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Opportunities And Threats to the Development of Renewable Energy in Rural Areas in the Czech Republic and Poland

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Abstract: The Czech Republic and Poland face serious challenges related to the further development of renewable energy sources. It should be emphasized that a significant part of renewable energy sources (mainly except for photovoltaics) can be particularly easily implemented in rural areas. This is due to the dispersed development and the possibility of locating RES installations away from residential buildings. This may be particularly important in the case of biogas plants or large wind farms, which may be considered burdensome by some residents. It should be emphasized that both the Czech Republic and Poland do not fully exploit the potential of renewable energy sources in rural areas. The aim of the article is to determine the potential of rural areas in the Czech Republic and Poland to implement solutions based on renewable energy sources in the production of electricity and heat. The Foresight method was used during the research. The article also indicates the conditions related to the relief of energy transmission networks in connection with the reduction of the importance of large coal-fired power plants. It should be emphasized that the dispersion of energy generation sites will mean that energy will not have to be transmitted over very long distances.

Keywords: renewable energy sources; rural areas; economy; Czech Republic; Poland

JEL Classification: O11; Q28; Q56

1. Introduction

The development of renewable energy in rural areas in the Czech Republic and Poland is associated with the need to improve the quality of the environment and living conditions of the inhabitants, who are still exposed to frequent exceedances of the permissible concentrations of harmful substances in the air (Kůdela et al., 2020). An increase in the share of renewable energy is also a must, especially in the long run, when fossil energy resources will become scarce and their price will rise significantly (Olczak, 2022). Economic issues are also gaining importance due to the rising prices of CO_2 emission allowances. The Czech Republic and Poland face serious challenges related to the further development of renewable energy sources (RES). It should be emphasized that a significant part of renewable energy sources (mainly except for photovoltaics) can be particularly easily implemented in rural areas (Angowski et al., 2021; Luňáčková et al., 2017; Mik et al., 2021). This is due to the dispersed development and the possibility of locating RES installations away from residential buildings. This may be

particularly important in the case of biogas plants or large wind farms (Pommeret et al., 2017), which may be considered burdensome by some residents. It should be emphasized that both the Czech Republic and Poland do not fully exploit the potential of renewable energy sources in rural areas (Klepacki et al., 2021).

The implementation of ecological solutions in agriculture and industry is very important for the development of renewable energy in rural areas (Frantál & Prousek, 2016). The aim of the article is to determine the potential of rural areas in the Czech Republic and Poland to implement solutions based on renewable energy sources in the production of electricity and heat (Chu et al., 2022; Olczak et al., 2021). The article also indicates the conditions related to the relief of energy transmission networks in connection with the reduction of the importance of large coal-fired power plants (Raczkowski et al., 2022; Yan et al., 2021). It should be emphasized that the dispersion of energy generation sites will mean that energy will not have to be transmitted over very long distances. Moreover, the publication indicates the negative impact of energy generation by burning fossil fuels on the quality of life of the inhabitants and the environment (Mikhno et al., 2022).

It should be emphasized that in 2020 the share of renewable energy sources in Poland was lower than in the Czech Republic (Table 1). Although the Czech Republic and Poland in 2004 had a similar share of RES. It should be added that the share of RES to be achieved by the Czech Republic in 2020 was 13% of RES. In the case of Poland, however, it was 15% of RES in total energy production (Dzikuć & Tomaszewski, 2016).

Table 1. Share of energy from renewable sources (Eurostat, 2022)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EU	9.6	10.2	10.8	11.7	12.6	13.9	14.4	14.5	16.0	16.7	17.4	17.8	18.0	18.4	19.1	19.9	22.1
Belgium	1.9	2.3	2.7	3.1	3.6	4.7	6.0	6.3	7.1	7.7	8.0	8.1	8.7	9.1	9.5	9.9	13.0
Bulgaria	9.2	9.2	9.4	9.1	10.3	12.0	13.9	14.2	15.8	18.9	18.0	18.3	18.8	18.7	20.6	21.5	23.3
Czechia	6.8	7.1	7.4	7.9	8.7	10.0	10.5	10.9	12.8	13.9	15.1	15.1	14.9	14.8	15.1	16.2	17.3
Denmark	14.8	16.0	16.3	17.7	18.5	19.9	21.9	23.4	25.5	27.2	29.3	30.5	31.7	34.4	35.2	37.0	31.6
Germany	6.2	7.2	8.5	10.0	10.1	10.9	11.7	12.5	13.5	13.8	14.4	14.9	14.9	15.5	16.7	17.3	19.3
Estonia	18.4	17.5	16.0	17.1	18.8	23.0	24.6	25.5	25.6	25.4	26.1	29.0	29.2	29.5	30.0	31.7	30.2
Ireland	2.4	2.8	3.1	3.5	4.0	5.2	5.8	6.6	7.0	7.5	8.5	9.1	9.2	10.5	10.9	12.0	16.2
Greece (p)	7.2	7.3	7.5	8.2	8.2	8.7	10.1	11.2	13.7	15.3	15.7	15.7	15.4	17.3	18.0	19.6	21.7
Spain	8.3	8.4	9.2	9.7	10.7	13.0	13.8	13.2	14.2	15.1	15.9	16.2	17.0	17.1	17.0	17.9	21.2
France	9.3	9.3	8.9	9.4	11.2	12.2	12.7	10.8	13.2	13.9	14.4	14.8	15.5	15.8	16.4	17.2	19.1
Croatia	23.4	23.7	22.7	22.2	22.0	23.6	25.1	25.4	26.8	28.0	27.8	29.0	28.3	27.3	28.0	28.5	31.0
Italy	6.3	7.5	8.3	9.8	11.5	12.8	13.0	12.9	15.4	16.7	17.1	17.5	17.4	18.3	17.8	18.2	20.4
Cyprus	3.1	3.1	3.3	4.0	5.1	5.9	6.2	6.2	7.1	8.4	9.1	9.9	9.8	10.5	13.9	13.8	16.9
Latvia	32.8	32.3	31.1	29.6	29.8	34.3	30.4	33.5	35.7	37.0	38.6	37.5	37.1	39.0	40.0	40.9	42.1
Lithuania	17.2	16.8	16.9	16.5	17.8	19.8	19.6	19.9	21.4	22.7	23.6	25.7	25.6	26.0	24.7	25.5	26.8
Luxembourg	0.9	1.4	1.5	2.7	2.8	2.9	2.9	2.9	3.1	3.5	4.5	5.0	5.4	6.2	8.9	7.0	11.7
Hungary	4.4	6.9	7.4	8.6	8.6	11.7	12.7	14.0	15.5	16.2	14.6	14.5	14.4	13.6	12.5	12.6	13.9
Malta	0.1	0.1	0.1	0.2	0.2	0.2	1.0	1.8	2.9	3.8	4.7	5.1	6.2	7.2	7.9	8.2	10.7
Netherlands	2.0	2.5	2.8	3.3	3.6	4.3	3.9	4.5	4.7	4.7	5.4	5.7	5.8	6.5	7.4	8.9	14.0
Austria	22.6	24.4	26.3	28.1	28.8	31.0	31.2	31.6	32.7	32.7	33.6	33.5	33.4	33.1	33.8	33.8	36.5
Poland	6.9	6.9	6.9	6.9	7.7	8.7	9.3	10.3	11.0	11.5	11.6	11.9	11.4	11.1	14.9	15.4	16.1
Portugal	19.2	19.5	20.8	21.9	22.9	24.4	24.1	24.6	24.6	25.7	29.5	30.5	30.9	30.6	30.2	30.6	34.0
Romania	16.8	17.6	17.1	18.2	20.2	22.2	22.8	21.7	22.8	23.9	24.8	24.8	25.0	24.5	23.9	24.3	24.5
Slovenia	18.4	19.8	18.4	19.7	18.6	20.8	21.1	20.9	21.6	23.2	22.5	22.9	22.0	21.7	21.4	22.0	25.0
Slovakia	6.4	6.4	6.6	7.8	7.7	9.4	9.1	10.3	10.5	10.1	11.7	12.9	12.0	11.5	11.9	16.9	17.3
Finland	29.2	28.8	30.0	29.6	31.1	31.0	32.2	32.5	34.2	36.6	38.6	39.2	38.9	40.9	41.2	42.7	43.8
Sweden	38.4	40.0	41.7	43.2	43.9	47.0	46.1	47.6	49.4	50.2	51.2	52.2	52.6	53.4	53.9	55.8	60.1

2. The Importance of Using Renewable Energy Sources in Rural Areas

Climate change, which is a frequent cause of the intensification of rapid atmospheric phenomena, contribute to huge losses associated with the repair of infrastructure, which is increasingly damaged as a result of, among others high winds. According to the report of the World Health Organization (WHO), which includes data from 2018, out of 50 cities in the

European Union with the highest concentration of PM2.5 suspended dust, as many as 36 are in Poland (Rokicki et al., 2022a). The problem of excessively polluted air does not only apply to cities (Simionescu et al., 2022). It is very common for rural areas (especially during the heating season) to have more polluted air than city centres (Zarębska & Dzikuć, 2013; Zaporozhets & Khaidurov, 2020). This is because in most large cities, combined heat and power plants operate, which must meet stringent ecological standards. In rural areas, however, solid fuel heating dominates in single-family buildings, which is often of poor quality (Olczak & Komorowska, 2021). On the other hand, heating installations are often based on energy-inefficient technologies that allow the combustion of fuels at relatively low temperatures, which contribute to excessive emissions of harmful substances into the air (Uğurlu, 2022).

It should be emphasized that the share of renewable energy sources in the total energy balance of Poland should increase in the coming years (Szumilas-Kowalczyk & Giedych, 2022). According to the National Plan for Energy and Climate for 2021-2030, Poland in 2030 should achieve a 21-23% share of renewable energy sources in gross final energy consumption. However, it should be expected that the future EU regulations will strive to significantly increase the share of renewable energy sources. Such a situation may result in the need to import renewable energy from other EU countries that will have a surplus of this energy. According to the estimates of the Supreme Audit Office, the costs of such an undertaking in Poland may amount to as much as PLN 8 billion. The relatively small share of renewable energy in Poland is caused, among others, by insufficient state support and the lack of stable and favorable legal solutions. Too small share of renewable energy sources in Poland could be caused, among others, by insufficient state support and the lack of stable and favourable legal solutions (Mazurek-Czarnecka et al., 2022).

It is worth noting that the prospect of increasing costs of coal-based energy (CO_2 fees) may contribute to the increased interest of renewable energy sources by Polish entrepreneurs, national authorities at various levels and individual energy consumers (Urban & Dzikuć, 2013), many of which live in rural areas that have greater potential for renewable energy development (Poór et al., 2015; Zhao et al., 2021). In rural areas there are more opportunities related to renewable energy production due to the difficulty of locating such investments as urban biogas plant or wind farm in urban areas (Piwowar & Dzikuć, 2013). Moreover, rural areas allow the production of large amounts of biomass (Aviso et al., 2020), which can be, among others, pyrolyzed or otherwise used during the production of energy based on renewable energy sources (Piersa et al., 2022; Saeed et al., 2022).

Broadly understood rural development in the Czech Republic and Poland is an important issue related to the quality of life of the inhabitants, which is also connected with ecological, economic and social aspects. Activities for economic development without caring for the environment in which man lives is not possible in the long run. Excessive use of natural resources over a longer period of time can lead to negative and irreversible effects that will significantly reduce the quality of life for future generations. It becomes necessary to take measures to reduce the negative impact of man on the environment.

It should be emphasized that bad air quality in Poland also occurs in rural areas due to excessive use of contaminated solid fuels for heating buildings using ecologically inefficient

technologies. Rural areas usually do not have access to district heating and a large part of rural areas lack access to natural gas, which is a more ecological fuel and is burned in boilers, which are usually characterized by higher energy efficiency than old-type coal boilers.

3. The Results of Research Using the Foresight Method

The share of renewable energy sources in Poland deviates from the standards of many countries, the so-called old EU (EU-15). The relatively low share of renewable energy sources in the total energy balance is one of the causes of poor air quality in Poland. The problem is not only large coal-based power plants that emit huge amounts of greenhouse gases (mainly CO_2), but also small installations for heating single-family buildings, a large part of which is located in rural areas. Low-grade fuel is often used in home boiler rooms, a large proportion of which do not meet the latest energy standards. As the project author's previous research shows, a significant percentage of Polish residents do not see the need to replace heating installations with more ecological ones. Poles also carry out investments to a lesser extent than residents of countries such as Germany, Belgium or Denmark. Support for renewable energy installations in rural areas will be a major challenge in the coming years. Without a real economic incentive, RES development in rural areas will be much less dynamic.

Analyzing the data of the European Environment Agency (EEA), it can be assumed that the air quality in the Czech Republic is better than in Poland. Although these are only estimates, the difference in values is so significant that it gives grounds to indicate the air quality in the Czech Republic as better. It is estimated that around 9,000 people died in the Czech Republic in 2018 due to poor air quality, which accounted for over 6% of all deaths in the country. In the same year, about 45,000 people died in Poland due to poor air quality, which accounted for over 12% of all deaths in the country (European Environment Agency, 2022).

The state authorities of the Czech Republic and Poland develop their own national RES development policies. In accordance with the assumptions of the National Plan for Energy and Climate, Poland plans to increase the maximum capacity of photovoltaic installations to approx. 7.3 GW in 2030. The national contribution to energy efficiency (primary and final energy consumption) of the Czech Republic and Poland should be assessed as insufficient (Table 2).

The Foresight method was used during the research. This method was be carried out among representatives of decision-makers (public authorities), industry, scientific circles and the media. Research on the future of various branches of the economy can also be conducted using foresight tools (methodologies). Foresight is an attempt to look into the future in a systematic way. This distinguishes foresight from natural script building in everyday life. Foresight covers a long period, with a time frame of up to 30 years. The research proposes to take a time interval of 10 years due to the significant dynamics of changes in the analysed sector (Szarucki et al., 2022). It should be emphasized that foresight should not be dominated by science and technology, but should also take into consideration socioeconomic factors that shape innovation. Foresight focuses on new, forward-looking technologies, for the development of which it is justified to support formal institutions. When conducting foresight, emphasis should also be placed on social aspects (the possibility of revitalizing the area in terms of its social adaptation).

Table 2. Objectives, targets and contributions under the Governance Regulation of countries of the Czech Republic and Poland (European Commission, 2022; European Union, 2018)

National targets and contributions	Countries	Latest available data	2020	2030	Assessment of 2030 ambition level
Binding target for greenhouse gas emissions compared to 2005 under the Effort Sharing Regulation (ESR) (%)	Czech Republic	4% (2018)	9%	-14%	As in ESR
	Poland	21%	14%	-7%	As in ESR
National target/contribution for renewable energy: share of energy from renewable sources in gross final consumption of energy (%)	Czech Republic	15% (2018)	13 %	22%	Unambitious (23% is the result of RES formula)
	Poland	11.3%	15%	21%-23%	Unambitious (25% is the result of the RES formula)
National contribution for energy efficiency: a) primary energy consumption (Mtoe) b) final energy consumption (Mtoe)	Czech Republic	a) 40.4 (2018) b) 25.3 (2018)	a) 43.3 b) 23.9	a) 41.43 b) 23.65	a) Low ambition b) Modest ambition
	Poland	a) 100.9 Mtoe b) 71.8 Mtoe	a) 96.4 Mtoe b) 71.6 Mtoe	a) 91.3 Mtoe b) 67.1 Mtoe	a) Modest b) Modest
Level of electricity interconnectivity (%)	Czech Republic	26.6% (2018)	29.6%	44.1%	N.A.
	Poland	4%	4%	8.7%	N.A.

In November and December 2022, Foresight surveys were conducted among representatives of energy sector companies, local governments, scientific communities and non-governmental organizations. The research involved 30 experts from Poland and the Czech Republic, who answered questions related to opportunities and threats to the development of RES in rural areas in the Czech Republic and Poland. Experts pointed out the most important problems and suggested possible solutions of developing renewable energy sources in rural areas.

According to the experts who participated in the research, the main barriers to renewable energy sources include: legal conditions, complex and often changing procedures for supporting investors, relatively high price of energy installations based on RES and old power grids. Old power grids often make it impossible to connect new RES-based installations due to the inability of power grids to receive electricity. The problem of old power grids, which hinders the development of renewable energy sources, is also noticed by

other researchers (Zou et al., 2021). As barriers to the development of renewable energy sources in rural areas, experts also indicated insufficient regulations in the field of implementing energy cooperatives, which could associate prosumers with renewable energy sources. Another problem is the insufficient development of small household energy storage facilities. The results of the analyzes carried out in the article are consistent with the results of research published by other scientists (Szymańska et al., 2022; Raczkowski et al., 2022; Rokicki et al., 2022b).

4. Conclusions

Research conducted using the Foresight method shows a significant potential for the development of renewable energy sources in rural areas. However, in order to increase the share of renewable energy sources in the total energy mix in the Czech Republic and Poland, it is necessary to consider to taking many actions. The most important of them include: implementation of solutions encouraging investors to build new installations based on RES.

Reducing existing barriers should also be considered, e.g. related to the ban on building wind farms at a distance from buildings of less than 10 times the height of a single installation (about 2 km). Moreover, it seems necessary to invest in transmission networks that will be able to receive more energy from prosumers. It is also important to create more favorable legal, economic and technical conditions for the use of energy storage facilities and the creation of energy cooperatives associating prosumers with RES-based installations. It should be noted that the development of renewable energy sources is particularly beneficial in rural areas, where less dense buildings make it possible to build installations that in cities could be a nuisance for neighbors, e.g. biogas plants or wind farms.

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