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The Development of Biogas Production in the Context of Energy Transition: The Case of Poland

Abstract

Objective: The aim of this article is to identify the chances of further development of biogas production as a way to diverisfy the structure of energy production in Poland. Another one is to analyse biogas production as a part of getting closer to achieving the targets of the climate and energy framework of the European Union and Polish long-term energy sector strategies.

Research Design & Methods: The research methods used in the study include: the analysis and study of the literature, heuristic techniques for data analysis, the SWOT (strengths, weaknesses, opportunities, threats) analysis.

Findings: The production of biogas can be beneficial for local economic growth, environmental awareness, and social wellbeing. There is a strong need to overcome the barriers of further development of biogas production as well as analyse the opportunities, given that a type of renewable energy source is further developed. Biogas production can help meet the national and international goals concerning energy transition, developing low-carbon economies, and addressing modern economic trends.

Implications / Recommendations: The aim of this paper is to investigate the chances of further development of biogas production in spite of current changes in Polish agendas. The topic is of great importance when analysing the strategy of Poland to develop a low-carbon economy. It is also a significant part of current discussions between the scientific community and business practitioners in terms of energy transition in Poland. What is worth noting is that Polish strategies concerning the development of renewable energy production should be aligned with the climate and energy targets of the European Union, which can prove problematic. Polish energy mix is still based on energy production from coal, while the EU is steadily increasing gross energy production from renewable energy sources.

Contribution / Value Added: The analysis defines the role of biogas in circular economy as well as in modern economy with the consideration of environmental economics and sustainable development. It underlines the importance of biogas in energy transition in Poland, taking into consideration the *Energy Policy of Poland until 2040* (Pol. *Polityka energetyczna Polski do 2040 r.*)

Keywords: biogas production, energy transition, Polish energy production, renewable energy

Article classification: research article

JEL classification: O13, Q01, Q28, Q42

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Introduction

Ensuring sustainable global development should be related to increasing the share of energy produced from renewable sources in total gross electricity generation. It is of great importance to implement new solutions, which would ensure the acquisition of clean energy and would not be associated with negative environmental impact during the process. Nowadays, a paradigm shift in energy production can be witnessed. Initially, energy systems had been monopolistic and centralised, whereas currently, decentralisation is becoming clearly visible. Energy can be seen as a specific type of a commodity, where the recipient is both a customer and a participant in the energy market. Current international discussions have been dominated by the analyses of the possible scenarios of developing low-carbon economies.

The regulations of the European Union contain a number of policies and strategic documents directly related to the issue of biogas production. This kind of a renewable resource finds its place in documents concerning the production of energy from renewable sources in general, as well as in regulations relating to the development of circular economy systems, the promotion of clean technologies, mobility, environmental economics, and bioeconomy.

In 2018, the European Parliament adopted new energy goals, in which particular emphasis was placed on increasing the use of energy from renewable sources and improving the energy efficiency of the Member States. It has been established that by 2030, the share of energy from renewable sources in total energy consumption is to be at least 32.5%, and that at least 14% of fuels used in transport are to come from renewable sources. The plans of the European Parliament include the goal of achieving an emission-free economy that would start functioning by 2050. This would allow compliance with the provisions of the Paris Agreement, as well as allow a limitation of the emission of harmful gases into the atmosphere, as well as it would make it possible to overcome environmental problems, which are considered as one of the major challenges that the humanity is facing. The mentioned provisions are consistent with the conclusions on the "Clean Energy for All Europeans" legislative package and the "Clean Planet for All" vision. The principles and priorities of the EU have been defined with regard to a debate of the ministers of energy of the Member States, which took place during the informal meeting in Bucharest in 2019. The findings were then discussed by the Working Party on Energy, which was followed by deliberations of the Committee of Permanent Representatives of the European Union (Council of the European Union, 2019a).

In 2019, the EU's Green Deal has been introduced as the new strategy to ensure economic growth and the transition towards a sustainable model of the economy. The actions of the Member States would contribute to making Europe the first climate-neutral continent. The goal is to be achieved by 2050. The main elements of the Green Deal are connected with renewable energy production, i.e. climate action, clean energy, and eliminating pollution. The financing will be covered by the EU's Green Deal Investment Plan. The two main streams of funding will total in €1 trillion, from which €528 billion will come from the budget of the EU and the Emissions Trading System. The remainder will be covered by the InvestEU programme (Norton Rose Fulbright, 2021).

In order to adjust to international resolutions concerning energy production, the Council of Ministers of Poland adopted the „Energy Policy of Poland until 2040", which is based on achieving just transition, building a zero-emission energy system, and ensuring good air quality. Energy transformation – i.e. one towards low-carbon economy – can facilitate guaranteeing energy security, achieving fair cost distribution, and protecting the interest of some social groups (Ministerstwo Energii i Środowiska, 2021, p. 7). Furthermore, Poland's membership in the EU's structures makes it necessary to adjust national

strategies to international provisions, thus redefining the national structure of energy production.

The article attempts at supplementing the reflection on the role of biogas in the structure of energy production in Poland. It depicts the necessity of change in order to meet the goals adopted by the EU. The author believes that intensifying the production of biogas in Poland can positively influence local economic growth, environmental awareness, and social well-being. The main research questions in this article are:

- How can biogas production contribute to the energy transition, with particular attention to energy transition in Poland?
- What are the strengths, weaknesses, opportunities, and threats for biogas production in Poland?

In order to answer these questions, an analysis of the literature concerning the role of biogas in energy transition has been performed. The place of biogas production in energy transition and circular economy has been described in order to highlight the flexibility of this renewable energy source. Obtaining basic information on the state of biogas production in Poland became the reason to use the techniques of strategic planning, i.e. performing a data-driven and fact-based SWOT (strength, weakness, opportunities, threats) analysis of the production of biogas in Poland. The creation of a SWOT matrix enables an in-depth insight into the state of biogas production in Poland.

Literature review

Biogas can be described as "Gaseous fuel produced from biomass, as defined in point 24 of Article 2 of Directive (EU) 2018/2001, including energy-carrying gas that is primarily methane and mixtures that are partially methane produced from biomass feedstocks through anaerobic digestion, gasification, or other processes" (The International Council of Clean Transportation, 2019, p. 2). The production of biogas makes it necessary to obtain appropriate amount of biomass, i.e. organic material of plant or animal origin. This renewable resource can be used directly to produce electricity and heat in cogeneration (combined heat and power – CHP). Taking into consideration the method of obtaining, the following types of biogas can be distinguished (Główny Urząd Statystyczny, 2020, p. 42):

- Landfill biogas – a result of anaerobic fermentation of landfill waste;
- Biogas from sewage sludge – produced by the anaerobic fermentation of sewage sludge;
- Other – this group contains two types of biogas, which are: agricultural biogas obtained in the process of anaerobic fermentation of biomass from crops energy, plant production residues, animal manure, and biogas obtained in the process of anaerobic digestion of biomass from waste in slaughterhouses, breweries, and other food industries.

In the literature of the subject, one can find various scientific articles and industrial reports concerning the topic of the place of biogas in energy transition (Lyytimäki et al., 2018, pp.1–11; Lyytimäki, 2018, pp. 65–73; Faller & Schulz, 2017, pp. 1–8; Xuequing et al., 2021, pp. 1–20; Frankowski, 2017, pp. 15–32; Kurczyńska, 2020). Biogas production has also been analysed with regard to sustainable development (Marchaim, 1992; Pawlita-Posmyk & Wzorek, 2018, pp. 1043–1057; Khoiyangbam et al., 2011; Meeks et al., 2019, pp. 763–794; Lybæk et al., 2013, pp. 171–182) as well as barriers and chances of its development (Surendra et al., 2014, pp. 846–859; Gottfried et al., 2018, pp. 632–647; Brudermann et al., 2015, pp. 107–111; Igliński et al., 2015, pp. 93–101). A wide range of available references indicates a specific flexibility of biogas both as a renewable energy source and as a part of contemporary economic trends. It also shows the need to redefine the approach to the problem of the inclusion of biogas in the energy mix. The process is dependent on many factors, such as the legal status of biogas production or the impact of the investment on the local society.

Biogas production in terms of energy transition and circular economy

Biogas production can play an important role in terms of the basics of energy transition and circular economy, which is due to the fact that the necessity of natural environment preservation and the promotion of sustainable development have both been taken into consideration. The specific role of biogas can also be analysed in the context of low-carbon energy transition. The implementation of the concept of circular economy may serve as a way of improving self-sufficiency with regard to energy. Furthermore, it is related to energy efficiency and the use of renewable energy sources, both of which can be seen as key pillars of energy transition (Kalchenko et al., 2019, p. 2).

The adoption of an action plan regarding circular economy by the European Commission (2015) – which is intended to support and stimulate the transition of the EU's Member States to the circular economy – can indicate the necessity of the implementation of the plan by individual Member States. Financial support for the initiative is to be provided by the European Structural and Investment Funds, the Horizon 2020 programme, and the European Fund for Strategic Investments and the LIFE+ programme. The emphasis has been placed on the development of innovative solutions and the development of investments accompanying the initiative (Council of the European Union, 2019b). The purpose of closing the loop is to address individual stages of the life cycle of a product: from its production, through consumption, and ending with waste management and the re-use of raw materials.

Biogas production is in line with the concept of circular economy, which is often seen as a specific type of remedy for contemporary economic, environmental, and social problems. At the same time, it can be described as a shift in the way that societies use and treat products. Circular economy is regenerative in nature, aiming at achieving the maximum utility of components and materials. The higher the degree of waste reuse in industry, the more the process is aligned with the concept (Sariali, 2007, pp. 31–34). The use of biogas generated from waste, which is produced in a regenerative manner, does not increase the amount of carbon dioxide in the atmosphere, because biogas plants are qualified as a source of energy with zero CO_2 emissions. Energy combustion of biogas is associated with CO_2 emissions which are nearly identical to the amount that is able to be consumed by plants or animals, which are the source of substrates for its production (IEA Bioenergy, 2018). Research related to the production of biogas from various raw materials has shown that its use can lead to minimal CO_2 emissions. Therefore, in absolute terms, the amount of CO_2 that can be absorbed from the atmosphere due to the complete cycle of energy production can be higher than the amount of CO_2 produced during the supply of raw materials and the operation of a biogas plant (Naglis-Liepa & Pelse, 2013, pp. 18–25). In consequence, biogas is a carrier of renewable energy, essential for the transition towards decarbonisation. Furthermore, one of the main advantages of using biogas is the flexibility of energy generation. In this case, the production of energy is not as prone to fluctuations as photovoltaics or wind energy are. The dependence on unpredictable climatic factors is low and energy production is resistant to seasonality, as the amount and type of substrate can be relatively easily controlled (Hoffman, 2017).

In the social context, biogas could be used in a much wider sense than it is today, and it could be successfully used in industries requiring access to warm air, e.g. in laundries, carpentry shops, and other places where there is a need for quick drying. The use of purified biomethane can also be of great importance in gastronomy and the food industry, where continuous heating and the possibility of its regulation are required.

The opportunity for further implementation of solutions that are in line with the concept of circular economy can also be seen when analysing the benefits of the construction of micro and small biogas plants, as well as looking into biodegradable waste processing centres equipped with a biogas

installation. Their impact would be significant to the needs of a micro-region; in the case of Poland, this would be a commune or a municipality (Pol. *gmina*), or a poviat (Pol. *powiat*). Micro biogas plants are characterised by a simplified structure, which is why the process of their placing and starting up the production is much faster. In addition, they are mobile and easy to relocate. The frequently used solutions include the use of container micro biogas plants. The structure is placed in two containers – one of them is used for the fermentation of wet substrate, while the other one is for the production of energy in cogeneration. Due to a smaller scale of the investment in comparison to a classic biogas plant, micro biogas installations are based on the use of a limited type of substrates in appropriate proportions. For rural households, it can be animal faeces, enriched with a trace amount of co-substrate, which is an addition that stabilises the production process. In the case of cattle breeders, the appropriate amount of substrate can be provided by a herd of 60 LU (large livestock unit), while the appropriate amount for plant substrates will be provided by approx. 6 ha of maize cultivation and a small number of animals, e.g. pigs. These amounts would enable the operation of a 10 kW reactor for a year. A herd of approx. 100 LU or the cultivation on an area of 20–26 ha would enable the proper functioning of an installation with a power of approx. 40 kW (Kubiak, 2018). Electricity and heat generated by such facilities could be used for meeting the individual needs of producers, while the surplus could be used at the local level. Such a procedure would make the development of distributed energy easier, and the continuous improvement of biogas technologies could result in the intensification of activities, resulting in the creation of self-sufficient energy areas or energy clusters.

Even though biogas production can play a significant part of renewable energy production, there are many barriers that should be taken into consideration while analysing the chances of its implementation in the energy mix. These can be separated into various groups, i.e. economic, market, technical, institutional, environmental, and socio-cultural (Nevzorova & Kutcherow, 2019). They should be considered separately both for individual countries (with particular emphasis on the characteristics of a given region) and for individual investments in biogas plants.

Research methodology

Biogas production in Poland – basic information and the European context

In the period of 2005–2018, a significant increase in the volume of biogas production could be observed in the Member States of the EU. In 2018, it was 705 PJ, which meant an increase of 531,3 PJ compared to the production level observed in 2005 (173,7 PJ). In the analysed period of time, the contribution of biogas generated in the degassing process of landfills remained at the same level. The largest contribution to the increase in biogas production was made by the group classified as "other", while the smallest – by biogas obtained in the wastewater treatment process (Figure 1).

Recent years have shown a steady growth in the number of biogas plants located in Europe (Figure 2). In the years 2009–2017, the total number of biogas installations operating in Europe increased from 6,227 to 17,432. From 2010 to 2012, there was a twofold increase in the number of operating biogas plants. Biogas production has been boosted due to the growing numbers of agricultural installations (those in which the main substrate is the organic matter acquired from agriculture). In 2009, there were 4,797 installations of this type, whereas in 2016 – 12,496. In the years 2015–2017, the number of biogas plants in Europe started to stabilise.

The volume of biogas produced in individual countries of the EU is very diverse. The leading country for the production of biogas energy is Germany, where the total biogas production reached 319.5 PJ in 2018. It accounted for approx. 45% of the total biogas production in the EU's Member States (705 PJ).

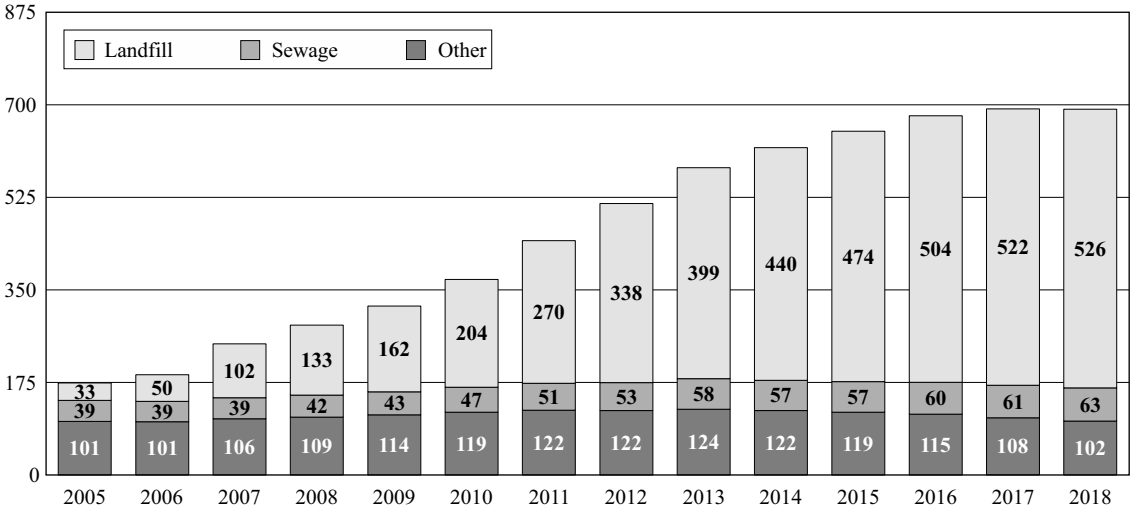

Figure 1. Biogas production volume in EU member states in 2005–2018 (PJ)

Source: own elaboration based on data retrieved from Eurostat, 2020.

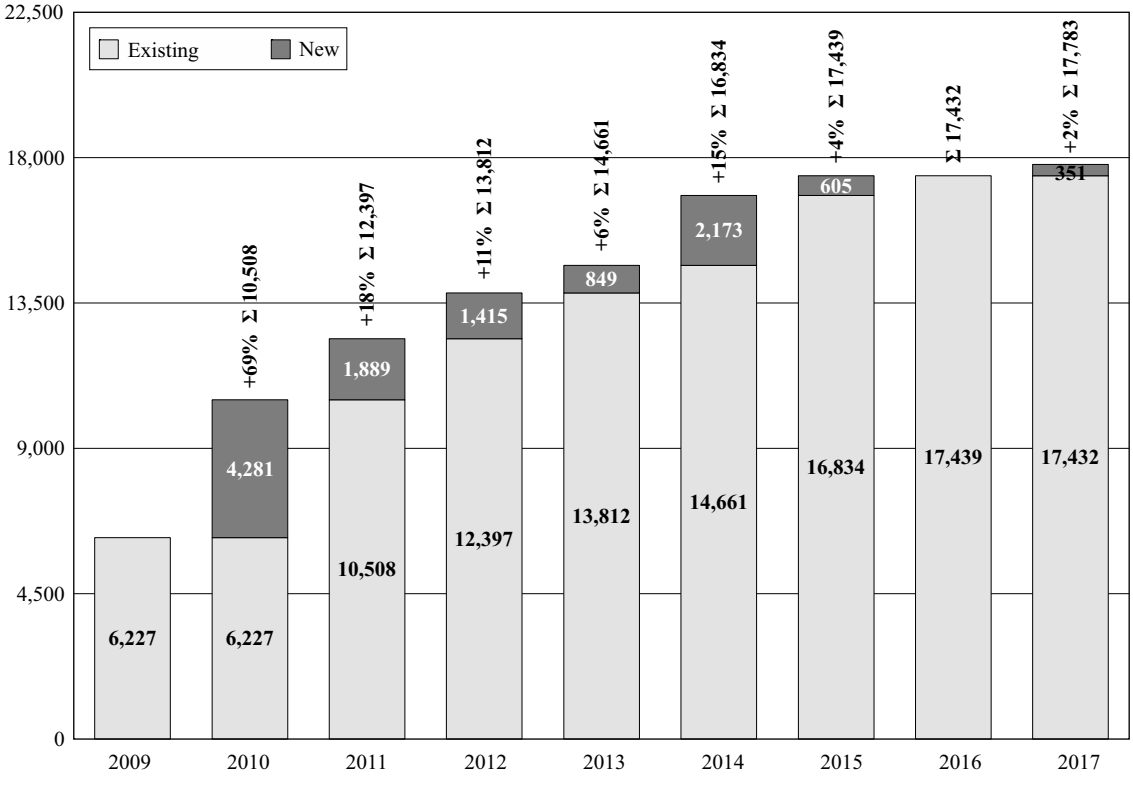

Figure 2. Change in the total number of biogas plants in European countries in the years 2009–2017

Source: European Biogas Association, 2018.

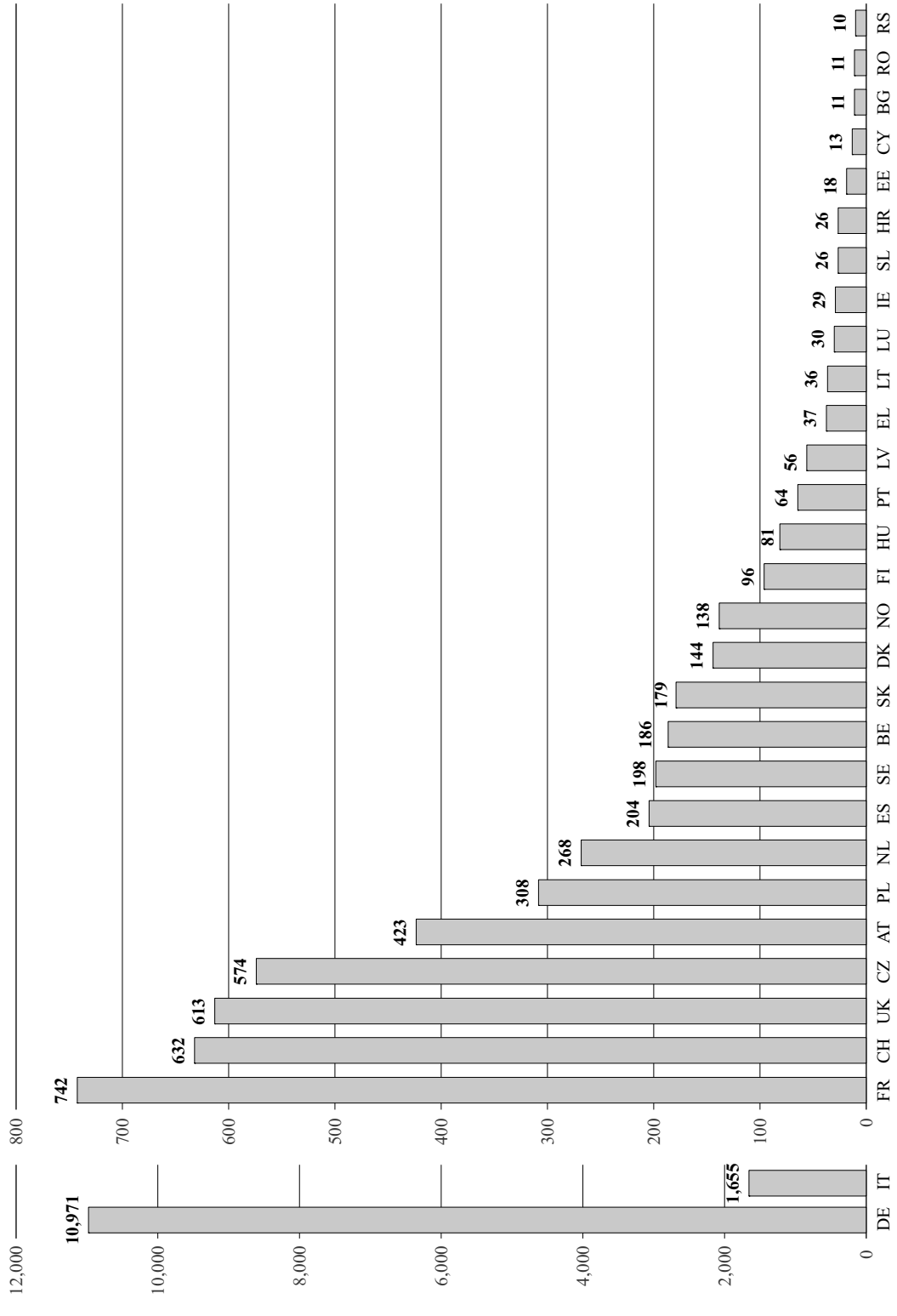

Figure 3. The number of biogas plants by individual European countries in 2017

Source: European Biogas Association, 2018.

Germany was also a country with the highest number of biogas plants in 2017 (10,971). The next country in the rank was Italy, with significantly lower number of plants of this kind (1,655). In 2017, there were 308 biogas plants located in Poland (Figure 3). According to the Polish 'National Support Centre for Agriculture' (Pol. *Krajowy Ośrodek Wsparcia Rolnictwa – KOWR*), by the end of 2020, there wer 116 agricultural biogas plants operating in Poland. All in all, 335 biogas plants were operational at that time (Portal komunalny, 2022).

In Poland, biogas production is on the 4th place in terms of energy production from renewable sources. The share of biogas in overall energy production from renewables increased from 2,55% in 2015 to 3,15% in 2019 (Figure 4).

Between 2015 and 2019, a great increase in the amount of biogas produced in Poland could be observed (Figure 5). It was used mainly to generate electricity and heat. Even though the overall biogas production was on the rise, the amount of produced landfill biogas was slowly decreasing (a decrease by 17,4% in 2019 when compared to 2015). It could be because of the fact that the plants producing this type of biogas are less prone to localisation processes due to the necessity to place them near landfills. When analysing the dynamics of sewage biogas production, a slow growth could be witnessed (an increase by 24,8%). The largest increase in biogas production was in the group of "other biogas" (66,9%) (Główny Urząd Statystyczny, 2020, p. 43).

It is estimated that the potential of biogas production in Poland could reach 31 TWh, which would constitute approx. 18% of overall energy production in Poland in 2019. Considering the potential of agricultural waste processing, Poland could produce 13,5 billion m^3 of biogas annually. If Polish maize production reached similar scale to that visible in Germany, and if this were used as a substrate to produce biogas, the potential of energy production from this source would reach 8 GW. Considering agricultural biogas production, the main factor blocking the location of new biogas investments includes high costs of such undertakings, especially at the early stages of the project (Balicka-Sawiak, 2021).

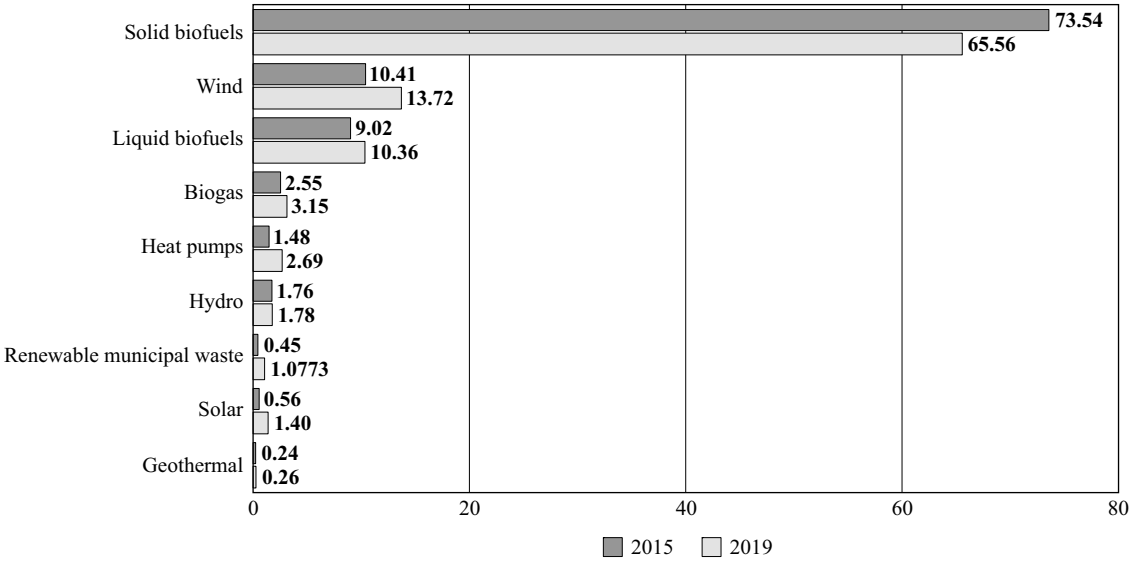

Figure 4. The structure of energy production from renewable energy sources by carriers (% of overall energy production from renewable energy sources)

Source: own elaboration based on data retrieved from Główny Urząd Statystyczny, 2020.

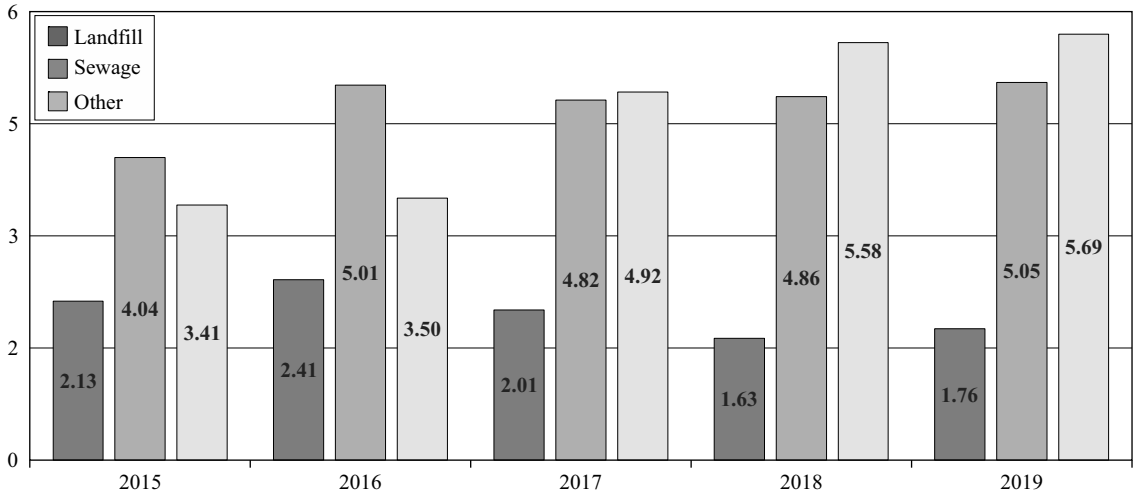

Figure 5. The structure of biogas production in Poland between 2015 and 2019 by types (in thousand TJ)

Source: own elaboration based on data retrieved from Główny Urząd Statystyczny, 2020.

Biogas production in Poland in terms of the PEP2040

The route of Poland towards energy transition can be described as difficult in terms of long-term strategic planning. The PEP2040 contains decisions of strategic importance which are connected to the selection of technologies that should be used in order to build a low-carbon energy system. The strategy is in line with the Paris Agreement, which was concluded in 2015 during the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change. It can be viewed as Poland's national contribution to the implementation of climate and energy policy of the EU. Further development of biogas production in Poland contributes to the fulfillment of the following specific objectives of the PEP2040 (Ministerstwo Energii i Środowiska, 2021, p. 6):

- Specific Goal 1: Optimal use of local raw materials for energy production;
- Specific Goal 2: The development of power infrastructure for various generation sources and networks;
- Specific Goal 6: The development of renewable energy sources;
- Specific Goal 7: The development of district heating and cogeneration;
- Specific Goal 8: Improving energy efficiency.

According to the PEP2040, high priority should be given to offshore wind energy and to plans to build the first Polish nuclear power plant. The construction of this type of energy source in Poland is a contentious issue, but the analyses of the possibility of using this type of energy cannot be omitted. In 2010, the Ministry of Economy developed the Polish Nuclear Power Programme, which was supplemented by appropriate forecasts. At the same time, public consultations were conducted with the participation of about 100 domestic entities. The document presented the process of implementing nuclear power, operating infrastructure facilities, and decommissioning them after their operating period. The implementation of the programme is scheduled for 2011–2030, while its updates would take place every four years. The draft was adopted by the Ministry of Economy in October 2013, and by the Standing Committee of the Council of Ministers in January 2014. According to the assurances of the director of the Nuclear Energy Department of the Ministry of Energy, by 2043, two nuclear

power plants should be built in Poland, one of which would be located in the centre of the country and the other in its northern part (Business Insider Polska, 2019).

Simultaneously with large-scale energy production, decentralised energy systems are also planned to be developed, e.g. photovoltaic installations or agricultural biogas plants. The biogas and biomethane sector is expected to be a significant part of energy policy, which will affect the meeting of the EU's goals. In the mid-2020, at the initiative of the Deputy Minister of Climate and Environment, academics and the representative of biogas and biomethane sector as well as the transportation sector all agreed on producing the "Letter of intent about the establishment of a partnership for the development of the biogas and biomethane sector and the conclusion of a sectoral agreement" (Regatrace, 2020). It aims at joint activities to be undertaken for the further development of Polish biogas and biomethane sector. Agricultural biogas plants can help solve some of the problems of the Polish energy transition, including restrictions on the use of nitrates, the increasing costs of using natural fertilisers, and the fluctuating prices of agricultural products.

SWOT analysis for biogas production in Poland

A frequent volatility of support systems and other barriers to the development of biogas production in Poland (such as legal inconsistency and social anxiety) negatively affect the willingness of business entities to invest in the process. This kind of situation is unfavourable – especially considering agricultural biogas production – and it indicated the need to use strategic planning techniques, such as the SWOT analysis, to evaluate the situation of biogas in Poland. The method can be seen as one of the key tools used to analyse situations of strategic importance. It reduces their complexity and the quantity of information that ought to be taken into consideration. The creation of a SWOT matrix can improve the process of decision-making, as it enables the assessment of various alternatives

Table 1. SWOT analysis for biogas production in Poland

Strengths	Weaknesses
• The flexibility of energy production, free from seasonality;	• Location of new plants forces the necessity to overcome the resistance of local community; the NIMBY (not in my backyard) location dilemma;
• Wide range of substrates that can be used in biogas production;	• Low governmental financial help for future in-vestments;
• Independence from climatic factors, i.e. wind or sun;	• No public awareness programmes showing the advantages of biogas production;
• Implementation of innovative solutions on the micro scale;	• Time-consuming and lengthy realisation process;
• The creation of new job opportunities in surrounding areas, i.e. green jobs or renewable energy jobs;	• A wide range of spatial restrictions related to the location of new biogas investments, i.e. environ-mental ones;
• A way to utilise waste and fulfil the provisions of circular economy and sustainable development;	• Problems with the connection to the electrical or gas grid;
• Building a society based on knowledge and territorial specialisation;	• The lack of properly educated and experienced staff in terms of running a biogas plants;
• The possibility of using post-fermentation pulp (the so-called digestate) as a fertiliser;	• A possibility of the generation of odour and explosion hazard.
• Low price of renewable energy in comparison to non-renewable alternatives.	

Table 1 – continuation

Opportunities	Threats
• The development of biogas production technology, i.e. one connected with minimising the nuisance of locating new biogas investments or increasing the quality of produced biomethane;	• Ambiguity and constant changes in Polish legislation concerning the production of energy not only from biogas, but also from renewable sources in general;
• The chance to use upgraded and purified biogas in transportation, i.e. as a transportation fuel for road vehicles;	• The necessity of maintaining strategic connections in terms of substrate availability and fluctuations in the prices of substrates;
• Renewable energy source development is postulated in international regulations;	• Development of biogas production can result in increased competition in the process of gathering the substrates;
• The introduction of feed-in tarrif and feed-in premium for biogas production as a way to attract potential investors;	• Investing in coal energy production and the strength of professional groups related to coal mining in Poland;
• A chance to create energy clusters and energy cooperatives.	• The development of other renewable energy sources in the vicinity of planned biogas investments;
	• The destructive impact of discussions on the development of nuclear energy in Poland.

Source: own elaboration.

in multifaceted-decision-related situations (Helms & Nixon, 2010). Performing a SWOT analysis is useful when conducting research that aims at highlighting the strengths, weaknesses, opportunities, and threats in strategic planning. It can be valuable when analysing the advantages of – and barriers to – the development of biogas production in Poland. The benefits of using this method include acquiring a comprehensive set of information that can be applied, e.g. analysing different kinds of RES in Poland (Table 1).

The current situation of the Polish energy sector is difficult and controversial in terms of deciding about which scenario of long-term energy strategy should be seen as the default one. Discussions about it are a consequence of socio-economic considerations and problems related to the impact of energy on the quality of life. On the one hand, solutions based on bringing short-term benefits are proposed, while on the other hand, an attempt is made to create a specific vision of the country's development, one based on a long-term approach and focusing on the analysis of phenomena occurring in the country's external environment.

Concluding remarks

The inclusion of renewable energy in the structure of energy production must be considered individually for each country. The use of RES implies the need to take into account unique features of a given region as well as an individual set of substrates that can be used during the production. The process of the location of biogas plants should be accompanied by political and social research, which seems to be difficult to conduct. Biogas production can be seen as a significant element for the process of energy transition, which is constant and which is a natural result of the changes in the way that societies see the way of energy production and use.

The multifaceted nature of biogas through the use of anaerobic digestion is its undeniable strength. Biogas production systems consist of processes related to the treatment of waste, which is linked with the protection of the environment; it also allows the transformation of low-value materials into those of higher value. Biogas is used to produce electricity and heat from waste. Therefore, value is generated from materials

that would not be used otherwise. The flexibility of biogas production is its strength, which should be taken into consideration when deciding about the long-term strategy of implementing renewable energy solutions into the energy mix.

The volume of biogas production in the EU is gradually increasing, but in the last five years, the change has been less dynamic. The level of biogas production differs greatly in individual Member States. The increase in biogas production is related to the increase in the number of biogas plants. The leading country in the production of biogas is Germany, which is responsible for the production of approx. 45% of the total biogas production among the EU's countries. The most intense dynamics of locating new units in 2017 was visible in Germany, Italy, and France.

Biogas production in Poland is also in the phase of growth. However, compared to the production leaders in the EU, this volume of produced biogas is small. High hopes are placed in the production of agricultural biogas, which is seen as an opportunity for an increase in the use of biomass, as well as a way to develop rural areas by means of using modern technologies in their area and providing new jobs. Agricultural biogas plants can contribute to solving some of the problems of the Polish agriculture, including restrictions on the use of nitrates, the increasing costs of the use of natural fertilisers, and the fluctuations in the prices of agricultural products. There is a large legal inconsistency in Poland related to the production of biogas. A frequent volatility of support systems negatively affects the willingness to invest in the production of agricultural biogas. The SWOT analysis can be seen as an attempt at summarising the determinants of – and obstacles to – the development of biogas production in Poland.

Improving the flexibility of electricity generation in Poland is important, both in the context of broadly understood energy security and in terms of the economic efficiency of energy production processes. Taking into consideration the strengths and opportunities that biogas production gives in the micro scale as well as at the macro level, it can prove to be beneficial for promoting this kind of renewable energy. The weaknesses and threats should also be taken into consideration in order to make the location of new biogas plants easier from the point of view of the investors, as well as to make the investment decisions less risky.

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