

RENEWABLE ENERGY AND ITS IMPACT ON THE DEVELOPMENT OF RURAL AREAS

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Abstract. The aim of the study is to present the issues of renewable energy sources and their importance in the development of rural areas. In Poland, renewable sources of energy, out of which 71 % are biomass-based, are created in rural areas. The desk research method of an analysis was used in the paper. The analysis of the subject literature and data from the GUS, URE and EUROSTAT databases have rendered it possible to establish the facts, verify the data and present the results obtained. The research has shown that renewable energy sources are a prospective direction of energy development of rural areas, which is mainly due to the availability and inexhaustibility of natural energy carriers. At present, the attitude towards RES has changed because of the lack of support for RES or unfavourable conditions for certain sectors of RES, to name but a few. While it is true that RES not only allow to secure the energy needs of the region and bring about many positive social and economic phenomena, meeting the 15 % requirement in 2020 might be problematic and it might prove necessary to purchase energy from neighbouring countries.

Key words: renewable energy, energy security, rural areas.

JEL code: Q42

Introduction

The natural environment is a set of elements closely related to each other by a network of mutual dependencies. Any interference, even with one of those elements, triggers larger or smaller transformations in the environment, which have both a local and a global dimension. This environment is also a source of valuable resources, not only conventional but also renewable. This provides inexhaustible energy resources, which is important for ensuring energy security.

Energy security is the main task of the state and should be understood as:

- 1) security of supply, i.e. ensuring continuity and quality of energy supply at the level resulting from social and economic needs. At the national level, this also means reducing dependence on energy imports;
- 2) economic security understood as ensuring that energy prices will not create barriers to economic development and will not lead to energy poverty;
- 3) ecological safety, which means that energy production will not cause excessive pollution of the environment or its irreversible changes (including depletion of resources) (Karaczun Z., 2012; Wilczynski M., 2013).

In the global economy, a steady increase in the use of unconventional energy has been observed for over than ten years. The precursors to the development of this energy sector are mainly the Member States of the European Union, which first ratified the Kyoto Protocol – an international treaty on an agreement on fighting global warming (Graczyk A., Wielewska I., Piaskowska-Silarska M., 2017).

In order to promote the development of renewable energy, many countries in the world, including Poland, increase their expenditures on RES technologies each year. This is to increase the importance of energy produced in this way, so that it is an alternative to the energy produced from coal or oil. In the future, this will allow even a complete departure from energy production from traditional sources (Michalcewicz-Kaniowska M., Zajdel M., 2017).

The use of renewable energy sources (RES) is closely related to the following factors: diversity of renewable sources, savings on fossil fuels, permanent renewal of resources, fixed unit cost of

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obtaining energy from these sources, minimal impact on the environment, occurrence of RES in various intensities in any location, no need for long-distance transmission of energy in connection with obtaining it from RES in any location (Nowacki M., 2010).

Energy from renewable sources is gaining more and more opportunities for use because it is perceived as ecologically "clean" and in accordance with the principles of sustainable development.

Rural areas are an excellent area for the development of renewable energy. This is due to the fact that agriculture has the largest potential of renewable energy resources, mainly biomass and biogas. In addition, rural areas are characterized by a considerable distance from the fields of conventional energy carriers and transmission networks, which results in an increase in the use of energy from renewable energy sources classified as so-called distributed energy.

It should be noted that the advantage of renewable energy sources is a less harmful and more efficient energy production process, as well as its distribution and maintenance of homeostatic equilibrium between: energy security, meeting social needs, competitive management and environmental protection.

The aim of the study is to present the issues of renewable energy sources and their importance in the development of rural areas. It was assumed that the use of RES in rural areas is related, among others, to the diversity of renewable sources, savings in fossil fuels, the minimization of negative impact of those sources on the natural environment, no necessity to send energy over large distances – it is possible to acquire it anywhere, on the spot, and energy security. The article uses the desk research method of an analysis. The choice of methods was determined by the availability of source materials (including literature in the subject of renewable energy sources, rural areas, innovation, data from the Central Statistical Office, ERO, EUROSTAT), which allowed to establish facts, verify data and present the results.

Research results and discussion

The deteriorating condition of the natural environment and the prospects of depletion of fossil fuel energy reserves have significantly influenced the formation of a sustainable energy policy, both in the European Union and in Poland (Wielewska I., Zuzek D.K., 2015).

Renewable energy sources are conducive to respecting the principles of sustainable development in the aspect of energy management. This principle is consistent with the basic objectives of the energy and climate policy of the European Union (Wielewska I., 2016).

Renewable energy source means "primary energy, which is perceived as inexhaustible from the human time horizon" (Reichel M., Czambor F., 2013). RES are renewable, non-fossil energy sources including wind energy, solar energy, aerothermal energy, geothermal energy, hydrothermal energy, hydro energy, wave, current and tide energy, energy obtained from biomass, biogas, agricultural biogas and bioliquids (RES Act of 2015).

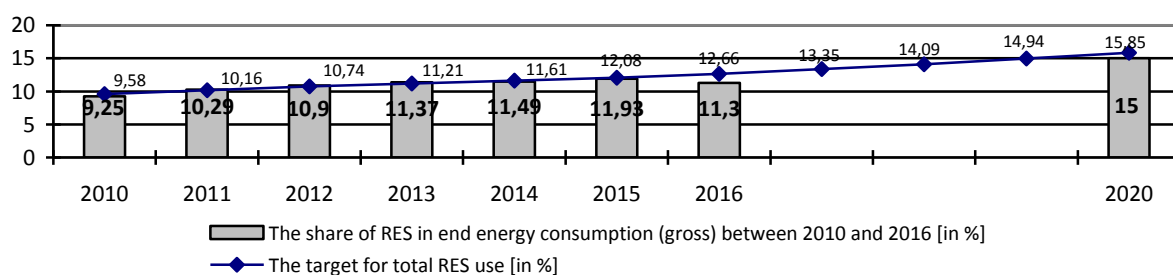
The European Union (EU) has imposed on all its Member States the obligation to produce and use renewable energy sources. Indices for the entire EU as well as its individual Member States are included in *Strategy Europe 2020* published in 2010 (European Commission 2010).

In Poland, specific tasks related to the use of energy from renewable sources were first presented in 2001 in the document called "Strategy for the Development of Renewable Energy", which sets quantitative objectives for the development of renewable energy in Poland by 2020. For Poland, this target objective is 15 % share of energy from renewable sources in the general balance until 2020 (Graczyk A., Wielewska I., Piaskowska-Silarska M., 2017).

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Source: author's own study based on GUS (2017) and KPD (2010)

Fig. 1. The specification of the share of RES use in end energy consumption in Poland between 2010 and 2016, with the target set in the National Action Plan

Taking into consideration the pace of changes that occur in the entire sector of renewable energy sources, it can be concluded that the 15 % output in 2020 will be very difficult to reach. Data suggest (Figure 1) that the share of RES ceased to increase and was 11.3 % in 2016 – 0.63 % less than in 2015, which shows that it was not consistent with prior assumptions (12.66 % in 2016) included in the National Action Plan (KPD) in the field of energy from renewable sources. This decrease may mean that Poland might have to purchase part of RES from another country.

The demand for energy, including renewable energy sources, is systematically growing. The structure of the acquisition of primary energy from RES according to sources in Poland and selected countries of the European Union is presented in Table 1. In the countries of the entire EU, biomass energy obtainment amounts to 44.6 %. Acquisition of energy from water takes the second place in the EU (14.3 %), and wind energy comes third (12.7 %). In the EU countries, it is the geothermal energy that has the lowest share in the structure of energy production from RES (3.2 %).

Table 1

The structure of energy obtainment according to RES in Poland and selected* European Union member states [in %]

Item	UE=28	Austria	Czech Rep.	Finland	France	Nether-lands	Lithuania	Germany	Poland	Slovakia
Solid biomass	44.6	48.1	69.0	76.0	45.2	28.3	82.2	31.0	73.2	55.9
Solar energy	6.4	2.9	5.0	0.0	3.4	2.6	0.4	10.3	0.5	3.1
Energy from water	14.3	34.2	3.6	13.9	21.9	0.2	2.0	4.2	1.7	20.9
Energy from wind	12.7	4.5	1.2	1.9	8.5	13.5	4.8	17.5	10.4	0.0
Biogas	7.6	3.2	14.3	1.0	2.5	6.8	1.6	20.2	2.5	9.3
Bio-fuels	6.7	4.8	5.0	4.6	11.8	29.9	7.8	8.5	10.4	9.4
Geothermal energy	3.2	0.4	-	-	1.0	1.2	0.1	0.5	0.2	0.4
Recyclable municipal waste	4.6	3.0	1.9	2.6	5.7	17.5	1.1	7.7	0.4	0.9

*presenting only selected EU states results from the availability of data from GUS (Statistical Office)

Source: Energy 2017, p. 27

The most widespread source of energy acquisition in all selected countries included in the Table 1 is solid biomass. The top countries are Lithuania, with 82.2 % share of biomass as a source of renewable energy, Finland (76.0 %) and Poland (73.2 %). Water is an eagerly used renewable energy source in many EU countries. The largest energy producers using this source are Austria (34.2 %), France (21.9 %) and Slovakia (20.9 %). In Poland, energy acquisition from this source fluctuates around 1.7 %. Wind is another source of energy. Germany (17.5 %), the Netherlands (13.5 %) and Poland (10.4 %) have the highest percentage of energy use from this source. Other renewable energy sources are used by individual countries to a lesser extent.

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According to the Polish Central Statistical Office data (2017), the indicator of biomass utilization for energy purposes in Poland in 2016 accounted for 70.74 % of total energy obtained from RES. In the period of 2012-2016, the share of wind energy increased from 4.79 % to 11.93 %, biofuels from 7.96 % to 10.16 %, biogas from 1.97 % to 2.88 %, solar energy from 0.17 % to 0.58 %, while the share of water energy decreased from 2.06 % to 2.03 %.

Currently, biomass is one of the most frequently used renewable energy technologies in Poland. The advantages of using it for energy purposes include, among others: the possibility of a constant supply of energy from the domestic market; providing additional income that is difficult to obtain in case of food overproduction; creating new jobs in rural areas; reduction of CO₂ emissions, and thus an improvement of the state of the environment; economic, commercial and industrial activation of rural communities; decentralization of energy production, greater energy security of Poland (Lewandowski W.M., Klugmann-Radziemska E., 2017).

Within the current legislation, it is the local boroughs that have the responsibility to prepare assumptions for plans for supplying heat, electricity and gas fuels. However, a small number of Polish boroughs meet this obligation. The main action in this direction should be improvement of local energy security, based mainly on energy from renewable sources, which are an environmentally beneficial alternative for dispersed rural settlements (Wielewska I., 2014a).

Some of the most important elements of energy policy implemented at the local level should be:

- striving to save fuel and energy in the public sector;
- maximizing the use of the locally existing potential of renewable energy, both for the production of electricity, heat, cold, combined production, as well as for the production of liquid biofuels and biogas;
- increasing the use of high-efficiency heat and power generation technology in combined systems as a favourable alternative to supplying heating systems and large facilities with energy;
- development of locally centralized heating systems, which allows to achieve improvement in the efficiency and ecological parameters of the heat supply process and increase the local level of energy security;
- modernization and adaptation to the current needs of the electricity distribution network customers, with particular emphasis on the modernization of rural networks and networks supplying areas characterized by low energy consumption (Graczyk A., 2010).

In Poland, rural areas occupy about 90 % of the country's area, and although the energy potential of most of those areas allows for energy self-sufficiency, they are characterized by a low degree of the use of modern energy sources, based more on satisfying energy needs with cheap, easily available, high-emission carriers that are not friendly to the environment and health of the local community. Coal and wood are most commonly used (over 80 %), which are burnt in inefficient home installations. This poses the threat of the so-called low emission, which includes pollutants emitted from sources at a height of up to 40 metres, i.e. emitted mostly by obsolete heating devices. On top of this, there is also the common use of poor quality fuels or burning waste. In rural areas, it is also common to occasionally run the heating stoves outside the heating season, which generates very large amounts of pollution. Another feature of these areas is the extremely poor condition of electricity distribution networks, which, combined with the distance from the generating units, causes power outages. The phenomenon of power outages does not only

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limit the development capacity of regions, but, above all, has a negative impact on the quality of life of the residents, particularly during the winter. Therefore, the energy policy in rural or little urbanized areas faces the same challenges as national power industry (Graczyk A., Wielewska I., Piaskowska-Silarska M., 2017).

Table 2

RES installations in Poland

No.	Installation type	Number of installations	
		2016	2017
1.	Biogas power plants	301	305
2.	Biomass power plants	41	45
3.	Using solar radiation	473	579
4.	Wind power plants	1 193	1 206
5.	Water power plants	761	766
6.	Plants using co-combustion technology	35	35
7.	Total	2 804	2 936

Source: <https://www.ure.gov.pl/uremapoze/mapa.html> (access on 19.01.2018)

It is the renewable energy management alone that can be an opportunity to level the development conditions of rural areas, where there is a major dispersion of consumers and the infrastructure of energy supply is poor. Sustainable energy management should aim at ensuring a sufficient level of energy services for all people within the limits of nature's tolerance (Wielewska I., Zuzek D.K., 2015).

Newly emerging investments (according to Table 2, an increase by 132 during the year) are becoming a great opportunity for sustainable development of rural areas, including the interdependence of socio-economic factors (stimulation of local business initiative, providing jobs for less qualified workers, increasing their income) and ecological factors (prevention of greenhouse gas emissions, clean technology of energy production (Graczyk A., 2010).

It should be noted that in the power industry, also in the so-called distributed energy, it is equally important to apply new technologies, technologies of high energy and economic efficiency.

Agriculture is an integral part of the rural areas. It is both a user and a producer of energy.

Table 3

Participation of agriculture in the national balance of needs for direct energy carriers and the use of renewable sources in agriculture – current state and future prospects

Type of prognosis parameter	unit	Number of units per year					
		1996	2002	2005	2010	2020	2030
Energy demands of the country and agriculture	PJ	1060	1080	1010	1150	1280	1400
Participation of the country and agriculture in the national energy demands	%	25.5	25.4	25.3	25.0	24.2	23.7
National usage of RES	PJ	145	170	210	345	724	1180
Participation of RES in the national energy balance	%	3.5	4.0	4.8	7.5	14.0	20.0
Usage of RES in the country and agriculture	PJ	80	90	100	145	273	385
Usage of RES in agriculture and rural households	PJ	47	49	52	60	78	83
Participation of RES in the energy balance of the country and agriculture	%	7.5	8.3	9.1	12.7	21.3	27.5
Participation of RES in the energy balance of agriculture	%	13.7	15.3	16.9	20.7	30.2	36.0

Source: Pabis J., 2011

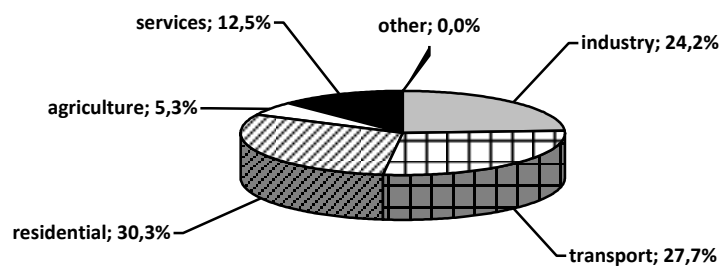
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The energy needs of rural areas and agriculture (Table 3) in 1996 were at the level of 1060 PJ, and in 2010 amounted to 1150 PJ. It is estimated that in 2020 they will be formed at the level of 1280 PJ, and in 2030 - 1400 PJ. Both the domestic use of RES and the share of renewable energy in the national energy balance is characterized by an increasing trend. The use of renewable energy in rural areas and in agriculture in 1996 was at the level of 80 PJ, in 2010 it amounted to 145 PJ. According to forecasts, in 2020 it should be in the range of 273 PJ, and in 2030 - 385 PJ. On the other hand, the use of renewable energy in agriculture and agricultural households is less dynamic: from 47 PJ in 1996 to the level of 83 PJ estimated in 2030.

In today's agricultural households, the demand for energy is growing; the energy being mainly used for production purposes, but also in the household. Energy technologies based on the use of renewable energy sources can be used on farms as an additional source of heat or electricity, and they also open the prospect of the total independence of the farm from the supply of energy and heat. The prevalence of low-power installations based on dispersed energy sources, producing and using energy directly on the farm, is part of sustainable agriculture (Wielewska I., 2014b).



Source: author's own study based on EUROSTAT data

Fig. 1. Structure of end-customer energy consumption in Poland in 2015 by sector

The largest share in the end-customer energy consumption in Poland in 2015 was held by households (30.27 %). Transport, with the share of 27.7 %, ranks second and industry (27.7 %) comes third. The share of agriculture was at 5.31 %. EUROSTAT data shows that the share of Polish agriculture in energy consumption was twice as large as in the EU-28.

The high level of mechanization of modern agriculture makes this sector of the economy one of the largest energy consumers. This is particularly evident in fruit-growing or dairy farms as well as large-scale farms focused on grain and fodder production (Michalcewicz-Kaniowska M., Zajdel M., 2017).

The use of renewable energy sources for production and household purposes would allow to minimize the percentage of harmful gases and dust emitted into the atmosphere, which are a consequence of the traditional combustion of fossil fuels. In every farm, there is a potential for production of energy from renewable sources. It should be noted, however, that in connection with the geographical location of RES and depending on weather conditions, time of day and year, renewable energy sources are characterized by high variability of the energy they offer (Wielewska I., 2014b).

Along with the socio-economic development of Poland, its energy and fuel needs are increasing, but meeting the requirements for reducing energy consumption and greenhouse gas emissions as

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well as increasing the use of renewable energy do not seem feasible in the next 10-15 years. As opposed to the energy needs of the country and non-agricultural part of the countryside, the energy needs of commodity farms will be decreasing, despite the predicted increase in end production of Polish agriculture until 2030. Energy has a significant share in production expenditures in agriculture. Changes in the level and technology of agricultural production, the increase in the prices of energy carriers and the reduction in the number of entities included in the category of farms have an impact on energy consumption. The increase in agricultural production is associated with an increase in energy demand, at least in the scope of its carriers, which are employed during the implementation of production operations (Wysokinski M., Trebska P., Gromada A., 2017).

The production of energy from renewable sources leads to: diversification of energy sources available in the countryside, creating active attitudes towards participation through the use of renewable energy in the national energy system (prosumerism), shaping ecological awareness of rural residents, improving the stability of energy supply in rural areas, improving conditions for business and the quality of life in the countryside (Wielewska I., 2014). The use of renewable energy that comes from agriculture allows for the creation of an additional source of income for farms and the creation of new jobs. All the above contribute to the development of rural areas.

Summing up, the development of renewable energy sources gives rise to a chance for sustainable development of the local economy in the energy sector by eliminating environmentally hazardous fossil fuels, by using economy-profitable and non-hazardous energy from renewable sources, by less harmful and more efficient energy production, its transmission, distribution and usage, as well as by maintaining a homeostatic equilibrium between: energy security, meeting social needs, competitive management and environmental protection.

Conclusions, proposals, recommendations

- 1) The development of renewable energy sources is a fundamental objective of the European Union's energy and climate policy.
- 2) Energy from renewable sources is gaining more and more opportunities for use because it is perceived as ecologically "clean" and in accordance with the principles of sustainable development.
- 3) Poland has yet to fulfil EU obligations, so it must care about the popularisation of the idea of sustainable development and more actively support the process of investing in renewable energy, mainly at the basic level, i.e. in those boroughs where it is necessary to use distributed energy.
- 4) The pace of changes that occur in the entire sector of renewable energy sources might indicate that the 15 % output in 2020 will be very difficult to reach.
- 5) Renewable energy sources satisfy a small fraction of the country's energy demand, but they are of great local importance as they contribute to improving the energy supply for areas with poor energy infrastructure, i.e. undisturbed energy supplies, which affects energy security.
- 6) The increase in the share of RES in the fuel and energy balance of boroughs contributes to the improvement of the efficiency of using and saving energy resources and improving the condition of the environment.
- 7) Power industry, both in the world and in Poland, should be based on safe, clean and sustainable renewable energy sources. Effective energy use should be based on the principles of sustainable

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development, because the sensible use of energy from renewable sources is its component which brings visible environmental and energy effects, which also affects the development of rural areas.

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