
General Determinants and Directions of Development for the Utilisation of Renewable Energy Sources in the West Pomerania Province

Submitted 11/07/21, 1st revision 29/07/21, 2nd revision 26/08/21, accepted 30/09/21

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Abstract:

Purpose: The depletion of conventional energy sources with a constantly growing energy demand requires a new approach to our energy policy and in a wider approach, a new social and economical development policy. The article presents the determinants and directions of development of utilisation of renewable energy sources in the West Pomerania province.

Approach/Methodology/Design: The study was based on secondary data, i.e., quantitative data available for the renewable energy sector in Poland and West Pomerania province and the analysis of available literature. The theoretical issues were determined based on the analysis of available literature on the regional development and renewable energy. The research methods used in the study included a critical analysis of the literature, comparative analysis and secondary data analysis.

Findings: There is a growing interest in renewable energy source due to increasing environmental pollution, depletion of conventional energy sources, regular increase in prices of energy resources and constantly increasing energy demand. A new, competitive regional economy can be formed with the energy obtained from the renewable sources.

Practical Implications: The analysis and evaluation carried out in the article shows that a key factor affecting the development of this sector is an active participation of the local government and resources provided by the European funds. The results can be used to develop a long-term strategy on the development of the renewable energy sources including the programs to counteract the negative effects of utilisation of conventional energy sources.

Originality/Value: The proposed solutions are to contribute to the development of renewable energy in the studied area.

Keywords: Renewable energy sources, factors supporting the development of renewable energy sources, regional competitiveness, West Pomerania province, borderland.

JEL classification: O12, O13, Q20.

Paper Type: Research article.

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1. Introduction

The depletion of conventional sources energy sources with a constantly growing energy demand requires defining a new approach to our energy policy and in a wider approach, a new social and economical development policy (Dye and Yang, 2015; Górka, 2014; Helm, 2014; Van Asselt and Biermann, 2007). An increase in environmental pollution forces us to take action to redefine the role of energy industry as a key sector of the economy of a modern country (Marino *et al.*, 2011; Panwar, Kaushik, and Kothari, 2011; Pavlova-Marciniak, 2014).

An increase in the energy demand of the global economy and prices resulted in an increase in interest in the energy based on renewable sources in recent years (Dec and Krupa, 2014; Lewandowski, 2007; Sadowski *et al.*, 2008). In particular, it can be observed in highly developed countries which first noticed the issues with the development based on non-renewable sources. The actions taken by the European Union countries are a key factor here. Europe is an undisputed leader in the renewable technologies and implementation of the rules of sustainable social and economic development.

The study aimed to present the determinants and directions of development of utilisation of renewable energy sources in the West Pomerania province. The West Pomerania province with its capital in Szczecin is located in the northwest Poland, at the Baltic Sea coast. It borders the Pomorskie province in the east, Wielkopolskie and Lubuskie province in the south, and German states, Brandenburg and Mecklenburg-West Pomerania in the west. It covers 22,892.48 km² and has a population of over 1.7 million. It is a leader in utilisation of renewable energy sources.

2. The Scope and Methods of Research

The study was based on a desk research analysis using quantitative data available for the renewable energy sector in Poland and the West Pomerania province and the analysis of available literature. The theoretical issues were determined based on the analysis of available literature on the regional development and renewable energy. The research methods used in the study included a critical analysis of the literature, comparative analysis and secondary data analysis.

3. European Green Deal as a Challenge to Poland

A key factor for the transformation of the European energy policy was to establish precise and time-specific goals for the energy policy of the EU countries (Correlje and Van der Linde, 2006). In particular, the goals cover the need to guarantee a supply of sustainable, safe and competitively priced renewable energy to the economy and the society. Based on the assumptions, a continuous growth of the renewable energy sector will become a key element of the policy at the EU level and

for individual membership countries. An increase in the utilisation of renewable energy sources in the European energy balance will not only guarantee independence from the external sources of energy resources but will also improve the competitiveness of the European economy.

The effects of a new approach to sustainable economic and social development was to approve a series of key legislative solutions allowing for the rapid development of the renewable energy sector in Europe. It also significantly affected the situation in Poland. Despite the opposition of the mining and conventional energy sector lobby, the changes and the new age of energy supply and utilisation using state-of-the-art technologies can also be observed in Poland.

Not without the obstacles, the renewable energy sources are a key alternative to traditional means of obtaining energy from fossil fuels, important for the Polish economy. The solutions related to the renewable energy sources are gaining more and more traction and are an example of changes in society's mindset and rapid technological developments in the economy. Those energy sources are renewable can be considered as sources of unlimited energy with a minor effect on the environment. In the context of improving the ecological awareness of Poles and a growing opposition to the environmental pollution, the direction of changes in the energy industry seems to be approved by the majority of the society.

To face those challenges, Europe needs a new strategy to build a modern, economical and competitive economy. One of the proposed solutions is the European Green Deal. This concept involves actions aimed at implementing a sustainable model of the European Union's economy that involve transformation of all areas of the country's operations while simultaneously making sure that the energy transformation does not result in social exclusions.

The main goals for the countries of the European community as part of the Green Deal is to achieve a zero net emission of greenhouse gases by 2050 while maintaining a high level of economic growth (Ciechanowska, 2020; Gawlik, 2020; Górka and Szyja, 2020). The economic growth will also be made independent from the utilisation of natural resources. The transformation aims to improve the solidarity between the EU regions. These premises are based on a conviction that the level of technological development and social awareness allows to effectively use the resources by shifting to a circular economy (Ciechanowska, 2020; Gawlik, 2020; Górka and Szyja, 2020).

The circular economy is a concept based on an assumption that it is possible to run the economy in which products, materials and resources remain in the loop for as long as it's feasible. It also means that waste generation must be reduced to a minimum. In the circular economy, the waste must be treated as a resource by taking actions prior to the generation of waste and by developing new technologies to manage and reduce waste.

Implementing the circular economy rules will improve the innovativeness of the European entrepreneurs and competitiveness in relation to other entities from around the world. The strategy of using the available waste gave rise to a wide range of possibilities to develop unconventional energy solutions including the solutions based on biomass.

The Green Deal concept in Poland is one of the key tasks for the government, local governments, entrepreneurs and the society as a whole that will require a change in the perception of the role of the natural environment in the life of a statistical Pole. Creating a friendly environment for the proposed changes, which due to their nature, will significantly affect the daily life of Poles, is also important. Reaching this goal will require action taken by all the sectors of Polish economy including:

- investment in the environmentally friendly technologies,
- supporting the industrial innovations,
- introducing cleaner, cheaper and healthier modes of private and public transport,
- reducing the emissions of the energy sector,
- improving the energy efficiency of buildings.

Those tasks will be possible with the aid of EU funding. The European Union also provides financial and technical support for the people affected by the transition to a green economy based on the 'just transition' principle. It will provide a targeted support to invest at least 100 billion Euro between 2021 and 2027 in the regions mostly affected by the negative social and economical effects of the transition and to mitigate those effects.

The main challenge in implementing the Green Deal in Poland will be to mitigate the effects of the energy sector transformation and to create a friendly environment for the transition and to manage the risks from social protests. The residents of the regions most affected by the transition will be provided with additional support to:

- improve the ability to find employment in new and transformed sectors;
- allow and facilitate changes in qualifications based on the local labour market demand;
- improve the energy efficiency of buildings;
- mitigate the effects of energy poverty by investments;
- provide access to clean, cheap and safe energy.

The premises of the future policy of the European Union create serious challenges facing both Poland, and individual regions. They not only apply to the energy sector but also to the economy as a whole, both at a local, regional and national level, highly dependent on energy supplies.

4. Potential for Renewable Energy Development in the West Pomerania Province

According to the experts, the only real chance to improve the energy security and thus ensure continuous social and economic development is a common use of distributed renewable energy sources (Aized *et al.*, 2018; Criqui and Mima, 2012; Jun *et al.*, 2009). The future energy industry will be mostly based on new forms of distributed energy using renewable sources (Klugmann and Klugmann-Radziemska, 2005; Owczuk *et al.*, 2013; Sarica and Tyner, 2013). The decarbonisation of the economy will allow to create a new model of economic development based on clean energy sources. Thus, it is important to determine the capabilities of using the clean energy sources including wind, solar, biomass and geothermal energy in the region. In the following years, use of renewable energy sources will determine the ability to build competitiveness of the regional economies, both at the national and international level. The steps taken to limit carbon footprint will directly affect the client's perception of a product or a service. It will lead to creating new business models supporting the sustainable development and socially responsible businesses.

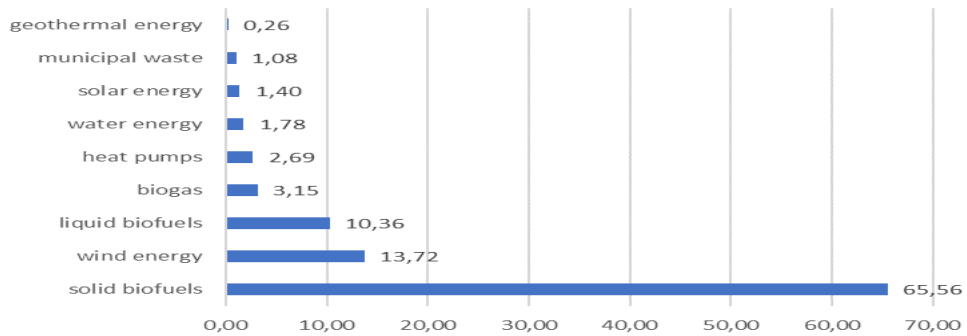
In Poland, similar steps have already been taken for a very long time, and their scope has only increased after Poland joined the EU. The Polish economy is still dependent on the supplies of energy from conventional energy sources, mainly from combustion of hard and brown coal (73.6% of total energy production in Poland in 2019). The national energy potential is insufficient. The energy production in 2019 was the lowest in the last five years at 164 TWh. In 2019, the amount of energy imported by Poland was 10.6 TWh - twice as high as in 2018.

The share of renewable energy sources in Poland is approx. 14% of its total energy production capabilities. The energy obtained from renewables in Poland in 2019 was mostly sourced from solid biofuels (65.56%), wind (13.72%) and liquid biofuels (10.36%). Total energy density of the primary energy obtained from the renewable sources in Poland in 2019 was 396,498 TJ (Figure 1). The renewable energy sector in the West Pomerania province is based on relatively small, distributed generating modules, located close to the consumers - a key component of the system providing local energy security and a chance to improve energy supply in the areas in which the power network has not been sufficiently developed. The production of energy from renewable sources means lower pollution and some positive ecological effects that are in high demand, especially in the areas used for agricultural or tourist purposes.

The development of renewable energy sector is a key element of social, economic and ecological transformation of the West Pomerania province. The West Pomerania province is a national leader in the development of renewable energy sources. According to the data provided by the Marshal's Office of the West Pomerania province, currently, there are 271 systems generating electrical energy using

renewable energy sources with a total installed power of 1675.828 MW - 18.4% of the total renewable energy sources power installed in Poland.

Figure 1. The structure of energy obtained from the renewable sources in Poland by energy carrier in 2019 (%)



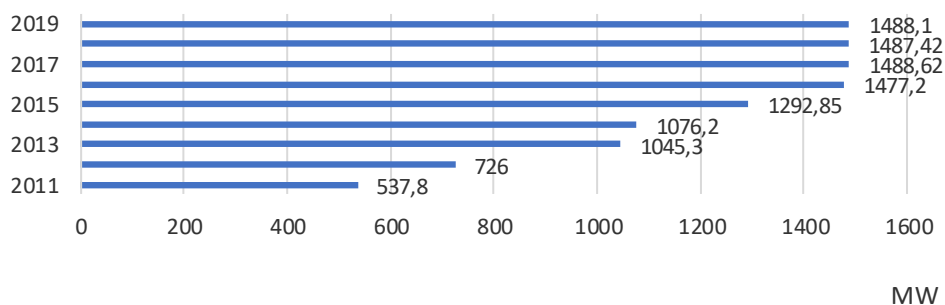
Source: Compiled by the authors based on Central Statistical Office, 2000.

This is a result of the social and economic transformation of the region since 2004. Joining the European Union affected the intensification of transformation of the energy sector in Poland as a whole. One of the effects is an increase in the power output of renewable energy systems operated in Poland. Compared to 2005, the power output of renewable energy systems operated in Poland has increased from 1,157.537 MW to 9,106.258 MW in 2019. The growth is mainly related to the wind energy sector, increasing its power output from 83.23 MW in 2005 to 5,917.243 MW in 2019.

The analysis of data on the power output of renewable energy systems operated in the region shows that in the recent years, wind energy was the fastest growing area of utilization of renewable energy sources in the West Pomerania province (Figure 2). The economic potential of the wind energy in the West Pomerania province is the highest in Poland (Wiśniewski, 2011), mostly due to special wind conditions of the coastal region and relatively low population density, making it easy to find a location for new wind farms.

The wind power plants built in the West Pomerania province after 2017 can produce energy for PLN 250-300 per MWh, i.e., similar price to offered by the coal power plants. The wind energy facilities are not only one of the largest suppliers of green energy, but also play a key role in supporting the competitiveness of regional economy and meeting the climate goals. Over 60% of the energy obtained from renewable sources in Poland comes from the wind. Currently, the installed capacity of the wind farms in the West Pomerania province is 1/4 of the overall installed capacity of all the wind energy facilities operated in Poland. The total power output has increased from 56 MW in 2005 to 1,488.1 MW in 2019.

Figure 2. The installed capacity of the wind power plants in the West Pomerania province between 2014 and 2019 (in MW)



Source: Compiled by the authors based on The energy regulatory office, 2020.

98 wind power plants are located in the discussed region, including some of the biggest investments in Poland, Karścino-Pobłocie (90 MW), Marszewo (80 MW), Resko II (76 MW), Kozielice II (58 MW), Kukinia (52,9 MW), Jarogniew-Mołtowo, Wartkowo (51,5 MW), Karcino, Sarbia (51 MW), Tymień, Tychowo Bardy, Dygowo, Świelubie, Pustary and Dębogard (50 MW). The local preferences for the location of the wind farms include arable land as a preferred location. In the West Pomerania province, the arable land covers the area of 1 million hectares, approx. 49% of its land area.

The observed growth of wind energy sector is limited by several factors (Krzyzanowska and Nuskiewicz, 2012; Szlufik and Sasinowski, 2018). The study conducted among the investors shows that the main obstacle inhibiting the growth of the wind energy sector is the complexity and opaqueness of the procedures related to the preparation of the investment. It applies both to the rules of agreeing the conditions for connecting the investment to the national grid and the evaluation of the investment effect on the environment. The ever-growing social opposition to the location of new systems, in particular in the coastal areas is also important. The arguments against the construction of wind farms include the aesthetic issues and the potential loss of value of local properties.

The legislative changes introduced in Poland in 2016 has also affected the locations of new investments in the West Pomerania province. As per the relevant regulations, the wind farm location is based on the local development plan in the distance from the housing development and any areas covered by the environmental protection and forest complexes, equal or larger than the tenfold height of the wind power plant measured from the ground level to the highest structure point, including the technical components, e.g. the impeller with the blades (total height of the wind power plant). Allowing for the limitations and using a 10 hectare area per 1 MW of installed capacity, the location potential for the growth of wind energy sector in the West Pomerania province is approximately 360 MW. It is approximately 14% of the

overall location potential for the wind farms in this province, i.e., 2,600 MW estimated before the strict location requirements were introduced.

Biomass is also an interesting direction of the development of power technologies using renewable energy sources (Owczuk *et al.*, 2013; Polak *et al.*, 2014; Sałagan *et al.*, 2011). Poland has some largely advantageous conditions for the development of biomass production (Ćwil, 2011; Kupczyk and Piechocki, 2010; Pawilonis and Kupczyk, 2006). The available analyses show that without any loss to the food production, Polish agriculture can allot 0.6 million hectares of grains for production of bioethanol, 0.4 million hectares of rape for production of biodiesel and 0.5 million hectares for production of biomass for the power sector (Kuś and Faber, 2007; Mystkowski, 2008).

The agricultural conditions of the province are advantageous for the development of power systems using biomass and biogas (Czyż *et al.*, 2011). The province is an area of traditionally developed, bulk plant production, highly advantageous and showing a great production potential for obtaining energy from biomass (Bancer *et al.*, 2015; Jasiulewicz, 2004; Podkówka, 2016).

A significant potential of the West Pomerania province is the ability to produce biomass from permanent grassland (Jankowska-Huflejt and Domański, 2008; Terlikowski, 2012). In recent years, decreasing profitability of animal breeding reduced the demand for pasture feeds, hay and silage. Unfulfilled potential of the permanent grassland results in soil degradation and brings economic losses. The grasslands can be used for production of biomass for energy production.

Advantageous natural and economic conditions in the region contribute to the development of crops grown solely for energy production. In Polish conditions, the most popular species is the basket willow. Many other species grown in a perennial cycle, including poplar and silvergrass also show promise (Faber, 2020; Grzesik *et al.*, 2011).

Table 1. *The potential utilised agricultural area for energy crops in the West Pomerania province (willow, poplar and silvergrass)*

Province	Land area	
	Thousand hectares	%UR
Lower Silesia	88.3	6.8
Kujawy-Pomerania	8.1	0.6
Lubelskie	68.8	3.1
Lubuskie	53.4	6.5
Łódź province	80.2	4.9
Lesser Poland	15.1	2.3
Mazovia	105.2	3.3
Opolskie	49.9	7.2
Podkarpackie	92.2	10.3

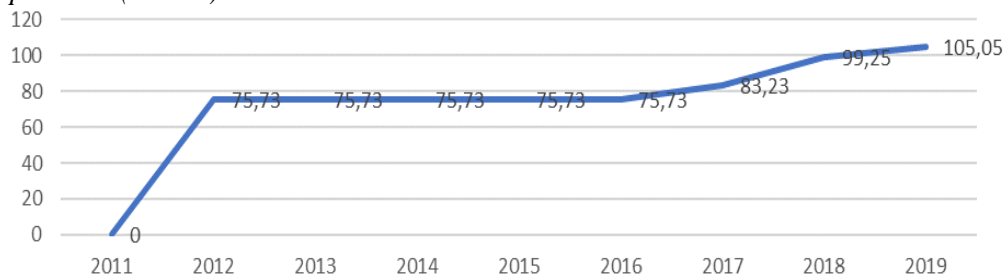
Podlaskie	56.2	3.6
Pomerania	49.1	3.8
Silesian province	70.8	9.0
Świętokrzyskie	21.9	2.3
Warmian-Masurian	42.6	2.3
Greater Poland	42.9	1.8
West Pomerania	109.4	6.5
Total in Poland	954.1	4.6

Source: Compiled by the authors based on Central Statistical Office, 2000.

An overall potential of energy crops in Poland has been estimated at approximately 954.1 thousand hectares. The regions with the highest potential include, West Pomerania province – 108.4 thousand hectares, Mazovia province – 105.2 thousand hectares, Podkarpackie province - 92.2 thousand hectares. The estimated energy potential of using the biomass from perennials in the West Pomerania province is approximately 4,500 TJ (Jarosz, 2017).

The discussed region is the fourth most forested province in Poland at 35.6%. At the moment, the forest biomass that cannot be used in the timber industry is used for energy production. Almost 4 million cubic metres of timber is obtained every year in the West Pomerania province, yielding approximately 600 thousand cubic metres of forestry waste. The experience shows that biomass is one of the most effective methods for continued and planned production of renewable energy, predictable throughout the year. The estimated energy potential from using plant biomass in the West Pomerania province is over 28.2 thousand TJ (Jarosz, 2017). In recent years, an increase in energy production from biomass in the West Pomerania province was observed. Currently, the total output of biomass-based systems is over 105 MW – (Figure 3).

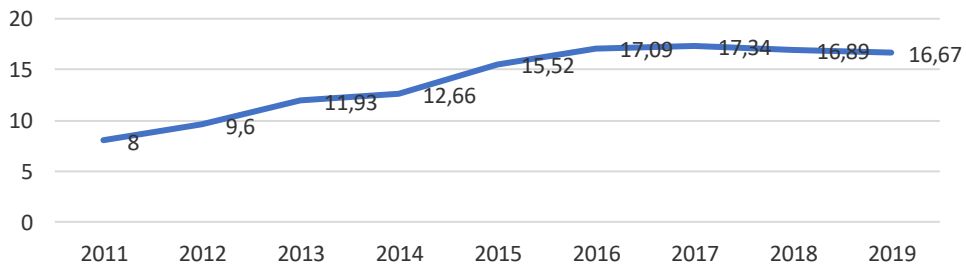
Figure 3. Installed capacity of biomass-based systems in the West Pomerania province (in MW)



Source: Compiled by the authors based on The energy regulatory office, 2020.

23 biogas-based systems with a total power output of 16.668 MW, producing energy from biogas from the waste water treatment plant, landfill biogas and agricultural biogas are currently operated in the region – (Figure 4).

Figure 4. Power output of biogas power plants in the West Pomerania province (in MW)



Source: Compiled by the authors based on The energy regulatory office, 2020.

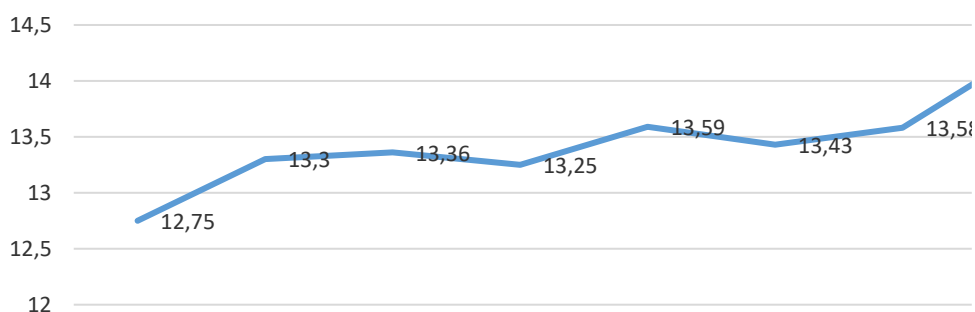
The majority (13 biogas power plants) with a total power output of 12.69 MW are the agricultural biogas power plants. The installed capacity of the agricultural biogas plants puts the region in the lead (as of 31 March 2018). The mixed biomass plants located in the region put the West Pomerania province in the 7th place.

The largest producer of biomass energy is Dolna Odra Power Plant. Since January 2012, in the advanced fluidised bed boiler installed in Szczecin Power Plant with 68 MW power output, approximately 600 thousand tonnes of biomass is combusted annually. Another large producer of biomass energy in the region is the Thermal Recycling Facility in Szczecin which, in 2018, has obtained a licence for production of energy by thermal recycling. The installed capacity of the cogeneration unit is 15.481 MW.

The natural conditions in Poland are not favourable for the development of hydroelectric power. The majority of land area is covered by lowlands characterised by low gradients of the rivers. The economic potential of hydroelectric power (considering the profitable resources only). It contributes 37% of the overall hydroelectric power potential in Poland due to the natural conditions (Sobolewski, 2010)⁴. Compared to Poland, in particular its lowland regions, the hydroelectric power potential of the West Pomerania province is relatively good. The total length of the watercourses in the West Pomerania province is 30,200 km. Average density of the river network in the West Pomerania province is 1.32 km/km². The longest river networks include Parsęta (4100 km) and Rega (4000) river basins. The density of the river network is highest (over twice the national average) in the Przymorze region, Dziwna-Rega (2.85 km/km²) and Świńca (2.78 km/km²) river basins. The hydroelectric power potential of the discussed region is also affected by the difference in elevation (Rabe *et al.*, 2020). The highest differences in elevation in the unit areas in the West Pomerania province has been reported for the Drawskie Lake District. The difference reaches up to 150 m at the area of 36 km² (Kozłowski *et al.*, 2004). The hydroelectric power potential mainly depends on the unit run-off

of the river basin. The average unit run-off in Poland is 5.2 l/(s km²)(Byczkowski, 1999). The number and power output of hydroelectric power systems operated in the West Pomerania province is getting higher by the year (Figure 5).

Figure 5. Power output of the hydroelectric power plants in the West Pomerania province (in MW)



Source: Compiled by the authors based on The energy regulatory office, 2020.

The rivers in the West Pomerania province are characterized by the highest unit run-off at 9.5 l/s km² (Byczkowski, 1999). 64 hydroelectric power plants are operated in the discussed region, the majority of which are located in the Łobeski, Gryficki, Koszalin, Stargard and Myślibórz region. Most hydroelectric plants are microinstallations (57 systems) with power output up to 0.3 MW.

Utilisation of geothermal energy is mainly determined by the temperature (Zabłocki, 2013). The maximum temperature in the roof of the Lower Jurassic reservoir of the Szczecin basin is approx. 85°C (Chociwle area), however, just similar temperatures has been recorded for just 1% of the Lower Jurassic reservoirs. More than half of the water accumulated in the Lower Jurassic aquifers shows a temperature at the layer's roof between 40-60°C. The temperature is too low for use in energy production, but can be used in the heating sector. The potentially available geothermal resources in the West Pomerania province are estimated at 2.92x10¹¹ MJ – (Table 2).

Table 2. Geothermal resources in the West Pomerania province

Resource group	Resources [MJ]
Available geothermal resources	4.612 x 10 ¹⁵
Available resources	2.92 x 10 ¹¹

Source: Compiled by the authors based on Zabłocki, 2013.

The most promising available geothermal resources for use in the heating sector in the West Pomerania province are focused around Stargard Szczeciński, Dobrzany and Chociwle region. The available unit resources in this region are over 35 MJ (“Program rozwoju,” 2105).

Despite the significant geothermal resources in the region, the utilisation of geothermal energy is relatively low. The available geothermal resources are characterised by the temperatures that render them unusable for energy production. The geothermal energy resources in the province are not used for energy production, but instead are used in the heating sector. Two geothermal facilities are located in the West Pomerania province: “Geotermia Pyrzyce” (investment costs over 60 million PLN) and “GEOTERMIA STARGARD” (investment cost over 33 million PLN). In 2018, the company from Stargard covered approximately 34.1% of the overall heat of Przedsiębiorstwo Energetyki Ciepłej Sp. z o.o. in Stargard.

Due to significant investment costs, the location of a heating system based on geothermal resources should include a large number of consumers. The most suitable locations include Szczecin, Police, Goleniów and Nowogard, however, the available resources are approximately 25-25 MJ/m² (Byczkowski, 1999)

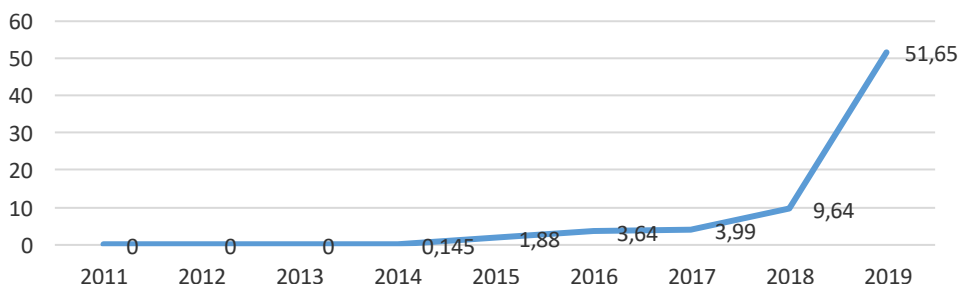
A total solar irradiation in Poland (in a horizontal plane) is between 950-1150 kWh/m² with sunshine duration between 1,377 to 1,700 hours depending on the region. The most advantageous conditions for the development of solar energy sector in Poland can be found in the coastal region, with the highest overall irradiation and sunshine duration from April to September (over 70% of the overall irradiation, which for Kołobrzeg is 1,056 kWh/m²). The most advantageous conditions for solar energy in the province can be found in the coastal region between Świnoujście and Kołobrzeg, in the Odra river valley between Kostrzyn and Cedynia, and in the Wałęckie Lake District. The total solar energy potential in Poland is 19,341 TJ, i.e. 5,372.5 GWh, with an average irradiation at approximately 1,100 kWh/m².

The West Pomerania province is characterised by advantageous conditions for the development of power systems using solar energy. With an average insolation of 1,000 kWh/m², the potential of the solar systems is estimated at 393.2 GWh. In this region, the solar energy is used in energy production (photovoltaics, solar cells) and heating (solar collectors). For economic reasons, the solar collectors are mostly used for heating. Solar energy is gaining popularity in the West Pomerania province by the year - Figure 6. It results from the ability to secure financing both by the local government and individuals who would like to use solar energy-based systems as part of the Prosumer programme.

In 2019, a 5-time fold increase in the power output of installed photovoltaic systems (from 9.6 MW to 51.7 MW) has been observed, contributing 3% of the total power in the province [Graph 6]. The largest installation with a power output of 1.529 MW (3,120 x 0.00025 MW and 2,996 x 0.00025 MW) is located in Kołbacz. A photovoltaic project developed on a recultivated landfill near Kukinka, Ustronie Morskie is an interesting example of an investment in solar energy as the first installation in Poland which is part of the recultivation process of a decommissioned

landfill. The power output of this photovoltaic installation is 0.9932 MW, and the energy is used by the local government.

Figure 6. Power output of the photovoltaic systems in the West Pomerania province



Source: Compiled by the authors based on The energy regulatory office, 2020.

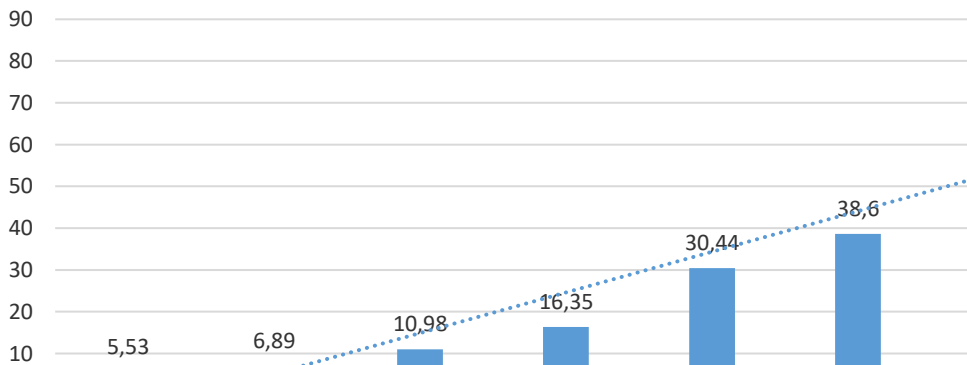
5. Future of Renewable Energy in the West Pomerania Province

The West Pomerania province is a national leader in utilising the potential of renewable energy sources in Poland. The development of installations using wind, solar and biomass energy is a result of not only advantageous natural conditions but also transformation of the economy at the regional and national level. Renewable energy sources are the key factors affecting the energy balance in the region. An increase in production of energy from renewable sources in the West Pomerania province increases the energy security and improves the energy supply to the areas with less developed power infrastructure.

The renewable energy sources became a marketing component used not only by the local authorities but also by the entrepreneurs. A growing interest in the environmental protection issues among the consumers also increases their interest in the products and services with a low carbon footprint. It also improves the competitiveness of products and services provided by the West Pomeranian companies.

The potential for the development of renewable energy sources in the West Pomerania province should be used to develop local power systems and can become a solution to a plethora of problems with the supply of electricity and heat to the economy and the society. Local, distributed energy producers can form a supply system independent from external suppliers with a flexibility to use the energy from conventional energy sources and able to create local energy subsystems, providing high level of energy self-sufficiency. Creating the distributed energy subsystems in the province shows a real possibility of independence from the energy supplied by the producers and distributors operating within the conventional systems located outside of the region – (Figure 7).

Figure 7. Share of energy production from renewable sources in a total energy production in the West Pomerania province between 2005 and 2019 (%)



Source: Compiled by the authors based on The energy regulatory office, 2020.

An increase in interest in the prosumer energy production in the West Pomerania province shows the validity of modernisation of medium and low-voltage networks, mainly in the rural areas and smaller towns. The power output available that can be achieved from the renewable energy installations in the West Pomerania province exceeds a peak demand of the consumers in the region. However, a high-quality transmission infrastructure must be developed to export the energy to the national grid. The ability to obtain the energy from renewable sources will provide a new source of energy for the producers, distributors and consumers. The development of renewable energy sector is possible with the support of a public sector. The government of the West Pomerania province supports various projects related to the construction, expansion and improvements of the energy and/or heat generating units based on renewable energy sources as part of the Regional Operational Program for the West Pomerania province - RPO WZ 2014-2020:

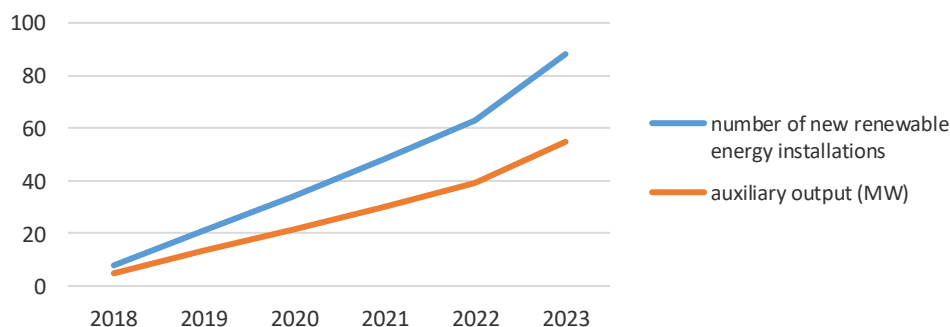
- 2.9. Replacing the conventional sources of energy with renewable sources,
- 2.10. Increasing the utilisation of renewable energy sources,
- 2.11. Increasing the power network's potential to utilise the energy from renewable sources

The support is dedicated to a wide range of entities including entrepreneurs, local government units, associations, public finance sector units, colleges, housing cooperatives, housing associations, agricultural producers groups etc. It supports projects involving construction, expansion and improvements of the power networks to utilise the energy from the renewable sources. The projects will be continued in the following years. Steps must also be taken to support new energy clusters and associations. The study shows that the minority of the local government units has included renewable energy sources as a goal of the planned undertakings in their current social and economic development strategies. It is unfortunate. The local government units are a valuable partner in the initiatives related to locating new

renewable energy installations and can initiate development of similar installation in the communal areas (Ustronie Morskie district). Furthermore, 66,135,000 Euro has been allocated for financing the renewable energy investment as part of the Regional Operational Program for the West Pomerania province for 2014 - 2020. The funds can be used to cover up to 85% of planned investment costs. 20 million Euro has already been allocated for that purpose in 2020. Figure 9 shows the expected results of the support.

It is also crucial to engage the scientific communities, including the West Pomeranian University of Technology in Szczecin or the Koszalin University of Technology to cooperate with the partners from social and economic communities. Regional entrepreneur associations, including the Northern Chamber of Commerce in Szczecin or the regional structures of the Polish Federation of Engineering Associations can also play an important role.

Figure 9. The expected results of renewable energy developments in the West Pomerania province



Source: Compiled by the authors based on WZ, 2020.

It is also crucial to engage the scientific communities, including the West Pomeranian University of Technology in Szczecin or the Koszalin University of Technology to cooperate with the partners from social and economic communities. Regional entrepreneur associations, including the Northern Chamber of Commerce in Szczecin or the regional structures of the Polish Federation of Engineering Associations can also play an important role. It will allow the West Pomeranian economy to achieve the goals of the Green Deal and to maintain high competitiveness. Constantly developed innovative technologies will allow a wider use of local renewable resources, contribute to the regional energy security and improve the quality of life.

6. Conclusions

In the 21st century, the stability of the economy's energy supply system is an expression of political and economical sovereignty. It also determines the direction

of social and economic development and is a decisive factor in building the regional, national and international competitiveness. Creating a modern economy based on clean energy requires a series of actions including the society, scientific community and entrepreneurs in the process. Increasing the utilisation of renewable energy sources in the energy balance of the West Pomerania province is a route to a long-term planning of the permanent basis for the development of the region.

The analysis of current trends show that on a regional, national and European level, the energy demand will increase, mostly due to the civilization development resulting in an increased energy demand. Improving the quality of life of the residents requires the prevention of climate change and environmental pollution, as well as a continued regional development of the energy sector based on renewable energy sources.

The developments in the renewable energy technology depend on many interconnected factors including both the natural resources and the economical and political mechanisms. The experience of the West Pomerania province shows that the distributed energy is a good direction of development of renewable energy sector.

Decentralized generation prevents a situation in which the coal power plants in Silesia reach the efficiency of approximately 40%, and the energy is transmitted by the outdated 400 kV and 220 kV power lines. The development of distributed networks based on highly efficient renewable energy sources eliminates those losses, both at the generation and transmission stage.

Currently, the region is mostly independent from the large energy suppliers and conventional energy sources. The recommended actions include further support for the development of wind and photovoltaic installations in the region. The development of offshore wind farms is a preferred direction of investments in the region. The investments involve high initial costs and almost non-existent operating costs.

Following the amortization of the investment costs, the energy generated is practically free. The agricultural character of the region with a large share of permanent grassland and extensive forest farming makes it well adapted for the intensification of biomass production. The biomass units using forestry and agricultural waste are perfectly correlated with the Green Deal policy. The energy transformation is a resultant of different interests of various interest groups. Their decisions are the result of changes in the perception of the role of local communities in the sustainable development policy. The actions aimed at shaping the desired position on respecting the energy and its sources are a key part and must be followed by establishing local energy cooperatives, producer groups and other civic community entities.

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