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FARMERS' ATTITUDES TOWARDS RENEWABLE ENERGY SOURCES

Key words: renewable energy, solar energy, wind energy, geothermal energy, biofuels

ABSTRACT. The main purpose of the paper is to analyze the renewable energy market and its importance for the agricultural sector. In order to assess the renewable energy market in the agricultural sector, a questionnaire survey was carried out among farmers. The survey was conducted in the years 2020-2021 in a group of 400 farm owners. A 15-question questionnaire was used to conduct the study. This study covered two issues, namely: the use of renewable energy sources and the production of renewable energy on farms. In order to characterize the current state of the renewable energy market, secondary data from the Energy Regulatory Office (ERO) were used. The use of renewable energy in agriculture makes it possible to solve various challenges related to the use of fossil fuels, and what is important, is associated with little or no emission to the environment of pollutants and greenhouse gases. The conducted analyzes allow to draw conclusions that the market of renewable energy sources in rural areas has great potential and significant importance for the agricultural sector, however, it requires efforts to increase the interest in using renewable energy sources.

INTRODUCTION

Agriculture is the largest source of human food. Most agricultural machinery runs on fossil fuels which contribute to greenhouse gas emissions, which in turn is accelerating climate change. Such environmental damage can be mitigated by promoting renewable resources such as solar, wind, biomass, tidal energy, geothermal energy, small-scale hydropower, biofuels and wave power. It should also be mentioned that fossil fuels face problems related to the depletion of their resources, security of supply and climate change, hence renewable energy (RE) may offer the best prospects for their long-term replacement [Moriarty, Honnery 2016]. One of the main elements of the goals of sustainable development, including sustainable agriculture, is the implementation of renewable energy technologies. Hence, the important role of integrated renewable energy sources

in improving the productivity and environmental sustainability of the agricultural sector seems to be invaluable. Energy is necessary for human existence because it is required to meet basic needs [Oyedepo 2012a, 2012b, 2014, Bigerna et al. 2021]. Currently, it is important that the energy demand is growing and to meet this extreme demand, the most effective solution is to develop the use of renewable energy sources. This is due to the fact that fossil fuels are limited, their prices often fluctuate, and a large amount of greenhouse gases is emitted during combustion [Roy, Das 2018]. It should be remembered that the agricultural sector (both agricultural and forestry production) can be a source of renewable energy, such as biofuel or biomass, but can also make a significant contribution to mitigating the environmental impact of energy consumption by consuming sustainable energy [Martinho 2018, Zbieć et al. 2022]. Renewable energies play a fundamental role in the current political and social framework in minimizing the effects of climate change [Esteban et al. 2019]. The use of renewable energy sources (RES) to generate electricity, in particular, has aroused interest all over the world. This is largely due to the negative environmental impact of burning fossil fuels to convert energy, which releases enormous amounts of carbon dioxide and other greenhouse gases into the atmosphere [Dhinesh et al. 2018, Viteri et al. 2019, Al-Shetwi et al. 2020]. It should be noted that the 2030 Agenda for Sustainable Development suggests that all developed and developing countries strive to achieve seventeen sustainable development goals. The world is making progress towards goal no. 7 above Agenda, that is, “Ensure access to affordable, reliable, sustainable and modern energy for all”, with encouraging signs that energy is becoming more sustainable and widely available [OECD 2017]. Renewable energy sources can play an important role in the implementation of the above-mentioned assumptions, addressing the problems of fossil fuel depletion and global warming [Momete 2018]. Therefore, renewable energy sources are considered clean energy sources and are of critical importance due to their environmentally friendly nature [Qazi et al. 2019]. In order to meet the excessive demand for energy, there is now a global trend to replace conventional fuels with RES [Borovik, Albers 2018]. Bearing in mind the issues of sustainable development, it is important to maintain the water-energy relationship (mainly green energy) – food, which is proposed as a conceptual tool to achieve sustainable development [Rasul, Sharma 2016], which is most important in the case of agricultural production. Bearing in mind the directions of changes and the pursuit of sustainable development, it is important to use energy sources that contribute to the reduction of greenhouse gas emissions, including those from agriculture [Lenka et al. 2015, Lakshmi et al. 2020]. Renewable energies are considered an essential element of any strategy for sustainable energy development [Bhattacharyya 2006]. Renewable energy is energy produced using natural resources that are constantly replenished. The use of these sources does not contribute to the depletion of natural resources and the emission of unfavorable compounds to the atmosphere. Renewable energy has the potential to provide solutions (that are effective and sustainable) to various

problems in agriculture. The following renewable energy sources are particularly important in the agricultural sector: solar energy, wind energy, biomass, hydro and geothermal energy [Phuangpornpitak, Tia 2013, Goldemberg 2006].

These sources are a viable alternative to fossil fuels and can be used for both heating and electricity generation. The use of renewable energy sources in agriculture can contribute to the creation of sustainable agriculture, which is based on the concept of increasing the efficiency of crops and ensuring savings, while ensuring the reduction of the consumption of natural resources, and thus the reduction of the negative effects of climate change [Babatunde et al. 2019]. Due to the environmental and climate damage caused by the production of electricity in fossil fuel power plants, installations generating it from renewable energy sources are built. In Poland, the greatest development potential has the generation of electricity in photovoltaic cells, wind farms and agricultural biogas plants. Due to the inconvenience for people and the environment, wind turbines and agricultural biogas plants must be located far from residential buildings. Such conditions exist in sparsely populated rural areas [Szyba 2021].

The constant increase in energy demand on a global scale contributes to the increase in costs in almost every sector, including the agricultural sector [Shinde, Wandre 2015]. The use of renewable energy sources in agriculture offers opportunities to reduce production costs, improving its profitability, and also brings environmental benefits [Tolulope et al. 2014]. In the case of agricultural production, energy is mainly used for such activities as: irrigation, fertilization, livestock breeding, lighting, processing, cooling, storage [Wiedmann 2009, Oyedepo 2013, 2014, Babatunde et al. 2018]. According to the data of the Central Statistical Office, in 2015-2020, electricity consumption in agriculture increased from 1,500 GWh to 1,847 GWh. Therefore, renewable energy in the agricultural sector, including horticultural production, can be used to maximize self-sufficiency, save funds and reduce pollution, which is often emphasized in the literature [Bellows 2008, Sonneveld et al. 2009, Chikaire et al. 2010, Chel, Kaushik 2011, Carbone et al. 2011, Xue 2017, Taki et al. 2018]. The large-scale use of renewable energies in the agricultural sector may also play a significant role in combating climate change [Babatunde et al. 2019]. Thus, unlike fossil fuels, RES provide environmental protection, a pollution-free environment, energy security and economic benefits [Bhowmik et al. 2017]. Accordingly, there is a need to promote the use of renewable energy systems for sustainable agriculture, e.g. photovoltaic water and electricity pumps, greenhouse technologies, solar post-harvest dryers and solar hot water heaters. Due to the significant role of renewable energies in building sustainable development, including sustainable agriculture, this paper analyzes the renewable energy market and its importance for the agricultural sector.

Nevertheless, the subject of connections between the RES market and the agricultural sector is of great interest among researchers. There have been many analyzes that combine these issues, but most of them refer to the potential of the agricultural sector in

the field of electricity production in both economic, technical and technological aspects. The study presents the latest items related to the subject of renewable energy sources and the agricultural sector. Justyna Chodkowska-Miszczuk [2015] presented the topic of agricultural biogas plants in the context of the development of small-scale installations of renewable energy sources (RES) in Poland. Izabela Wielewska [2016] in her study presented the problem of the use of renewable energy sources in rural areas of the Pomeranian Voivodeship. Research has shown that the possibilities of implementing renewable energy in farms are large. The allocation of energy from renewable sources is mainly related to the the needs of animal and plant production, i.e. lighting of buildings, heating and cooling of rooms and products, heating of utility water and drying of agricultural crops. Jan Pawlak [2016] in his paper undertook the analysis of the production and consumption of renewable energy in Poland, with particular emphasis on agriculture. The paper by Piotr Sulewski et al. [2017] attempts to assess the importance of agriculture in the processes of renewable energy development in Poland and the EU. Their results indicated that in many countries, including Poland, despite the large production potential, the share of agriculture in the production of renewable energy is relatively small. It was emphasized that agricultural biogas plants could play a special role in the process of increasing the importance of agriculture in the development of renewable energy. Izabela Wielewska et al. [2017] in their research attempted to answer the question whether farmers consider energy from renewable energy sources a social good, obtaining a positive answer to the research question. Also Waław Jarecki and Justyna Kipa [2019] took up the topic linking RES and agriculture, namely the issue of rapeseed production in the EU, Poland and Podkarpackie Province in terms of the development of renewable energy sources, to show that Poland has the potential to use this species in RES. Andrzej Borusiewicz et al. [2020] discussed the functioning of the basic types of agricultural biogas plants. In the context of renewable energy sources and their relationship with agriculture, also Aleksander Kiryluk [2020], who presented the possibilities of obtaining energy from substrates of agricultural origin in the article. In connection with the above, it seems important to take up the indicated topic. Therefore, the paper aims to show farmers' attitudes towards renewable energy sources. The issue of renewable energy sources in the context of agriculture was also analyzed by Magdalena Sudoł and Anita Zapałowska [2020] in the context of the possibility of using straw as a local fuel in the Podkarpackie Voivodeship.

MATERIAL AND METHODOLOGY

In order to deepen the knowledge of the renewable energy market and its importance for the agricultural sector, this study consists of a systematic review of the literature on the subject and empirical research. Part of the literature research discusses the importance of renewable energy and its sources, with particular emphasis on its importance for the

agricultural rector. The research part analyzes the current situation on the renewable energy market in Poland. In order to characterize the current state of the renewable energy market, secondary data from the Central Statistical Office (CSO), and the Energy Regulatory Office (ERO) were used. In order to assess the renewable energy market in the agricultural sector, a questionnaire survey was carried out among farmers. This study covered two issues, namely: the use of renewable energy sources and the production of renewable energy on farms. The survey was conducted in the years 2020-2021 in a group of 400 farm owners. A 15-question questionnaire was used to conduct the study. However, for the purposes of this study, only selected results were used. The sample selection was deliberate. The aim was to conduct research in a diverse group of farmers. The respondents own farms with a diversified production profile and ran them in different areas of the country. A questionnaire was used to conduct the survey, which was sent to farmers, both electronically and in direct contact. The interviewers conducted research during industry meetings, which made it possible to reach a group of recipients from all over the country, diversified in terms of the type of production, age and education of farm holders. In order to prepare the most representative sample, the questionnaires filled by farmers conducting both plant and animal production were used for further analyzes. The proportion in terms of the production profile was 54% for plant production, 46% for animal production. The respondents were a group diversified in terms of age, education and the area of the farm. Nevertheless, the analyzes did not show any correlation between the interest in RES and the variables indicated in the previous sentence. Therefore, it was decided that presenting these statistics did not provide relevant information for the paper. The only important fact is that this group is diverse, thanks to which it gives an overview of the approach of a wide group of farmers. In most cases, the respondents did not answer the question about their annual income.

RESULTS

Green energy has become a serious alternative to the traditional one, using fossil fuels. According to the data of the European Environment Agency, the share of green energy in the total gross energy consumption (electricity, heat and fuels) in European countries doubled between 2005 and 2020, reaching an average of around 22%. Small installations of renewable energy sources (RES) benefit from the preferences related to the facilitation of formalities related to their commissioning. There is no need to obtain a license – only an entry in the register of small installation producers kept by the President of ERO1 is required. Such installations also benefit from the system of certificates of origin or are covered by support systems in the form of fixed feed-in-tariffs (FIT) or the system of subsidies to the market price (feed-in premium, FIP). Some of them also use the auction support system (Report of the President of the ERO). In the last quarter of 2021, pursuant

to the amendment to Art. 2 point 18 of the Act on Renewable Energy Sources [Journal of Laws of 2015, item 478], there has been a change in the definition of a small RES installation with regard to the value of the total installed electrical capacity. Until October 30, 2021, installations with a total installed electrical capacity greater than 50 kW and less than 500 kW were eligible for small RES installations. With the entry into force of the amending acts, their maximum installed capacity was doubled: from the upper limit of less than 500 kW to a power of no more than 1 MW. According to the data analysis, as of December 31, 2021, 1,932 small installations were registered in the register of energy producers in small installations in Poland (may own several installations) (Table 1). According to the data, the ERO data shows that this value was 1034 higher than in the previous year, it should be noted, however, that this increase was mainly due to the change in the regulations on the range of total installed electrical capacity that defines a small RES installation. The largest group in terms of the number (1,128 installations) were small installations

Table 1. RES installations entered in the register of energy producers in a small installation (as of December 31, 2021)

Types of RES installations	Number of installations	Installed power [MW]	Amount of produced energy [MWh]	The amount of energy sold [MWh]
Using hydropower	375	77,074	180 667,889	167 188,810
Using the energy of solar radiation	1 128	758,541	115 500,566	81 799,875
Using wind energy	294	170,919	57 223,023	55 773,029
Using the biogas	132	43,287	178 770,271	48 098,377
Using biomass	3	0,670	0	0
Total	1 932	1 050,491	532 161,749	352 860,091

Source: own study based on [ERO 2022]

A survey conducted among farmers showed that the main source of renewable energy they use is solar radiation. Over 74% of the respondents declared that they use this energy source on their farms (Table 2). The least popular were hydropower and geothermal energy, in the case of which farmers do not use them and do not have plans, which is due to the fact that in the area of their agricultural activity it is not possible to use such energy sources. There was also little interest in renewable energy installations using raw materials of agricultural origin, i.e. biogas plants (including home agricultural biogas plants) and installations generating energy from biomass.

Table 2. The respondents' attitudes regarding renewable energy sources

Types of renewable energy		The respondents' attitudes [% of responses]				
		yes	probably yes	rather not	I don't know	no
Are there renewable energy installations in your commune?	hydroenergy	-	-	-	-	400
	photovoltaics	376	-	-	24	-
	wind energy	5	4	43	-	349
	biogas plants*	1	-	-	399	-
	biomass energy	4	-	23	373	-
	geothermal energy	-	-	-	400	-
Are you using renewable energy?	hydroenergy	-	-	-	-	400
	photovoltaics	298	-	-	-	102
	wind energy	1	-	-	-	399
	biogas plants*	1	-	-	-	399
	biomass energy	0	-	-	-	400
	geothermal energy	-	-	-	-	400
Are you interested in using renewable energy	hydroenergy	-	-	400	-	-
	photovoltaics	-	-	-	24	-
	wind energy	-	-	400	-	-
	biogas plants*	-	-	362	38	-
	biomass energy	-	-	43	-	357
	geothermal energy	-	-	-	-	400
Are there any information campaigns on renewable energy sources in your commune?	298	-	-	89	13	
Are there any programs supporting the development of obtaining energy from renewable sources in your commune?	-	21	95	273	11	
Do you produce plants that are used for energy production?	1	-	-	-	399	
In the event that there was an outlet, would you decide to produce energy crops/use the products for energy production?	21	132	-	150	97	

* Including home agricultural biogas plants

Source: own study based on survey research

Respondents who did not indicate the use of RES and did not declare their interest in changing this state as the main reason for their decision indicated the uncertainty as to the requirements (legal, environmental, etc.) in the future in the field of RES use (19%). In addition, the most frequently mentioned factors were: too high cost of building the installation, lack of conviction about economic benefits, fear of negative impact on humans (14% each) and lack of financial resources for the construction of RES installations (13%) (Figure 1).

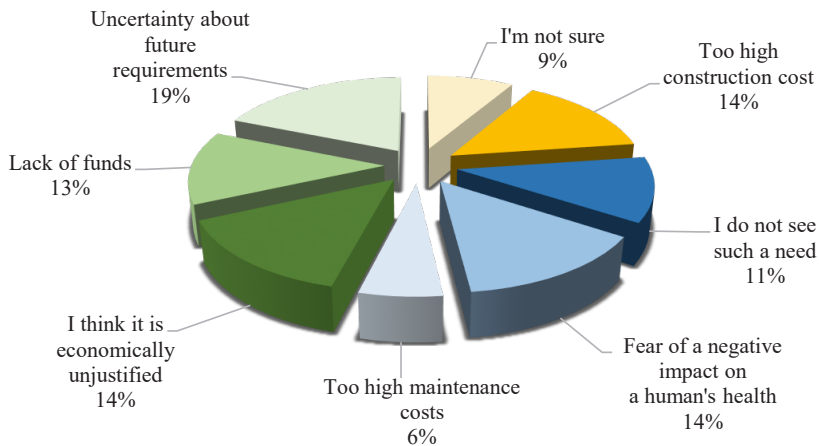


Figure 1. Factors influencing the lack of interest in RES installations among the surveyed farmers

Source: own study based on survey research

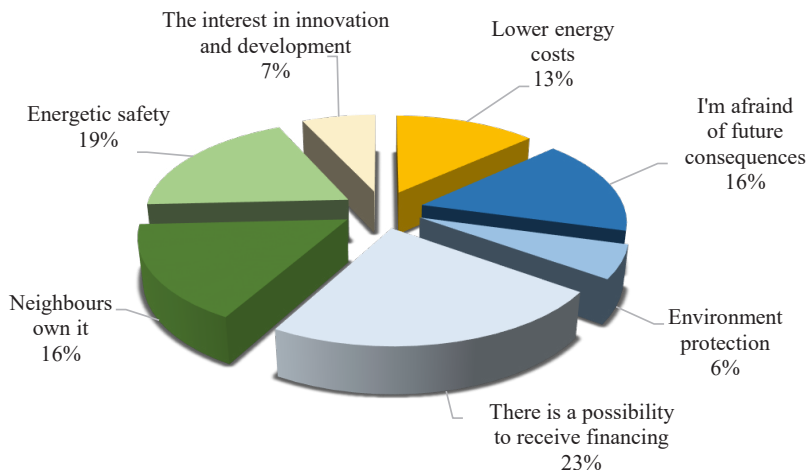


Figure 2. Factors influencing the decision to build renewable energy installations among the surveyed farmers

Source: own study based on survey research

Respondents who have installations to obtain energy from renewable sources indicated that when deciding on such an installation, they were mainly guided by the possibility of obtaining funding for the construction of renewable energy sources, the beneficiaries of which were. Among the important sentiments, energy security that can be achieved when using RES, fear of future consequences in the absence of such an energy source (i.e. legal restrictions, problems with traditional heat sources) and the fact that neighbors have renewable energy.

SUMMARY

It should be mentioned that the development of agriculture will require looking for solutions in the area of limiting electricity consumption and increasing the share of renewable energy in production processes in rural areas. Local production of energy for own needs from stable sources can significantly increase energy security in rural areas, which is of increasing importance. In Poland, the number of renewable energy installations is growing every year, and thus also the installed capacity and the amount of generated energy. The amount of raw materials used for energy production, including the production of agricultural biogas, is also gradually increasing. Despite the interest in the use of renewable energy sources by farmers, many of them indicate that they feel uncertain about the requirements (legal, environmental, etc.) in the future regarding the use of renewable energy sources. Moreover, they indicate that the costs of building renewable energy installations are too high for their budget. At the same time, many of them are not convinced whether such a solution is economically justified. At the same time, farmers who have energy from renewable energy sources declare that having such an installation enables them to obtain energy security. The conducted analyzes allow to draw conclusions that the market of renewable energy sources in rural areas has great potential and significant importance for the agricultural sector, however, it requires efforts to increase the interest in using renewable energy sources.

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POSTAWY ROLNIKÓW WZGLĘDEM ODNAWIALNYCH ŹRÓDEŁ ENERGII

Słowa kluczowe: energia odnawialna, energia słoneczna, energia wiatrowa,
energia geotermalna, biopaliwa

ABSTRAKT

Głównym celem artykułu jest analiza rynku energii odnawialnej i jego znaczenia dla sektora rolnego. W celu oceny rynku energii odnawialnej w sektorze rolnym przeprowadzono ankietę wśród rolników. Badanie przeprowadzono w latach 2020-2021 na grupie 400 właścicieli gospodarstw. Do badania wykorzystano kwestionariusz składający się z 15 pytań. Badanie dotyczyło dwóch zagadnień, a mianowicie: wykorzystania odnawialnych źródeł energii oraz produkcji energii odnawialnej w gospodarstwach rolnych. W celu scharakteryzowania obecnego stanu rynku energii odnawialnej wykorzystano dane wtórne z Urzędu Regulacji Energetyki (URE). Wykorzystanie energii odnawialnej w rolnictwie umożliwi rozwiązywanie różnych wyzwań związanych z wykorzystaniem paliw kopalnych, a co ważne, wiąże się z niewielką lub zerową emisją do środowiska zanieczyszczeń i gazów cieplarnianych. Przeprowadzone analizy pozwoliły na wyciągnięcie wniosków, że rynek odnawialnych źródeł energii na obszarach wiejskich ma duży potencjał i istotne znaczenie dla sektora rolnego, jednak wymaga podjęcia wysiłków na rzecz zwiększenia zainteresowania wykorzystaniem odnawialnych źródeł energii.

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