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**Article**

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# Renewable Energy Investment Stimulants in Polish Agricultural Holdings as a Part of Supporting Sustainable Agriculture<sup>1</sup>

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**Abstract:** The article concerns the analysis of the results of surveys conducted by the author in Lower Silesia region in Poland. The results of the research presented in the article have been narrowed down for the stimulants (benefits, advantages and reasons) of the renewable energy sources (RES) investment in agricultural holdings. Author also studied economic and social phenomena contributing to the RES increase in sustainable agriculture. The aim of the article is to identify and analyze the renewable energy investment stimulants in Polish agricultural holdings as a part of supporting sustainable agriculture. At the beginning the term of sustainable agriculture was defined as well as sustainable energy system. In the second part of the article the general overview on renewable energy sources in the Polish and the UE agriculture was presented. In the third part there was methodology, including sampling and purpose of the survey introduced. Next parts of the article concerned the results of conducted survey. The agricultural holdings investigation mainly were focused on the advantages of RES use in rural areas in Poland in the light of meeting sustainable agriculture goals. One of the most important aspects of sustainable agriculture is the use of sustainable energy systems, including RES. Investigated agricultural holdings emphasized: improving energy security, ensuring energy supply, as well as to be less dependent on future energy price increases, gaining health benefits (clean air and environment), using the local energy potential and enhancing energy security in the country and first of all, increasing opportunities for agricultural development. In the article there were used such research methods as statistical data analysis of conducted survey, synthesis, evaluation and observation

**Keywords:** Polish agricultural holdings, renewable energy sources, energy production, questionnaire surveys, sustainable agriculture

**JEL codes:** Q15, Q42, Q43

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## 1. Introduction

Treating the environment as a free good during the development of industrial agriculture has led to ecological imbalance and environmental degradation. Such management aimed only at generating and maximising economic benefits (profit) and focusing on intensifying production at all costs, without taking into account environmental constraints. Recognising the numerous dangers of further development of agriculture, related to the management of industrial formula, has made the sustainability of its development an important issue.

The concept of sustainable development is widely accepted and applicable in all areas of Polish economy, including agriculture (Roszkowska-Mądra, 2010:10).

It may be said that the European Union became focused on sustainable agriculture (Wrzaszcz, Zegar, 2016: 497-508). However, the term is differently interpreted by scientists (see Kociszewski, 2013: 44-49), which is noticeable in their focus on three pillars of sustainable development, defined as (Majewski, 2008: 36):

- environmental sustainability – capability of the system to produce without environment contamination,
- social sustainability – to satisfy basic needs of the population, ensuring social participation in the decision-making process,
- economy sustainability – the capability to generate satisfactory revenues, ensuring the right to use land and resources, technical capital, market access.

Similar interpretation of sustainable agriculture was introduced by J. Pretty (1995: 9), who emphasised the limitations of non-renewable resources, more socially fair forms of management, better usage of knowledge, local potential, and environmental conditions. This definition also refers to the importance of renewable energy sources (RES) in sustainable agriculture and usage of local energy resources such as: biomass, biogas, wind, solar power. Following K. Kociszewski, the durable category of sustainable agriculture, where the emphasis is on saving resources for the next generation, requires both the positive influence on environment and social participation in the process by all concerned parties (Kociszewski, 2013: 39).

One of the most important aspects of sustainable agriculture is the use of sustainable energy systems. Table 1 presents the difference between a conventional and sustainable energy system, which refer to the intra- and intergenerational justice, balance between economic, environmental and social goals, and, first and foremost, energy safety. The increased use of energy from renewable

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energy sources has an important part to play in promoting security of energy supply and technological developments, as well as in creating opportunities for the development of a low-energy market.

**Table 1. Conventional vs sustainable energy system**

<b>Non sustainable energy system</b>	<b>Sustainable energy system</b>
Focused on GPD growth	Focused on long-term environmental, economic and social aims
Dominance of economic aims	Balance occurs between economic, environmental and social aims
Managing fossil fuels without limits	Within and intergenerational justice- saving fossil fuels for the current and the next generation
Care for own interests, in terms of climate care- only compliance with the law and hardly meeting the EU requirements or paying penalties	Care for the climate, sustainable development policy, including CSR
Profits generated on monopoly markets	Profits generated on competitive markets
Regular management, regular technological and organisational solutions in terms of energy production	New technologies, ways of management in terms of energy production
Centralized energy system	Distributed energy (energy cooperatives, prosumers, mid-scale and micro-scale systems, off-grid systems)
Prevalence of fossil fuels	The emphasis on increase of RES in energy mix

Source: own elaboration based on Wach, 2008; Wielewska, 2017:191.

The research presented in this article were conducted in Poland, Lower Silesia region in 2016. Due to the limited capacity of the publication, in which, it is impossible to provide complete results of conducted surveys, as a goal of the article, identification and analysis of renewable energy investment stimulants in polish agricultural holdings as a part of supporting sustainable agriculture were chosen. The results of the research presented in the article have been narrowed down for the stimulants (benefits, advantages and reasons) of the renewable energy sources (RES) investment in agricultural holdings. Author also studied economic and social phenomena contributing to the RES increase in sustainable agriculture. At the beginning, the term of sustainable agriculture was defined as well as sustainable energy system. In the second part of the article the general overview on renewable energy sources in the Polish and the UE agriculture was presented. In the third part there was methodology, including sampling and purpose of the survey introduced. Next parts of the article concerned the results of conducted survey. In the article there were used such research methods as statistical data analysis of conducted survey, synthesis, evaluation and observation.

## **2. Renewable energy sources in the agriculture: Poland and the UE**

The EU and national regulations play a key role in the development of sustainable agriculture and RES. Firstly, agriculture is a producer of renewable energy, and secondly it can significantly reduce the use of fossil fuels and greenhouse gases emission, and it can improve the quality of life in rural areas (Alterra Wageningen UR, 2011:2).

Agriculture has the greatest potential for all renewable energy resources, especially solar and wind energy, as well as biogas and biomass (Wiśniewski, 2013:1). G. Wiśniewski stated that, according to the IPCC report, agriculture alone, excluding the needs of agricultural holdings, consumes more than 3% (8,000 PJ) of the world's primary energy balance. He also predicts that, thanks to the climate protection efforts, the overall share of renewable energy in the global energy balance will increase to 50%, and the share of renewable energy technologies in agriculture must increase to 2000 PJ as early as 2035 (Institute for Renewable Energy, 2016).

Scenarios introduced in "The Impact of Renewable Energy on European Farmers" report for the General Directorate for Agriculture inform about a fivefold increase of renewable energy produced in farms, from 11.8 million toe (tonnes of oil equivalent) in 2008 to 36-63 million toe in 2020 (Alterra Wageningen UR, 2011:2). The heat production output will exceed 6 Mtoe (Renewable Energy Institute, 2011). This increase is largely due to the production of electricity from renewable sources (more than 80% of total energy produced in agricultural areas, mainly due to wind turbines), whereas the increase in RES heat production, due to the improvement of its efficiency and the substitution with electricity, is estimated to remain small. The report confirms that agriculture is the only sector of the economy that produces many times more renewable energy than it consumes, so farmers are important players on the energy market, as they contribute the most to meet the EU's RES targets.

Taking into the account the report of The Institute for Sustainable Development, more than 50% of investigated Poles support the energy policy which develops RES in Poland. Moreover, in comparison to the previous study commissioned by this Institute in 2008 and 2009, support for RES has risen by 15% (Stanaszek, Tędziągolska, 2011:16-17).

The energy and climate policy of the EU obliges each country to implement instruments supporting RES development. In 2015, Directive 2009/28/EC (Directive 2009/28/EC) on the

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promotion of the use of energy from renewable sources was finally implemented in Poland by the new Renewable Energy Sources Act (Ustawa z dnia 20 lutego 2015). Unfortunately, the Polish Act on Renewable Energy Sources which passed by the Polish Parliament on the 20<sup>th</sup> of February that year was a return from the system of certificates of origin to the auction system, and to the implementation of different regulations for micro-installation of renewables. According to the last amendments of the Act (Ustawa z dnia 20 lutego 2015), the producers of renewable energy were deprived of the feed-in-tariff (FiT) system. The feed-in-tariff system means the price per unit (of electricity) that an eligible renewable electricity generator receives according to cost-based calculations for the specific resource used (European Commission, 2014: 29). This has made the RES micro-installation less cost effective in Poland.

The effectiveness of the FiT system is illustrated by the example of Great Britain and Germany. In 2008, there were less than 100,000 micro-installations in the UK for the production of heat and electricity. In 2009, there were introduced fixed tariffs. In 2011, there were 238.5 thousand micro-installations and at the end of the first quarter of 2012, 358.3 thousand (with a total capacity of 1.66 GW). The most popular installations (97.1%) were home ones. Only 12.2 thousand micro-installation were unrelated to buildings. However, Britain is not a country with great solar conditions, as almost 89% of the market for new renewables are photovoltaic installations (Central Feed-in Tariff register, 2013).

In Germany, guaranteed tariffs have led to market development and a significant reduction in the cost of RES technologies. It should be emphasized that since 2012, farmers in Germany have been producing renewable energy (photovoltaic, wind energy) cheaper than the price of electricity from the grid, thus increasing the competitiveness of German agriculture. There are already over four million renewable energy producers in this country, including almost two million electricity producers (average capacity is about 20 kW). Farmers account for 11% of all RES investors (share in total installed capacity), and in the photovoltaic (PV) sector they account for 22%. Farmers have invested more than €14 billion in the PV sector (Lettner, Aue, 2012).

### 3. The methodology of surveys

The main objective of the survey questionnaire was to identify and analyse factors influencing demand and supply for renewable energy in agricultural holdings<sup>2</sup>. The survey was conducted from April to May 2016 in agricultural holdings located in the Lower Silesian Voivodship in Poland as a computer-assisted telephone interview (CATI). The sample selection method was based on random sampling (division into: 5 hectares, 5 to 15 hectares, between 15 and 30 hectares, between 30 and 50 hectares, and over 50 hectares) (see Table 2). The statistical data was: maximum error: 4.36%, confidence interval at 95%, and fractional value: 0.5.

**Table 2. Structure of sample selection in agricultural holdings in the Lower Silesian Voivodship**

	Area to 5 ha	Area from 5 ha to 15 ha	Area from 15 to 30 ha	Area from 30 to 50 ha	Area <50 ha
<b>Number of farms in Lower Silesia</b>	29472	18071	5569	2149	2767
<b>%</b>	51%	31%	10%	4%	5%
<b>Sample size N= 501</b>	254	156	48	19	24

Source: Own elaboration

### 4. Research results

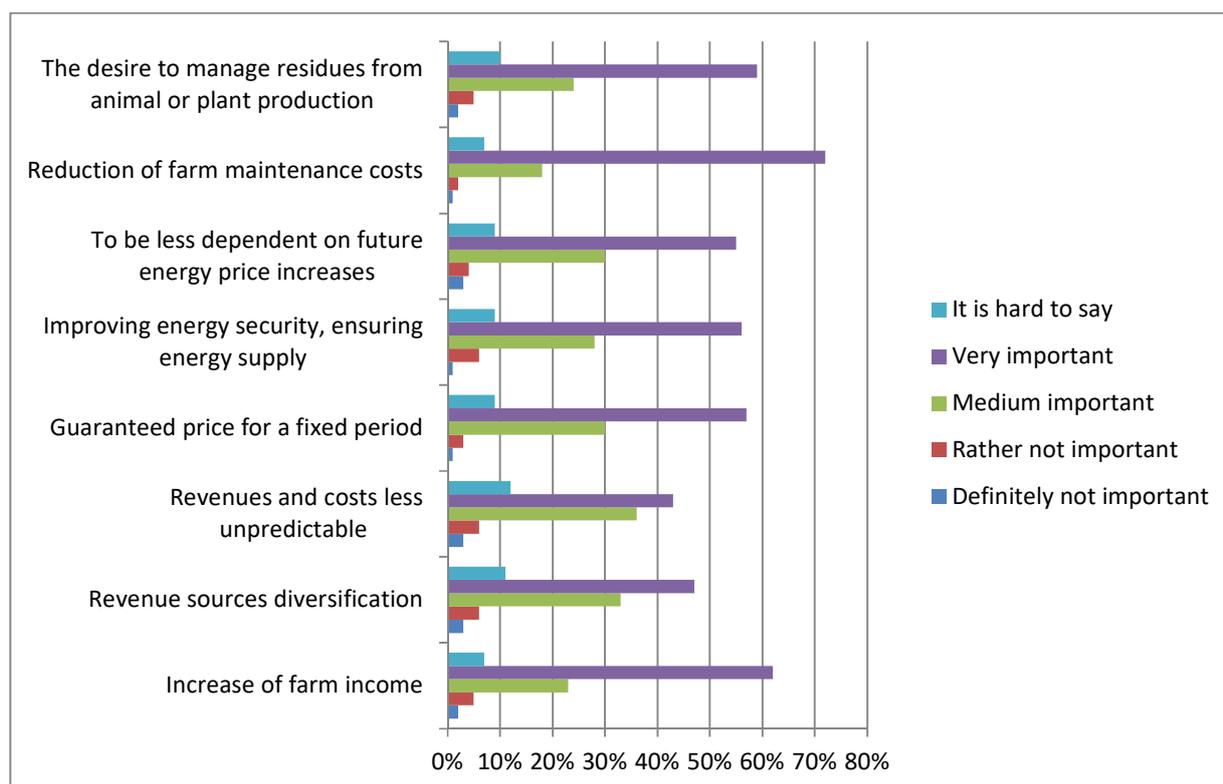
The research results presented in the article have been narrowed down for the reasons and benefits of the RES investment in farms in the Lower Silesia region. The author also studied economic and social phenomena contributing to the RES increase.

<sup>2</sup> “The holding of a legal person or an organisational unit without a legal personality is an agricultural holding run by legal person or an organisational unit without legal personality, the basic activity of which is f.e.:growing of crops, plant propagation, animal production, mixed farming, support activities for crop production”. “Holder of an agricultural farm is understood as a natural person or a legal person or an organisational unit without a legal personality actually using the land, regardless of whether he or she is an owner or a leaseholder, or uses the land in any other respect, and regardless of whether land constituting the farm is situated in one or in several gminas”, see GUS (2016). *Użytkowanie gruntów i powierzchnia zasiewów w 2015 r.* Warszawa: 25.

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The first question was to identify the benefits (reasons) of using RES in agriculture and their importance to the farmers. The most frequent reason of investing in renewables is reduction of farm maintenance costs (72%) and increase of farm income due to RES (62%). The study revealed that every second respondent considers the following as very important: improving energy security and ensuring energy supply, as well as to be less dependent on future energy price increases and having a guaranteed price for a fixed period. Less than a half of respondents outline the diversification of revenue sources and lesser unpredictability of revenues and costs as a very important factor. Analysing all the answers, we can notice that in each category of all presented benefits a maximum 6% of respondents stated that the benefits are rather insignificant or definitely not important. This is a good sign of the growing ecological awareness of farmers (see Figure 1).

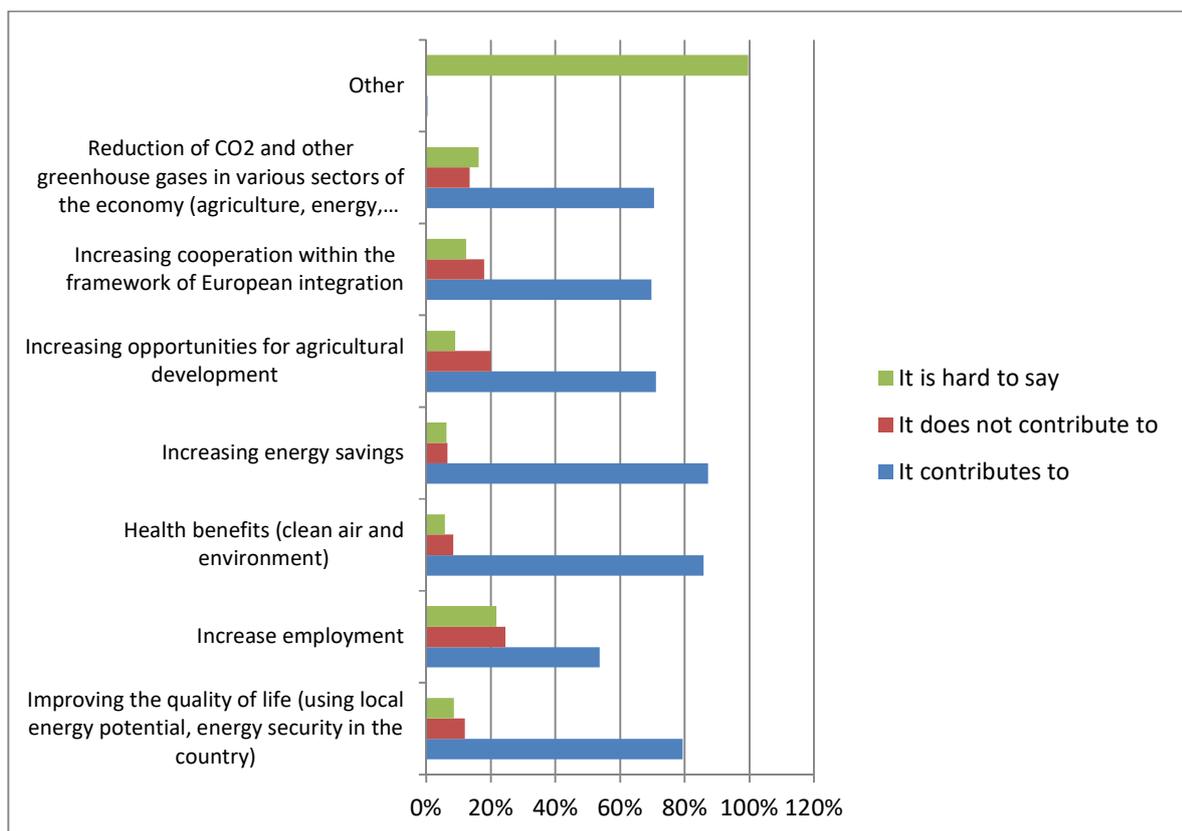
**Figure 1. The reasons (benefits) of using RES in agriculture**



Source: Own elaboration based on surveys.

Taking into consideration the economic and social phenomena contributing to the increased use of renewables, it is worth mentioning that 87% of respondents declare increasing energy savings and almost 86% indicate health benefits (clean air and environment). Almost 80% indicate such phenomenon as improving the quality of life by using the local energy potential and enhancing energy security in the country. More than two thirds of farmers point at the increasing opportunities for agricultural development, increasing cooperation within the framework of European integration and the reduction of CO<sub>2</sub> and other greenhouse gases in various sectors of the economy (agriculture, energy, transport). Every second respondent emphasises increasing opportunities for agricultural development (see Figure 2).

**Figure 2. The economic and social phenomena contributing to the RES increase**



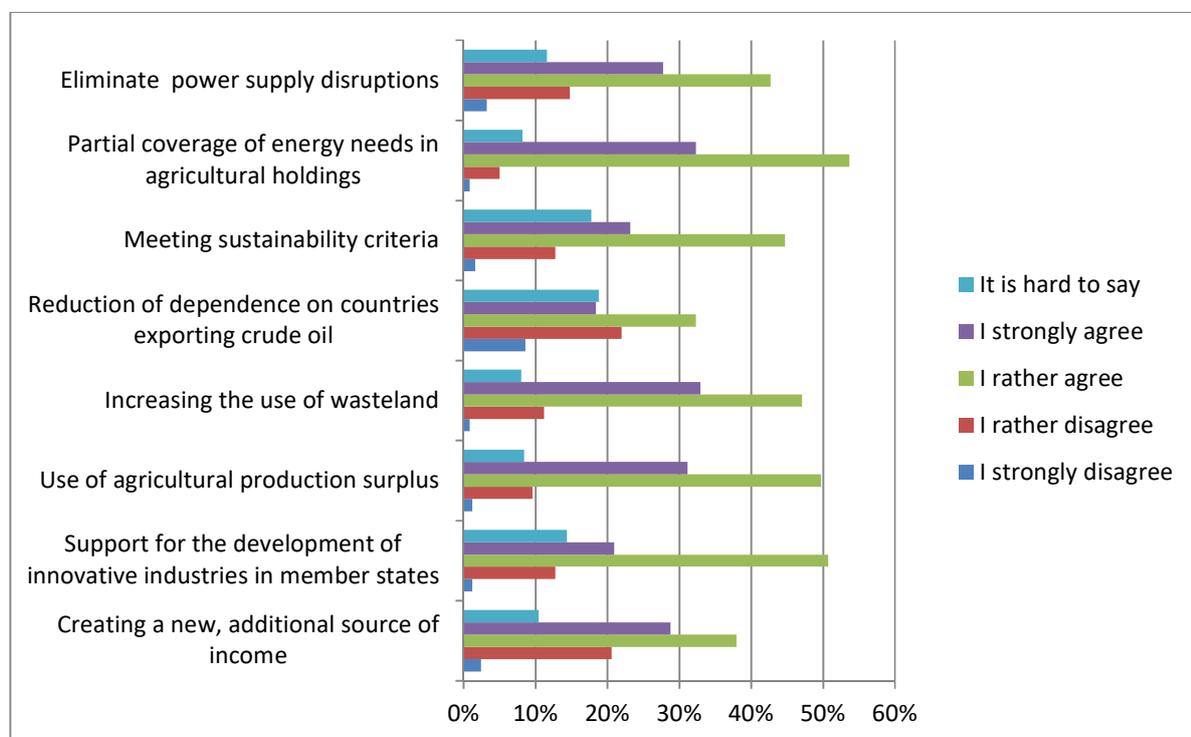
Source: Own elaboration based on own surveys.

The respondents were given several possible answers to the third question. They were able to assess them by a four-step scale from 1 to 4 where 1 = strongly disagree 2 = rather disagree 3 = rather

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agree 4 = strongly agree (see Figure 3). Responders were asked what kind of a role will be played by renewable energy from the Polish agricultural sector in transforming European agriculture into a sustainable model. The responses proposed to the farmers were mainly focused on the advantages of the RES use in rural areas in Poland in the light of meeting sustainable agriculture goals. Most of farmers rather agree with the presented statements. Every second respondent rather agrees that RES can support the development of innovative industries in member states and help use the surplus in agricultural production as well as partial coverage of energy needs in agricultural holdings. Less than half, but more than 40% of surveyed people indicate as an important issue the increasing use of wasteland, eliminating power supply disruptions and meeting the sustainability criteria. Only in one category, concerning the reduction of dependence on countries exporting crude oil, farmers are a bit indecisive: 18% of them definitely agree, 19% do not know, 22% rather do not agree and 32% rather agree with the statement. The reason for such a situation is probably the Polish energy policy, which still relies on fossil fuels.

**Figure 3. The role of renewable energy of polish agricultural sector in transforming European agriculture into sustainable model**



Source: Own elaboration based on own surveys.

To compare the research presented by the author, it is worth introducing the results of research conducted by the Institute for Renewable Energy (IEO). The survey was conducted on 800 farmers in eight regions from four EU countries: Germany, Austria, Poland and Spain. In Poland, the surveyed areas were the Mazowieckie Voivodeship and Warmian-Masurian Voivodeship. They confirm that farmers tend to invest in RES mainly for economic reasons. Another reason is the opportunity to contribute to the development of RES, and to be independent of future energy price increases. Polish farmers also pointed to an increase in agricultural incomes, availability of new technologies or technological advice (Renewable Energy Institute, 2011:5-7).

### **5. Other stimulants of RES development in rural areas in Poland**

Apart from the stimulators presented in the author's research, the following factors contribute to the increase of the use of RES in agriculture:

- **poor quality of energy services**, which encourages self-production and increases local energy security in rural areas. It is caused by frequent and long interruptions in the electricity supply, too much voltage in the distribution networks that can fluctuate from 180 to 230V. The length of unplanned interruptions in electricity supplies is in some areas of Poland more than several hours per year (Pytlos, 2014). The very low level of quality of energy services, especially in rural areas, is confirmed by the results of studies carried out by the Institute of Power Engineering in Gdańsk (Energy Institute, 2009). In this situation, it is impossible to connect the device which requires stable electricity supply, which results in limiting the development of modern agriculture. Having private power generation equipment, including energy storage, becomes a commendable solution.
- **much higher energy consumption in the agriculture than that of average households.** According to the research carried out within the OZERISE project, depending on their activity profile, farmers spend between 60% and almost 90% of their electricity consumption on production (OZERISE, 2013). For example, the annual demand for cold storage on a fruit farm was about 4,000 kWh per year, and the demand for energy used in a drying grains system about 9,000 kWh per year. Applying private RES installation could significantly reduce the energy costs (Karaczun, 2016: 3).
- **energy costs increasing relatively faster for farms.** In recent years, electricity costs for farms have increased faster than in private households. Currently, the share of electricity

costs in the costs of the entire agricultural production is already up to 15% in Poland. It is much higher than the average in industry (about 2-3% of production costs), even in the sectors that are considered to be the most energy intensive (the cost of energy amidst total costs varies between 8-12%)(Bukowski., Śniegocki,2014).

- **decline of investment costs for RES micro-installations.** It is estimated that till 2020, the price of electricity in Poland from private household photovoltaic systems will reach retail parity, and will be equal to or even lower than the price of electricity from the external network, especially if the Polish energy sector continues to include the subsidising costs of Polish coal mining (Karaczun, 2016: 1). It is worth mentioning that in 2006-2012, solar PV and wind energy experienced an annual worldwide capacity growth rate of 190% and 40% respectively. They both present the fastest growth of all types of renewable energy (International Renewable Energy Agency, 2015:3). Z. Karaczun estimates that the cost of autonomous systems, in comparison to increasing energy prices, may be so low in the next 10 years that for many citizens, especially farmers, it will be cost effective to disconnect from the distribution network (Karaczun, 2016: 1).
- **dynamic decline in home energy storage prices** (Battery storage, 2015:3). This may result in an increasing number of customers who want to disconnect from the distribution network (Karaczun, 2016: 2). The American Rocky Mountain Institute's experts, HOMER Energy and CohnReznick Think Energy estimate that in the upcoming five years, home energy storage prices will drop so significantly that US households will begin disconnecting from the grid (Why the Potential, 2014). The decline of energy storage prices will be the incentive for the rapid development of autonomous, individual energy systems. For instance, electric cars or lithium batteries can be used for energy storage.
- **guaranteed prices for the purchase of electricity produced in micro-installations.** For the next 15 years, a stable support system, e.g. guaranteed tariffs, may become a huge stimulant to the development of the RES market.

## 6. Final remarks

The European approach to sustainable agriculture is based on a coherent combination of environmental, economic and social goals. Using RES in the agriculture is a part of meeting

sustainability criteria in terms of intergenerational justice (saving natural resources, including fossil fuels, protecting environment by using clean green technologies).

The author's research shows that farmers are willing to invest in RES because it gives them confidence in the supply of energy, the possibility of diversifying their sources of income and their growth. Their income is then more predictable compared to agricultural production. The impulse to undertake these activities also forecasts rising energy prices in the coming years, falling investment costs of micro-installations and energy storage, and guaranteed revenues from the sale of green energy, most often in the form of FiT. In addition, farmers want to become less dependent on the increase of energy prices in the future and contribute to the development of RES.

The surveyed farmers also emphasize the health benefits (clean air and environment), improving their quality of life by using the local energy potential, and enhancing energy security in the country. Most of them indicated the increasing opportunities for agricultural development by using RES. The survey revealed that investing in RES in agriculture will help meet the goals of sustainable agriculture. More than 50% of respondents agree that RES can support the development of innovative industries in member states, help with the use of agricultural production surplus, and partially cover energy needs in agricultural holdings while meeting the sustainability criteria.

The agricultural sector will certainly be able to achieve a fivefold increase in RES production by 2020, accompanied by an increase in farm incomes and a positive impact on rural development as well as a reduction of greenhouse gas emissions. However, the profitability of RES production on farms is heavily dependent on many factors, for instance governmental support like using the feed-in tariffs system. According to the Institute for Renewable Energy in Poland, feed-in tariffs are very effective for RES investments in agricultural holdings. Guaranteed prices for fixed periods, dedicated primarily to small-scale RES, are the most desirable. Farmers are willing to accept lower tariffs if they are guaranteed in the long run (Renewable Energy Institute, 2011:8).

The so-called *Energiewende* (energetic revolution) in Germany is also taking place in Poland. The ecological awareness of the local community is growing. People are aware of the need to reduce air pollution, climate care and energy independence from the main electric energy distribution network (energy supplier). They attach increasing value to energy security. Large technological progress gradually enables them to implement investment plans in RES. If citizens find the governmental support system attractive, they will be willing to invest in renewables. This applies especially to farmers who are accustomed to investing in agricultural production.

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### ***Stymulanty inwestycji w energię odnawialną w polskich gospodarstwach rolnych jako element wspierania zrównoważonego rolnictwa***

#### ***Streszczenie***

Artykuł dotyczy analizy wyników badań prowadzonych przez autorkę na Dolnym Śląsku w Polsce. Wyniki badań przedstawionych w artykule zostały zawężone do stymulant (korzyści, zalety i przyczyny) inwestycji w odnawialne źródła energii (OZE) w gospodarstwach rolnych. Autorka zbadała także zjawiska gospodarcze i społeczne przyczyniające się do wzrostu OZE w zrównoważonym rolnictwie. Celem artykułu jest zidentyfikowanie i analiza stymulant inwestycji w energetykę odnawialną w polskich gospodarstwach rolnych w ramach wspierania zrównoważonego rolnictwa. Na początku określono definicję zrównoważonego rolnictwa i zrównoważonego systemu energetycznego. W drugiej części artykułu przedstawiono znaczenie odnawialnych źródeł energii w rolnictwie polskim i UE. W trzeciej części ujęto metodologię, w tym dobór próby i cel przeprowadzonego badania. Kolejna część artykułu dotyczy wyników przeprowadzonego badania. W badaniach rolników koncentrowano się przede wszystkim na zaletach wykorzystania OZE na obszarach wiejskich w Polsce w świetle realizacji celów zrównoważonego rolnictwa. Jednym z najważniejszych aspektów zrównoważonego rolnictwa jest stosowanie zrównoważonych systemów energetycznych, w tym OZE. Badane gospodarstwa rolne podkreślały: poprawę bezpieczeństwa energetycznego, zapewnienie zaopatrzenia w energię, a także mniejszą zależność od przyszłych wzrostów cen energii, przynoszenie korzyści zdrowotnych (czyste powietrze i środowisko), wykorzystywanie lokalnego potencjału energetycznego i zwiększenie bezpieczeństwa energetycznego w kraju a przede wszystkim, zwiększenie możliwości rozwoju rolnictwa. W artykule wykorzystano metody badawcze, takie jak: statystyczna analiza danych przeprowadzonego badania, synteza, ocena i obserwacja.

***Słowa kluczowe*** : polskie gospodarstwa rolne, odnawialne źródła energii, produkcja energii, badania ankietowe, zrównoważone rolnictwo

***Kody JEL***: Q15, Q42, Q43

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