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## Renewable sources of energy in Poland – biogas

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### Abstract

The main cause for the global environmental pollution is obtainment of energy from the conventional sources, that is black and brown coal, mineral oil, natural gas, which when burned, all cause the emission of the greenhouse gases and dusts to the atmosphere and the accumulation of huge amounts of the industrial waste. The intense exploitation of conventional sources of energy on one hand leads to diminishing of those sources at accelerated rate, on the other hand poses as a threat to the environment. One of the proper solutions to this issue is implementing biogas as a source of energy in the production of energy in cogeneration, as well as its introduction to the transport as a renewable fuel in case of refined biogas (bio methane). The increase in renewable energy usage is important mostly due to the possibility of increased independence from imported energy, diversification of delivery sources, as well as creation of conditions to further develop distributed power generation built on locally available resources. Renewable energy in Poland has a particular significance for realization of energy politics of our country. The article characterized the development of biogas production and its usage in the countries of EU and in Poland. The usage of biogas for energetic and transportation purposes had been discussed.

**Keywords :** biogas, renewable energy sources, energy policy

## Introduction

Nowadays, a lot of attention is being directed to the protection of the environment. As a method towards reduction of the human impact on the environment we can include obtainment of the renewable energy. The increased greenhouse effect caused by the burning of the fossil fuels and the following CO<sub>2</sub> and other gasses' emission to the atmosphere influences the global warming, which may change climate conditions and the life on Earth. That is why the biogas is recognized as the alternative to the fossil fuels. It is produced from the vegetal resources, and it helps to protect the environment by releasing the CO<sub>2</sub> absorbed previously by the plants from which it was produced. It may also be produced from the waste, biological leftovers and other renewable resources. Through these actions we reduce the amount of harmful substances in the air and the usage of natural resources.

According to the energy law – renewable energy source is the source which in the process of conversion uses wind, solar, geothermal, wave, sea current, tidal and river energy, as well as the energy obtained from the biomass, landfill biogas and the biogas produced in the process of sewage disposal or animal and plants remains decomposition [Act - Energy Law].

Renewable sources of energy are the sources in which case it can be stated that:

- their reserve is being constantly replenished through the natural processes
- they may be managed in a way that assures that they will never run out
- they have relatively minor impact on the environment [Dobrzańska and Dobrzański 2008 p. 327].

As a media of the renewable energy we include solid biofuel, heat pumps, urban waste, geothermal energy, liquid biofuel, biogas, hydro energy, solar energy and wind energy [Góralczyk and Tytko 2014, p. 7].

Biogas is obtained through the process of anaerobic fermentation of biomass. Biogas is the mixture consisting mostly of methane and CO<sub>2</sub>, produced by the microorganisms from the digestion of organic substances in anaerobic conditions. Created biogas consists in 50-75% of methane and 23-45% of CO<sub>2</sub>, as well as the small dosages of hydrogen sulfide, nitrogen, oxygen and hydrogen. The percentage of methane in biogas determines the heating value of the fuel. The higher the percentage, the higher the calorific value of the biogas. Biogas is used to produce electrical and heat energy, or may be transported to the existing gas network, when previously purified [Curkowski et al. 2009]. Biogas may be also used as a fuel for the engine vehicles – alternative to the fossil gas, so called bio-CNG (after purification) [Fuksa et al. 2012, pp. 475-485]. In the moment of production, aside from the majority of methane and CO<sub>2</sub>, biogas consists of intermixtures of substances, such as hydrogen sulfide, nitrogen oxide, carbon oxide,

and hydrogen. There are several technologies of enrichment and purification of biogas. First of all, biogas that comes from biogas plant needs to be dried and purified from any micropollutants, the amount of CO<sub>2</sub> needs to be minimized, and needs to be desulfurized, which means erasing the sulfur – in that case mostly hydrogen sulfide. [Kupczyk et al. 2009, pp. 522-556]. The production of biogas (biomethane) for the purpose of transportation seems to be a natural consequence to the development of the biogas market [Pomykała i Łyko 2013, pp. 454-461].

### **Production of energy from renewable sources in Poland**

Biogas can be obtained from landfills, sewage treatment plants or agricultural biogas plants. The production potential of biogas from municipal and industrial waste and landfills estimated at about 0.796 billion m<sup>3</sup> / year and in 2015 was used in only 12%. For biogas from sewage treatment plants, these values amounted to 0.0969 billion m<sup>3</sup> / year and 76% respectively. Much greater possibilities of producing this fuel occur in agriculture and agri-food industry [Gradziuk 2017, pp. 64-70].

The European Union directive assumes that in 2020 Poland will produce 15% of the energy needed from such sources. One of the indicated sources of primary energy are second-generation biofuels. This means that technologies related to energy production from biogas are of particular importance. It is expected that in Polish conditions there should be a significant increase in the number of installations producing and using this fuel [Grygier et al. 2018, pp. 25-37].

Despite the significant resource potential in Poland in 2016, the total installed capacity of biogas plants was 187 MWe, including 101 MWe in agricultural biogas plants, while in Germany it was respectively 3905 and 3596 MWe [Gradziuk 2017, pp. 64-70].

Table 2 The structure of obtaining renewable energy (according to sources) in 28 EU countries and in Poland in 2012-2015

Wyszczególnienie	Rok	UE-28 (w %)	Polska (w %)
Solid Biofuels Biopaliwa stałe	2012	10,4	56,5
	2013	9,4	46,5
	2014	9,4	46,2
	2015	9,7	39,8
Solar energy Energia słoneczna	2012	9,3	0,0
	2013	10,0	0,0
	2014	10,9	0,0
	2015	11,5	0,3
Water energy Energia wody	2012	43,8	12,1
	2013	43,4	14,3
	2014	41,7	11,0
	2015	36,5	8,1
Wind energy Energia wiatru	2012	26,9	28,1
	2013	27,5	35,2
	2014	28,1	38,7
	2015	32,3	47,9
Biogas Biogaz	2012	6,0	3,3
	2013	6,3	4,0
	2014	6,4	4,1
	2015	6,5	4,0
Liquid biofuels Biopaliwa ciekłe	2012	0,5	–
	2013	0,5	–
	2014	0,5	–
	2015	0,6	–
Geothermal energy Energia geotermalna	2012	0,8	–
	2013	0,7	–
	2014	0,7	–
	2015	0,7	–
Odnawialne odpady komunalne Renewable municipal waste	2012	2,4	–
	2013	2,2	–
	2014	2,2	–
	2015	2,2	–

Source 2 Rajchel D. Walawender A. *Renewable energy in the European Union and Poland including households*, [in:] Sitek S. (ed.) "Old and New" research problems in socio-economic geography, Polish Geographical Society, Katowice Branch, University of Silesia, Faculty of Geosciences, Sosnowiec, 8th class, p. 161-176.

Analyzing Table 2, it can be stated that in the discussed period (2012 - 2015), in the EU-28 there was an increase in the share of solar energy in electricity generation (from 9.3% to

11.5%) . In the EU-28 countries, an increase in the share of electricity generated by wind farms was noted, in particular in Poland . In addition, during this period there was a decline in the share of energy from RES in the production of electricity in the case of the use of water energy and solid biofuels . In the field of biogas production, Poland from 2004 increases its production potential, but still does not equal the average of 28 European Union countries [Rajchel and Wawalender 2018, pp. 161-176].

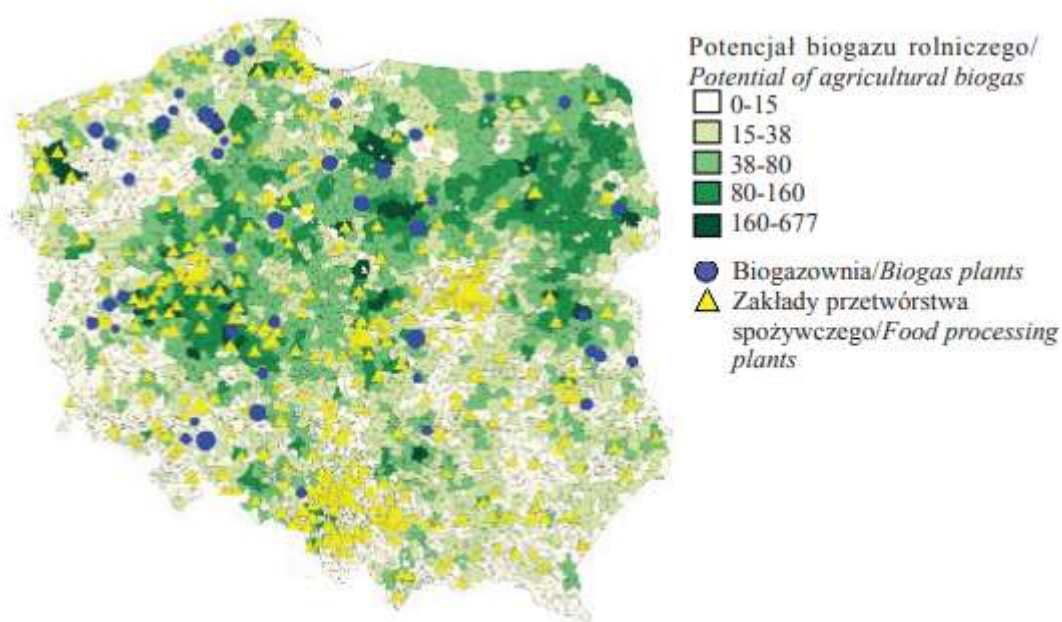
In 2015, the share of renewable energy in Poland in total energy consumption was 11.8%, which ranked us in the 21st position in the 28 EU countries. In terms of absolute increase in 2004-2015, Poland took the 25th place. This is an inadequate position in relation to the potential that Poland has in the field of renewable energy development opportunities [Gostomczyk 2017, pp. 48-64].

### **Biogas plants**

The biogas plant has a strictly defined technological process (methane fermentation of biomass) and, as a result, biogas is created. The construction of such an installation is a major resource and logistics challenge. The construction of each such facility is individual and depends on various factors, mainly on the type of batch material. Due to the type of substrates used , three types of biogas plants are distinguished [Obrycka 2014, pp. 163-176].

In the first of them slurry and manure are used, in the second type, the by-products from the agri-food industry (decoction, pulp, residues from the processing of vegetables and fruits) are the basis. The main purpose of their operation is the utilization of substances harmful to the environment, including waste from the meat industry, dairy industry, collective nutrition, expired food and feed, and many other substrates for which an alternative way of management is more costly and environmentally burdensome . The resulting energy should be treated as an additional effect, obtained "by the way". At the same time, to improve the efficiency of the technological process, it may be necessary to supplement such a feed with silage. In the third group of biogas plants, the basic substrates are obtained from targeted field crops or grassland, which is why the profitability of such biogas plants depends on the economic situation on crops [Gradziuk 2017, pp. 64-70].

Figure 1 Biogas plants in Poland due to the annual productivity of biogas production



Source 3 Wyszomierski R. Bórawski P. Jankowski K. Zalewski K. (2017) *Spatial differentiation of biomass production in Poland*, Scientific Annals of the Association of Agricultural and Agribusiness Economists, volume 19, No. 2, pp. 282-288.

### Agricultural biogas

One of the methods of generating electricity from renewable sources in Poland is the production of agricultural biogas. According to the definition included in the Act of 20 February 2015 on renewable energy sources, "agricultural biogas is a gas obtained in the process of methane fermentation of agricultural raw materials, agricultural byproducts, liquid or solid animal waste, by-products, waste or processing residues products of agricultural origin or forest biomass, or plant biomass collected from areas other than those recorded as agricultural or forestry, excluding biogas obtained from raw materials originating from sewage treatment plants and landfills " [Act on renewable energy sources].

The introduction of the concept of agricultural biogas was probably intended to promote agricultural substrates for the production of biogas and the creation of installations for their use. This allowed to separate agricultural biogas plants from previously existing installations producing biogas based on sewage sludge in sewage treatment plants or extracting biogas from municipal waste landfills. As a result, it was possible to support the construction of a new type of plant - agricultural biogas plants [Pomykała i Łyko 2013, pp. 454-461].

Many agricultural waste, due to its physio-chemical properties, can be a valuable energy and economic resource. Agricultural by-products, liquid or solid animal waste or residues of the agri-food industry can be used to produce agricultural biogas [Czop and Kłapcia 2017, pp. 5-16].

Biogas installations can make a significant contribution to rural development and create new income opportunities for farmers. The development of the biogas market has a positive impact on regional development and local, for expanding export prospects, social cohesion and employment opportunities, especially in case of small and medium-sized enterprises as well as independent energy producers [Zalega 2017, pp. 40-60].

The production of biogas from agricultural raw materials has many positive effects in the field environmental protection and economic development of the region near the biogas plant. The advantage of biogas production is also controlled reduction of methane emissions from manure from animal husbandry and breeding, utilization of severe slurry for the environment and reduction of odor nuisance [Szlachta and Dworaczyk 2017 pp. 83-99].

## **Summary**

The constantly shrinking reserves of the conventional energy sources and the increasing energetic needs of the country demand the consideration of using alternative solutions, which include renewable sources of energy. The additional driver to the development of the renewable energy are the directives adopted by the EU, which imposes on every country the obligation of achieving 20% of the energy usage from the renewable sources in the overall EU energy usage until 2020. In an attempt to meet the demands, Poland aims to achieve minimum of 15% of renewable energy usage until 2020, and to increase that percentage in the future. In the face of unstable and usually increased prices of the fossil fuels as well as the dynamic development of the economy, Europe seeks new, alternative sources of energy, which would meet the features of sustainability. Among all the renewable sources of energy: wind, solar, hydro, geothermal energy and biomass, the biomass seems to be the most promising due to its universality and possibility of employing in every place. Farm biogas plant may be a stable source of electrical energy. It is not dependent on the season of the year or on the atmospheric factors (wind, sun). The waste in this case are: CO<sub>2</sub>, which is produced in the processes of decay of the organic matter anyway, process water, which practically does not consist of any organic mass, but may be a good supplement of inorganic microelements for the soil.

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