menichetti 2010; Masini, Menichetti 2013, 2010; Wüstenhagen, Menichetti 2012; Devine-Wright; Wolsink (2007; 2007); Hekkert et al.; Wüstenhagen et al.; Stephens, Jiusto (2007; 2007; 2010)). The authors concluded that, apart from financial goals, psychological factors influence the decision-making regarding investments in Renewable energies. Yet, there is a lack of empirical research examining organisational decision-making in agriculture regarding investments in innovative agricultural technologies.

Literature review and expert interviews have provided the theoretical background for development of the conceptual model (Figure 2). The model examines which factors have a measurable influence on the top-managers´ willingness-to-invest in biogas. Building upon adoption and organisational theories we expect the top-managers´ willingness-to-invest in biogas to be affected by four groups of factors: perceived investment attributes, organisational, individual and business environment factors.

The model variables in the present study are considered as individual's subjective perceptions and not as the objective data.

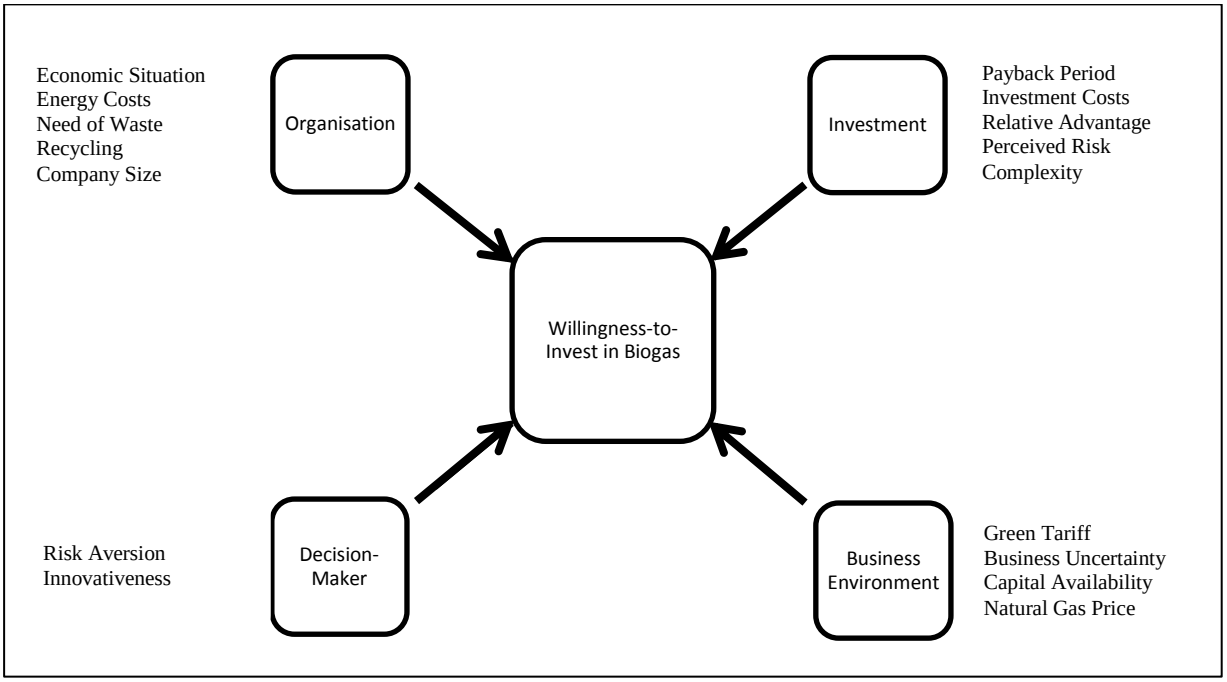

Figure 2: Conceptual model

2.1 Perceived Investment Attributes

Numerous scholars have found individual perception of investment attributes to be important in influencing the decision-making (Weng, Lin 2011; Sia et al. 2004; Lin, Ho 2011; Tornatzky, Klein 1982). We expect the following factors to influence the top-managers´ willingness-to-invest in biogas:

Payback Period

Payback is generally defined as the time required for the investment to recoup its initial costs. In other words, payback is a project profitability expressed in years. Profit maximisation is an important factor of decision-making in agriculture, as well as in other businesses (Sachs 1973; Gasson et al. 1993; Cary et al. 2001). Lack of financial benefits reduces the investment probability (Pannell, Marshall 2006). However, Cancian (1979) suggested that the relationship between profit expectations and adoption probability is not linear. In regard to the interviewed experts, a "six-years+" payback period seems to be a "psychological threshold" for the top-managers of agroholdings in Ukraine. If the project exceeds this mark, the top-management will probably reject it and will look for something more profitable. For that reason we argue for a negative impact of a "six years+" payback on the top-managers´ willingness-to-invest in biogas.

Investment Costs

Investments in biogas technologies are often characterised by high up-front costs (Reise et al. 2012). A high outlay, required for biogas plants, is a major barrier for a broader market penetration of this technology in Ukraine (International Finance Corporation (IFC) 2015; International Renewable Energy Agency (IRENA) 2015). Consequently, we expect that the top-managers of agroholdings, which perceive biogas investment costs as being high, will tend to reject biogas investments.

Relative Advantage of Biogas

In the context of the present study, this factor reflects a perception of top-managers that biogas is more advantageous than the technology it substitutes. Perceived relative advantage of a new technology is positively related to its adoption (Tornatzky, Klein 1982; Rogers 2003). Companies are more likely to invest in biogas technologies, if they are able to provide higher performance and economic gains than the conventional one (Weng, Lin 2011). Considering the benefits of biogas use for agroholdings, we argue for a positive influence of perceived biogas advantages on the top-managers´ willingness-to-invest in biogas.

Perceived Risk of Biogas Investments

Several authors investigated the impact of risk and uncertainty on the Renewable energy development (Meijer et al. 2007; Apak et al. 2011; Chassot et al. 2014). The researchers underlined a negative impact of perceived policy risks relating to investments in Renewables. In the context of the present study, perceived risk of agroholdings, associated with biogas investments, is a decision-influencing determinant. We expect a high perceived risk regarding biogas investments to negatively impact the top-managers´ willingness-to-invest in biogas.

Technology Complexity

Complexity is the degree to which a new technology is perceived as being difficult to understand and use (Peter et al. 2002). The greater its complexity, the greater the required information to be sure about the consequences of the technology use (Pannell, Marshall 2006). In general, greater complexity is hypothesised to be negatively correlated with the technology adoption (Weng, Lin 2011). Therefore, we expect a negative influence of technology complexity on the top-managers´ willingness-to-invest in biogas.

The aforementioned arguments for perceived investment attributes are summarised by the following hypotheses:

Hp. 1. The longer the payback period of a biogas investment, the lower is willingness-to-invest in biogas.
Hp. 2. The higher the investment costs of a biogas plant, the lower is willingness-to-invest in biogas.
Hp. 3. The higher the perception of biogas relative advantages, the higher is willingness-to-invest in biogas.
Hp. 4. The higher the perceived risk of a biogas investment, the lower is willingness-to-invest in biogas.
Hp. 5. The higher the perceived complexity of biogas production, the lower is willingness-to-invest in biogas.

2.2 Organisational Factors of the Agroholding

The organisational context implies a variety of company characteristics. Numerous scholars have discussed the impacts of different organisational factors on the decision-making regarding new technology use (Lin, Ho 2011; Etzion 2007; Gonzalez-Benito, Gonzalez-Benito 2006; Jeyaraj et al. 2006; Pohl 1996; Damanpour 1991; Tornatzky, Fleischer 1990; Kimberly, Evanisko 1981). We consider the following factors to influence the top-managers´ willingness-to-invest in biogas:

Economic Situation

Internal economic situation of the company impacts its ability to invest in new agricultural technologies. Farmers, fully satisfied with their finances, are likely not to invest in new projects (Granoszewski, Spiller 2012). Despite the objectivity of balance sheet numbers, indicating the company economic situation, there are several problems with the comparison of these numbers in the agricultural sector of Ukraine. For example, agroholdings may pass through different investment cycles, apply diverse profit & loss calculation methods, etc. As a consequence, researchers also work with subjective measurements of the company economic situation (Dawes 1999; Dess, Robinson 1984; Covin, Slevin 1994). Referring to Granoszewski, Spiller (2012) we expect a perceived positive economic situation in the agroholding to negatively influence the top-managers´ willingness-to-invest in biogas.

Energy Costs

The influence of perceived energy costs on the top-managers´ decision-making towards biogas emerged during the expert interviews (ch. 3.1). The experts suggested that growing energy prices motivate agricultural producers to better use their own resources. Conversely, scholars did not find significant correlation between investments in Renewables and energy prices, i.e. for natural gas, in developed countries (Sick 2014). However, we argue for a positive impact of high perceived energy costs of an agroholding on the top-managers´ willingness-to-invest in biogas.

Perceived Need of Waste Recycling

During the expert interviews we also discovered that agroholdings, which invested in biogas in 2000-2014, were impacted by the need of waste recycling. In many cases, a poor waste treatment led the agroholdings to diverse problems: penalty payments for missing waste recycling, conflicts with local citizens because of undesirable smells, soil pollution, etc.

Although we did not find any references in literature relating to the relationship between agricultural waste and biogas investments, we argue for a positive impact of perceived need of waste recycling on the top-managers´ willingness-to-invest in biogas.

Company Size

The influence of company size, namely of production factors (arable land, labour force, soil quality), on biogas investments was explored by Granoszewski, Spiller (2012). The authors found a significant positive influence of soil quality on the farmer decision behaviour. These results are consisting with the pioneering studies of Schramm (1977). His findings were confirmed by Yaron et al. (1992) who discovered a positive influence of production factors on the adoption rate of new agricultural technologies on farms. Voss et al. (2008) concluded that mainly larger farms in Germany decided to invest in biogas. We also argue for a positive impact of company size on the top-managers´ willingness-to-invest in biogas.

Based on the considerations, expressed above, we proposed the following hypotheses for organisational factors:

Hp. 6. The better the perceived economic situation in the agroholding, the lower is willingness-to-invest in biogas.
Hp. 7. The higher the importance of energy costs in the agroholding, the higher is willingness-to-invest in biogas.
Hp. 8. The higher the perceived need of waste recycling, the higher is willingness-to-invest in biogas.
Hp. 9. The larger the agroholding size, the higher is willingness-to-invest in biogas.

2.3 Individual Characteristics of the Decision-Maker

If one view decision-making as a social process, one can expect the decision to be affected by the individual´s specific factors, his social networks and personal circumstances. This chapter reflects the factors which are related to the individuals involved in the investment decision-making of agroholdings.

Risk Aversion

Risk aversion reflects a tendency of the individual to take or avoid risks in his decision-making (Pannell, Marshall 2006). The higher the individual´s risk aversion, the higher the tendency to invest in a new technology which is perceived to reduce risk (Shapiro et al. 1992). In contrast to it, if the innovation is perceived to increase risk, a risk averse individual will tend not to invest in this innovation (Ghadim et al. 2005). Voss et al. (2008) found that risk averse farmers in Germany tend to reject biogas investments. Sauer, Zilberman D. (2010) also approved a strong relationship between farmer´s risk aversion and decision-making on the example of automated milk systems adoption. These results have been endorsed by Kim, Chavas (2003a) on the example of irrigation technology adoption. Willock et al. (1999) suggested that farmer´s risk-taking attitudes are of major importance for explaining his decision-making. Therefore, we expect a negative impact of risk aversion on the top-managers´ willingness-to-invest in biogas.

Innovativeness

Concerning use of new technologies in organisations, researchers have found a relationship between the decision-maker´s innovativeness and innovation adoption (Marcati et al. 2008). The role of innovativeness in agriculture has been widely investigated by scholars (Granoszewski, Spiller 2012; Austin et al. 1998b; Willock et al. 1999; Roehrich 2004; Manning et al. 1995). Yaron et al. (1992) found that innovativeness correlated with the farm size. Voss et al. (2008) found that individual´s innovativeness had influence on biogas investments of German farmers. We expect innovativeness of the top-manager to have a positive impact on his willingness-to-invest in biogas.

The arguments for individual characteristics of the decision-maker, expressed above, are indicated by the following hypotheses:

Hp. 10. The higher the risk aversion of the decision-maker, the lower is willingness-to-invest in biogas.
Hp. 11. The higher the innovativeness of the decision-maker, the higher is willingness-to-invest in biogas.

2.4 Business Environment

In addition to organisational and individual factors, external business environment of the organisation has to be examined in the research framework. In the context of biogas investments in Ukraine, the following aspects are considered as decision relevant:

Perception of Green Tariff

Numerous scholars have investigated the positive role of preferential feed-in tariffs for lowering investor´s risks in Renewable projects (Lipp 2007; Menanteau 2003; Mitchell, Connor 2004; Mitchell et al. 2006; Bahrs et al. 2007; Ehlers 2008). Other researchers concluded that feed-in tariffs are the most effective support instrument, when compared to market-based approaches (Block 2006; Butler, Neuhoff 2004; Contaldi et al. 2007; Couture, Gagnon 2010). In contrast, Liebreich (2009) and Lesser, Su (2008) indicated negative impacts of feed-in tariffs. If designed inefficiently, i.e. set too high, they may offset the benefits of Renewables for the society by a welfare loss. However, we expect a positive relationship between the perception of green tariff and the top-managers´ willingness-to-invest in biogas.

Business Uncertainty

Business uncertainty has been often regarded as a primarily influencing factor for investments in innovative technologies, i.e. biogas (Aragon-Correa, Sharma 2003; Rothenberg, Zyglidopoulos 2007; Scupola 2014; Lee 2008). Weng, Lin (2011) refers environmental uncertainty as frequent and unpredictable changes of the external business aspects, perceived by the decision-maker. Li, Atuahene-Gima (2002) viewed uncertainty as the most relevant external aspect affecting business decisions of companies. In the case of high external uncertainty, business will address environmental changes by rapidly gathering new information (Gupta, Govindarajan 1984). To maintain company competitive advantages business will pay more efforts to increase the rate of technical innovation (Damanpour 1991; Kimberly, Evanisko 1981). Some scholars found that companies are more likely to invest in environmental innovations under uncertainty (Aragon-Correa, Sharma 2003; Rothenberg, Zyglidopoulos 2007). However, we argue for a negative impact of perceived business uncertainty in Ukraine on the top-managers´ willingness-to-invest in biogas.

Capital Availability

The capital needs may be high when investing in Renewable energies (Peter et al. 2002). Thus, lack of long-term capital may be a key barrier for biogas investments. Zinych, Odening (2009) suggested that financial resources are the main determinant for development of agricultural companies in Ukraine. A majority of interviewed experts has stressed negative impacts of the low capital availability on biogas investments. Based on these considerations, we argue for a negative influence of high interest rates on the top-managers´ willingness-to-invest in biogas.

Natural Gas Price

The interviewed experts suggested that uncertainty in gas supply and its price fluctuations have motivated agroholdings to look for options of reliable and independent energy supply. In a survey, conducted by Ukrainian Agribusiness Club (UCAB) in 2014, 47 % of Ukrainian agricultural producers emphasised energy price increase as one of the main obstacles for their business (Ukrainian Agribusiness Club (UCAB) 2014). Although scholars have not found a significant correlation between natural gas price and biogas investments in developed countries (Sick 2014), we argue for a positive impact of high natural gas prices on the top-managers´ willingness-to-invest in biogas.

The arguments for business environment factors, expressed above, are summarised by the following hypotheses:

Hp. 12. The better the perception of green tariff for biogas, the higher is willingness-to-invest in biogas.
Hp. 13. The worse the perceived business uncertainty in Ukraine the lesser is willingness-to-invest in biogas.
Hp. 14. The higher the perceived interest rate in Ukraine, the lower is willingness-to-invest in biogas.
Hp. 15. The higher the perceived natural gas price, the higher is willingness-to-invest in biogas.

3 Methodology

3.1 Sample Selection and Data Collection

Due to the lack of available data on biogas investments in the Ukrainian agricultural sector, first we conducted 34 face-to-face interviews with industry experts in the field of Renewable energies in Ukraine. As a second step of data collection, a database of target agroholdings was set up. In spite of a difficult political situation in the East Ukraine and the Crimean peninsula, the companies from these regions had to be excluded from the sample. The administration of the main survey took place in October-December 2015. We conducted 68 face-to-face interviews with top-managers of agroholdings from the collected database, which together cultivate 3.5 Mil ha arable land. Relating to the approximate number of 112 operating agroholdings in 2014 in Ukraine (Ukrainian Agribusiness Club (UCAB) 2015), our study represents 60.7 % of all agroholdings and 16.1 % of arable land of all agricultural companies in Ukraine.

Table 1 displays descriptive statistics of the sample. It can be seen that the group of interviewed agroholdings is fairly diversified with respect to the legal form, key business areas and arable land. Interviewed agroholdings are mostly limited or public liability companies (58.9 % and 27.9 % respectively) and have multiple business areas. In addition to arable and animal farming, 44.1 % of companies are food producers, i.e. meat, dairy or sunflower oil. Moreover, 52.1 % of agroholdings have also other businesses. The diversified business structure proves the common definition of agroholding as vertical incorporation of several enterprises in the agricultural value chain (Wandel 2011). Respondents are mostly senior executives of agroholdings: 87.0 % of the interviewed managers are in the executive level of agroholdings. The high-ranking profile of the interviewed managers can ensure a certain level of the responses accuracy, confirming the reliability of data collected.

Table 1: Descriptive statistics of the research sample (n = 68)

	N	%
Legal form of the enterprise		
Individual private farm	9	13.2 %
Limited liability company	40	58.9 %
Public liability company (including others)	19	27.9 %
Key business areas (multiple answer possible)		
Arable farming	65	95.6 %
Animal farming	50	73.5 %
Food production	30	44.1 %
Others (i.e. fertiliser production)	36	52.9 %
Arable land [ha]		
<10.000	28	41.0 %
>10.000-50.000	24	35.0 %
>50.000	16	24.0 %
Total arable land of the sample	3.5 Mil ha	60.7 % of all agroholdings
Total revenue [$ p.a. in average in 2012-2014]		
<1.000.000	1	1.5 %
>1.000.000-10.000.000	24	35.3 %
>10.000.000-50.000.000	21	30.9 %
>50.000.000	22	32.3 %
Responder´s position in the agroholding		
Executive level	59	87.0 %
Non-executive level	9	13.0 %

3.2 Operationalisation of Variables

The model variables were operationalised combining quantitative and qualitative scales, as appropriate. Interview partners were asked to express their individual agreement with the statements reflecting model variables. For these statements we used a 5-point Likert scale: from 1 – "agree strongly" to 5 – "disagree strongly". The statements were developed from the literature analysis and results of the expert interviews. The dependable variable "willingness-to-invest in biogas" was assessed by the statement: "We will invest in biogas in the following three years." Model variables, which originally consisted of multiple statements ("relative advantage of biogas", "economic situation", "energy costs", "perceived need of waste recycling", and "risk aversion"), were first factor analysed using orthogonal rotation. The procedure yielded a five-factor solution, representing the original model variables. The other independent variables were assessed by single statements (Table 2).

Table 2: Operationalisation of the model variables

Variable	Statement	Reference
Payback period	• If the payback period of biogas exceeds six years then such a project is not interesting for us.	• Pannell, Marshall (2006)
Investment cost	• Biogas requires large capital investments.	• Reise et al. (2012)
Relative advantage	• Biogas has more advantages for us than using of natural gas. • Biogas can improve the financial situation of our company. • We consider biogas to be an attractive investment.	• Tornatzky, Klein (1982); • Rogers (2003)
Perceived risk	• Please, evaluate an overall risk of a biogas investment for your company. [From very high to very low].	• Mitchell (1999); • Newall (1977)
Technology complexity	• Biogas is a complicated technological process.	• Weng, Lin (2011);
Economic situation	• We are satisfied with the financial situation of our company. • Our financial situation allows investing in new projects. • Key results of our business (revenue, profit) in 2012-2014 were excellent.	• Granoszewski, Spiller (2012); • Kollmann, Herr (2008)
Energy costs	• We are satisfied with the level of our heating and electricity costs. • We are not looking for possibilities to decrease our heating and electricity costs.	• Hertel (2014);
Perceived need of waste recycling	• Recycling of production waste is a problem for our company. • Production waste of our company has led to conflicts with local citizens.	• Expert interviews
Company size	• What number of hectares did your company cultivate in 2014-2015 financial year?	• Schramm (1977); • Granoszewski, Spiller (2012); • Reise et al. (2012)
Risk aversion	• When making decision regarding new investments we choose a project with a lower risk. • To achieve higher profits we are not ready to take higher risks in business.	• Voss et al. (2008); • Sauer, Zilberman D. (2010)
Innovativeness	• We are always among the first in Ukraine who apply and use modern agricultural technologies.	• Willock, J., et al. (1999)
Green tariff	• Investments in biogas without state guaranteed feed-in tariff are not interesting for us.	• Menichetti (2010); • Liebreich (2009)
Business uncertainty	• We are not sure in the development of economic situation in Ukraine and we are now cautious with new investments.	• Menichetti (2010); • Liebreich (2009)

Variable	Statement	Reference
Capital availability	• Interest rates in Ukraine make biogas investments not attractive for us.	• Zinych, Odening (2009)
Natural gas price	• Today´s natural gas price makes biogas an attractive investment.	• Expert interviews

The hypotheses of the conceptual model were tested by examining the multivariate linear regression model below:

$$Y_i = b_0 + \sum_{j=1}^{j} b_j x_{ij}$$

Where:

Y_i = Willingness-to-invest in biogas of the i-th observation (questionnaire)
b_0 = Constant term of the regression
b_j = Corresponding regression coefficients for the x_{ij} independent variables
x_{ij} = Influencing factors, presented in ch. 2.1 to ch. 2.4.

4 Results

A descriptive analysis of the responses revealed past and future investments of agroholdings in biogas. The data indicated that over a half of the agroholdings has already invested in some form of Renewable energies (Table 3). 48.5 % of interviewed agroholdings invested in biomass, mostly for energy purposes to reduce the natural gas consumption. Therefore, older gas boilers were replaced by straw, wood or pellets heating, in areas, where these energy sources were easily available in Ukraine. 14.7 % of agroholdings in the sample were already biogas producers. These projects generally aimed at waste recycling on large animal farms, sugar mills or food processing plants. 11.8 % of interviewed companies have undertaken investments in other types of Renewables, i.e. solar, wind or biofuels. These investments were small-scaled and, to a higher extent, considered by agroholdings as "experiments" (statement of the interviewed top-managers). 41.0 % of agroholdings in our sample were not familiar with Renewable energy investments.

Table 3: Firms exposure to prior investments in Renewable energies (n = 68)

	N	%
Prior Renewable energy investments		
Yes	40	59.0 %
No	28	41.0 %
Investments by technology (multiple answers possible)		
Biogas	10	14.7 %
Biomass	33	48.5 %
Solar, Wind, etc.	8	11.8 %

To analyse the determinants influencing the willingness-to-invest in biogas of agroholdings we estimated a multivariate linear regression model. First, it is worth signalling that the present study depicts a business context of large agricultural enterprises. The top-managers of these companies tend to minimise financial risks of their investments by grounding their choices on factual information available. They look for projects, promising a satisfactory profitability level, axed on acceptable risk as a prerequisite for the investment decision. Against this background, the multivariate regression model has provided some additional findings. In particular, we have identified significant causal relationships between top-managers´ attitudes towards biogas and top-managers´ willingness-to-invest in biogas, thus addressing the research question. Taking into account a sample size of 68 cases the linear regression model satisfies the statistical quality criteria (R^2 = .531; F-test = 3.932 with $p < 0.001$). This confirms the robustness of the developed conceptual model. The results of the statistical analysis are presented in Table 4.

Table 4: Results of the multivariate linear regression model (R^2 = 531; ***p ≤ 0,01; **p ≤ 0,05; *p ≤ 0,1)

Variable	Regression coefficient Beta	Standard error	T	Sig.	Variation inflation factor
Perceived Investment Attributes					
Payback period	**-.249**	.110	-2.261	**.028****	1.342
Investment costs	**.293**	.117	2.511	**.015****	1.515
Relative advantage	**.340**	.128	2.661	**.010*****	1.810
Perceived risk	-.034	.104	-.330	.743	1.203
Technology complexity	-.062	.113	-.552	.583	1.423
Organisational factors					
Economic situation	.075	.120	.628	.533	1.602
Energy costs	**-.368**	.109	-3.387	**.001*****	1.313
Perceived need of waste recycling	.127	.105	1.211	.231	1.221
Company size	**-.239**	.118	-2.031	**.047****	1.536
Individual factors					
Risk aversion	-.038	.118	-.319	.751	1.542
Innovativeness	.091	.117	.783	.437	1.510
Business environment					
Green tariff	.125	.110	1.136	.261	1.348
Business uncertainty	-.121	.140	-.866	.390	2.182
Capital availability	.022	.118	.184	.855	1.533
Natural gas price	-.062	.141	-.438	.664	2.201

As shown in Table 4, the perceived investment attributes of biogas represent the strongest predictor of the dependable variable. As hypothesised, a payback period (Beta = -.249, T = -2.261, sign. = .028) exceeding a six-year mark has a negative impact on the willingness-to-invest in biogas. This can be an indication that economic success of biogas is a "conditio sine qua non" (Masini, Menichetti 2013, p. 520) for the decision-making. In other words, the top-management seems to have stronger preferences for a technology which has already proven its financial efficiency. It also represents top-managers´ striving for profit maximisation by recouping his initial investments as soon as possible. These findings are in line with the works of Sachs (1973), Gasson et al. (1993), Cary et al. (2001) and Geletukha, G., et al. (2013).

In addition to the significant influence of the perceived payback period, also the perceived investment costs of biogas plants have a significant impact on the dependable variable (Beta = .293, T = 2.661, sign. = .015). These results support the findings of Reise et al. (2012), Granoszewski, Spiller (2012), International Finance Corporation (IFC) (2015) and International Renewable Energy Agency (IRENA) (2015). It is worth of mentioning that a positive sign of investment costs should not be interpreted directly[1]. Investment costs are an important determinant of the decision-making, with an indirect influence of its growth or decline on the top-managers´ willingness-to-invest in biogas.

[1] The positive sign would mean that increasing initial investment costs lead to a growing willingness-to-invest in biogas.

However, falling initial capital costs of biogas plants would probably not lead to a strong increase of biogas investments in the agricultural sector of Ukraine. The degree of perceived relative advantages of biogas (Beta = .340, T = 2.661, sign. = .010) has the strongest positive impact on the top-managers´ willingness-to-invest in biogas. These results endorse that of Tornatzky, Klein (1982), Rogers (2003) and Weng, Lin (2011). On the other hand, contrary to Meijer et al. (2007), Apak et al. (2011) and Chassot et al. (2014), the influence of perceived risk and that of technology complexity have been found as not statistically relevant in the present analysis.

In contrast with the hypothesised effect, the variables "energy costs" (Beta = -.368, T = -3.387, sign. = .001) and "company size" (Beta = -.239, T = -2.031, sign. = .047) are negatively associated with the willingness-to-invest in biogas. The explanation for energy costs might be that approx. 60 % of the interviewed companies had already invested in energy management before the interview took place in autumn 2015, mainly without biogas investments (Table 3). They might have reduced their energy costs largely by using wood biomass or straw for heating. We also assume that the studied companies might not consider biogas as an energy-cost-decreasing option. The negative influence of company size means that with decreasing arable land the willingness-to-invest in biogas grows. The interpretation of it might be that large-scale agroholdings are primarily concentrated on crops production. Hence, large agroholdings may oversee promising applications of biogas for them. Conversely, smaller companies often have high livestock population, resulting in larger waste amounts. Therefore, smaller agroholdings in our analysis showed a higher interest on biogas investments. In contrast to the findings of the expert interviews, the factor "perceived need of waste recycling" did not show statistically significant influence on the top-managers´ willingness-to-invest in biogas. This finding may have several explanations. First, mainly large agroholdings in Ukraine, which we addressed in the present work, do not generate high waste amount due to their concentration on crops cultivation. Therefore, primarily in agroholdings with high animal population the aspect of waste could be a significant factor for biogas. Second, biogas is not the only option of waste recycling. Composting of waste has been applied by several agroholdings, which required smaller initial investments than that for biogas.

Furthermore, the expected impact of individual factors could not be confirmed in the present analysis. Both factors "risk aversion" of the decision-maker and his "innovativeness" did not have a significant influence on the dependable variable. Our findings on risk aversion differ from that of other scholars (Shapiro et al. 1992; Willock, J., et al. 1999; Sauer, Zilberman D. 2010; Kim, Chavas 2003b; Ghosh et al. 1994) but confirm that of Masini, Menichetti (2013), what may also be associated with the limited sample size of 68 interviewed companies. Despite a low statistical significance level the initial hypothesised negative influence of the first factor and the positive impact of the second one could be proven in the analysis. Hence, the role of individual aspects needs to be researched more deeply. This implies, i.e. collecting more detailed information concerning the top-managers´ background. A categorisation of top-managers regarding their preferences for new technologies, the way they manage the company and make important investment decisions is also an interesting aspect to be further explored.

The variables related to external business environment did not demonstrate statistically significant coefficients. One explanation regarding green tariff can be that the interviewed agroholdings might reject the necessity to rely on governmental payments in the case of long-term investments. In fact, a 20-year horizon promised for green tariff in Ukraine may, contrary to the West-European countries, increase the perceived risk of agroholdings top-management because of the general political instability in Ukraine. Additionally, the research has also revealed that top-managers have limited knowledge relating to the legal framework for biogas support and bounded practical experience with Renewables. The questions in the questionnaire regarding the green tariff, its desirable duration and overall estimation of the legal framework for biogas in Ukraine were not answered by the majority of managers. An explanation can be that they have not yet become familiar with this topic. Although this is not surprising, since the biogas sector in Ukraine has emerged recently. Thus, at the moment of interview, the aspect of green tariff did not gain a high magnitude of influence concerning the top-managers´ willingness-to-invest in biogas. These findings may have profound implications for policy-makers in terms of communicating politics to business organisations in Ukraine. Additionally, this point should be taken into account in future studies of relationships between policy and investment.

Next, the variable "business uncertainty" did not show significant coefficients. Thus, our findings do not confirm the studies of Li, Atuahene-Gima (2002), Aragon-Correa, Sharma (2003), Rothenberg, Zyglidopoulos (2007). Current business uncertainty in Ukraine does not seem to motivate agroholdings to invest in technological innovations for maintaining their competitive advantages, as argued by Damanpour (1991) and Kimberly, Evanisko (1981). Negative impact of the geopolitical uncertain situation in Ukraine is also obvious. However, the statistically insignificant coefficients of this factor might find its explanation in the fact that life in Ukraine used to proceed under "stable instability". The ad-hoc political decisions regarding agricultural policies, high inflation, volatility of the prices for commodities and national currency devaluation are realities of Ukrainian business. Following this argument the statistically insignificant influence of interest rates on biogas can be also interpreted. Despite its clear negative impact on investments in the agricultural sector of Ukraine, proved in numerous studies (Zinych 2009; Zinych, Odening 2009), it may not have a definite relationship to biogas. If interest rates in Ukraine were lower, the agroholdings would probably allocate acquired financial resources in areas where capital needs are more obvious and acute: modernisation of agricultural machinery and buildings, paying previous debts, building cash reserves, etc. Thus, we assume that biogas projects would not directly favour from improved capital availability. Finally, an almost neutral statistical influence of natural gas prices, contrary to the findings of the expert interviews, might be explained similar to the factors "energy costs" and "perceived need of waste recycling". First, crops producers use relatively small amounts of natural gas. In this case, gas price increases may not be considered by the top-management as highly relevant in the annual financial statement of the agroholding. Second, due to the earlier gas price increase in 2006-2012, a majority of agroholdings might have already adopted to this situation during this time period. Thus, "the current natural gas price" as was asked in the questionnaire (Table 2), did not significantly influence the top-managers´ willingness-to-invest in biogas. Our findings also endorse the results of Sick (2014).

5 Conclusions and Implications for Theory and Practice

In the context of sustainable energy supply in Ukraine biogas technologies are regarded with increasing interest as an effective instrument for natural gas substitution. Yet, despite many advantages of biogas, biogas investments in Ukraine remain below expectations. In this paper the willingness-to-invest in biogas of Ukrainian agroholdings is investigated. We conducted 68 face-to-face interviews with top-managers of agroholdings which together represent 60.7 % of all agroholdings in Ukraine.

Our findings have proven that the conceptual model is able to capture the determinants influencing willingness-to-invest in biogas, as well as the direction and magnitude of the relationships between variables, therefore, providing answers to the research question. In particular, our analysis has revealed that the perceived investment attributes "payback period", "investment costs" and "relative advantage of biogas" play the most important role in driving the willingness-to-invest in biogas. Implicitly, these findings suggest that top-managers of agroholdings consider the proven financial efficiency of biogas technology and its comparable benefits as a necessary condition to invest in biogas. Therefore, the theories of rational choice and profit maximisation are suitable for explaining the willingness-to-invest in biogas in Ukraine. The results have also shown that in our sample the willingness-to-invest in biogas increases with reduction of arable land. The interpretation of it might be that large-scale agroholdings are primarily concentrated on crops production. Hence, large agroholdings may oversee promising applications of biogas for them. Conversely, smaller companies often have high livestock population, resulting in larger waste amounts. Therefore, smaller agroholdings in our analysis showed a higher interest on biogas investments.

The paper makes a contribution to the literature in the fields of organisational decision-making and agricultural economics. The development and examining of the conceptual model which embodies institutional and individual elements into the analysis of investment decision-making is an important theoretical contribution. It provides a more accurate description of the influence of decision relevant factors on the intention to invest in a new technology. Second, the research can advance the field of agricultural surveys. A majority of scholars has focused on a small farm production, where decisions are made by a single person (Groenwald 1987; Willock, J., et al. 1999).

By expanding the scope to large-scale agricultural companies, this paper contributes to evaluate and extend previous findings. Finally, since biogas industry is regulated under green tariff in Ukraine, understanding its influence on the willingness-to-invest in biogas of agroholdings may help policy makers design more effective support instruments.

Like most scientific research, the present work has its limitations. A first limitation is that our study is restricted to a special political and geographical context (Ukraine). Due to different conditions regarding legal framework in other world regions, i.e. the EU, our findings may be difficult to generalise. In order to validate the results and conclusions, it would be worth of trying to conduct a similar survey in countries where large agroholdings also operate: Brazil, China and Russia. Such future works would provide some interesting insights for international institutions, as well as for policy makers and professional organisations in the field of biogas. A second limitation pertains to a relatively small sample size. Although our survey represents 60.7 % of all operating agroholdings in Ukraine, the number of 68 cases has influenced the statistical estimations. Despite the fact that we have controlled the assumptions of regression analysis (multicollinearity, autocorrelation, etc.) the use of a larger sample would be necessary to validate our findings. A third limitation is that giving the confidential character of data collected, all model variables had to be measured by questionnaire. Due to reluctance of senior managers to disclose some specific information on their businesses mostly perceptual values had to be applied in the main study. In an ideal case, to measure investment activity of agroholdings we should have used objective data of economic performance of these companies.

To summarise, the recommendations derived from the present study are that more attention should be brought to communicating of Renewable energy policies in Ukraine to the business organisations. The design of the policy framework should take into account specific needs of the target group, in this case, agricultural producers. As expressed by one of the interview partners, the Government should give us clear signals that they want us to produce biogas. A mere increase of green tariff does not seem to significantly support a broader deployment of biogas in the agricultural sector of Ukraine. Therefore, if the share of biogas in Ukraine is to be increased, changes are needed not only in the field of governmental subsidies, but also in the social and cooperation contexts between business and state.

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