

Subsidies as Financing Opportunities – the Development of Renewable Energy Sources in Poland

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INTRODUCTION

Renewable energy sources are, in contrast to non-renewable energy sources, in the scope of interests to individuals and institutions (Oniszk-Popławska, Rogulska, Wiśniewski, 2003; Nagy, Körmendi, 2012). This is because Poland is a coal country, at the same time, the renewable energy resources are crucial components of future sustainable development that gives a chance to exert a rational economic, ecological and social effect (Paska, Sałek, Surma, 2009). There are many opinions that Poland presents ample opportunities for renewable energy resources to be deployed to obtain a stable supply of electricity (GlobalData Energy, 2019; Midor, 2012). It is also indicated that most of Polish thermal power plants are at least 25 years old and renewable resources constitute a great opportunity for replacement of these plants with new and more efficient power stations.

Because of the above, financial support for the development of the use of renewable energy resources became a very important objective in Poland. The literature states that renewable energy sources not only reduce the emission of CO₂ but can also be cost effective if only the initial investment is supported with financial aid. Thus, the aim of the article is to describe the most popular renewable energy installations in Poland and further to search for a case study indicating that investment in renewable sources is profitable without financial support. The results indicate that prior literature does not present any analysis of a profitable renewable energy investment without financial support.

SHARE OF RENEWABLE ENERGY IN POLAND – PLANS AND IMPLEMENTATION

The approved in 2001 “Development Strategy for Renewables” called for 14% contribution of renewable energy to total primary-energy production in 2020.

In September 2019 the regulation about renewable energy sources were amended in order to help achieve 15% share of energy from renewable sources until 2020. This solution is to increase energy security. In the future, the changes introduced are to guarantee constant access to renewable energy for end users. In addition, ongoing activities are important to protect customers from significant increases in electricity prices, as they are intended to keep electricity prices as low as possible. Although the share of renewable energy is constantly growing as it is inevitable worldwide trend, it seems that it will be hard to reach the 2020 Poland's target (Ecofys, 2017; Figure 1).

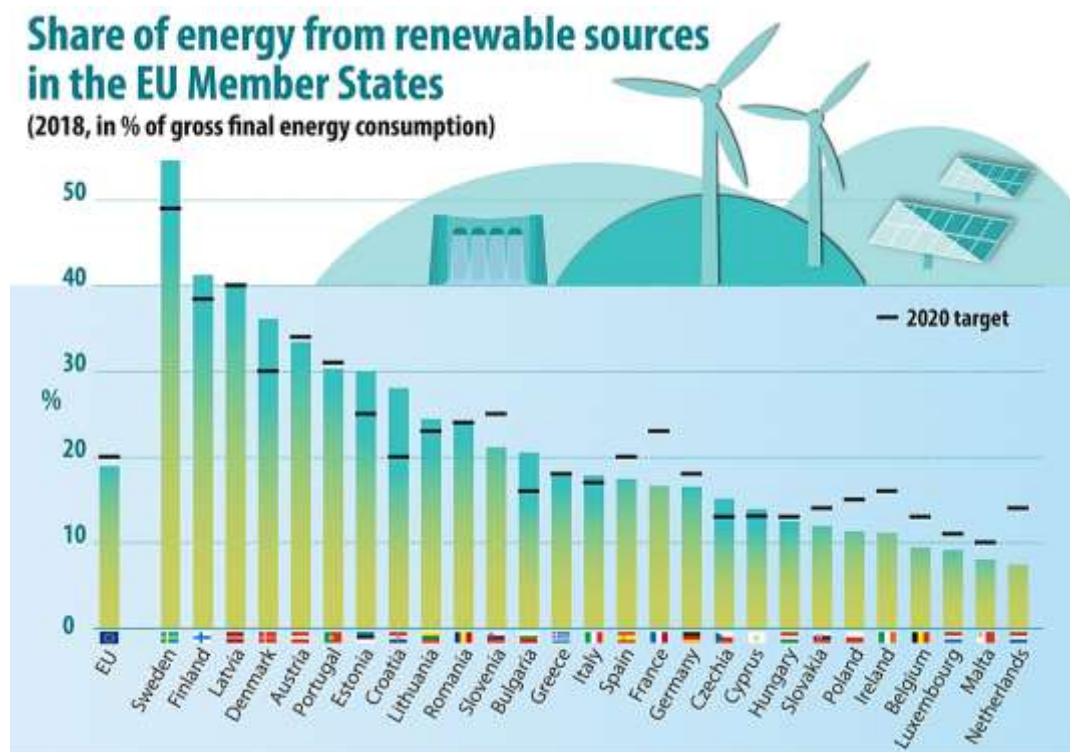


Fig. 1 Share of energy from renewable sources in the EU Member States

Source: Eurostat. Available at www.ec.europa.eu/eurostat

Many experts indicate that in order to ensure the renewable target for 2020, Poland should quickly take additional measures to encourage increased use of renewable energy in all sectors of economy. Additional actions are crucial especially when taking into account the increase in energy consumption in the coming years.

SOURCES OF RENEWABLE ENERGY IN POLAND

A renewable source of energy is defined as any natural, non-fossil energy source including solar energy, wind energy, aerothermal energy, geothermal energy, hydrothermal energy, hydropower or wave energy as well as energy obtained from biomass, biogas from landfills, from sewage disposal or decomposition of vegetable or animal (Regulation as of 20.02.2015). It can be concluded from the definition that renewable energy is characterized by the fact that its use does not generally limit available resources, because the resource

is renewable in a short time. Based on the definition of renewable energy resources, the following types of energy can be distinguished:

- Solar energy – energy produced by the sun in a way of thermonuclear reactions occurring on the suns' surface,
- Wind energy – kinetic energy of moving air masses,
- Geothermal energy – non-anthropogenic energy accumulated in the form of heat under the earth's surface,
- Hydrothermal energy – non-anthropogenic energy accumulated in the form of heat in surface waters,
- Aerothermal energy – non-anthropogenic energy stored in the form of heat in the air in a given area,
- Hydropower energy – energy derived from the movement of water,
- Wave energy – energy derived from ocean surface waves,
- Other forms of energy – mainly obtained from biomass and biogases.

Poland is located in the region characterized by a very uneven distribution of **solar energy** in the annual cycle. In moderate climate, the average number of sunny hours per year is 1600 hours, including 80% of total sunshine for the spring and summer time, from April until September. During summer months the daylight time lasts for 16 hours, while during the wintertime it shortens to 8 hours per day. The most favorable region in terms of insolation are the southern part of the Lubelskie Province and the coastal part of Poland's territory (Figure 2).

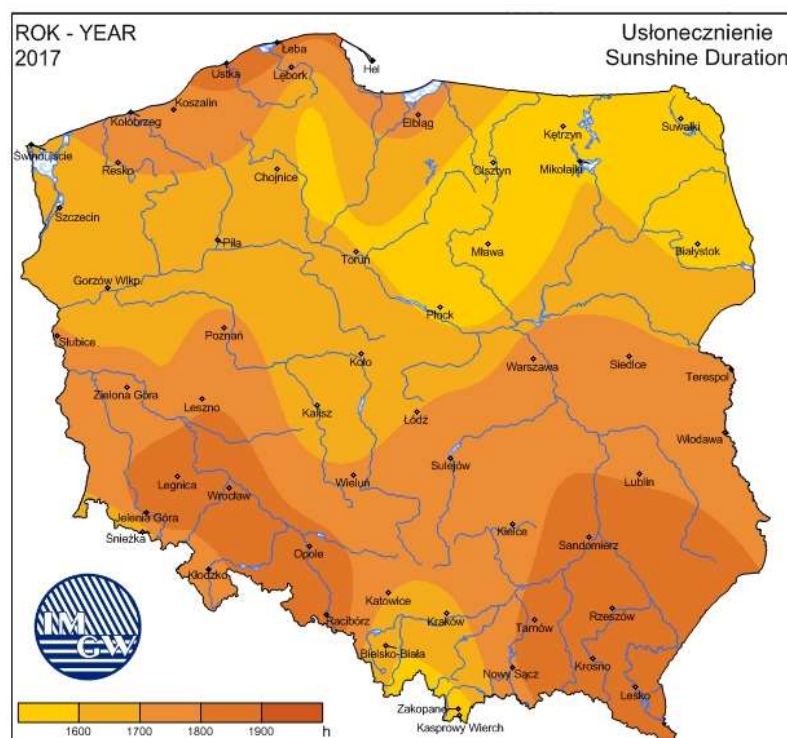


Fig. 2 Sunshine duration in Poland

Source: Instytut Meteorologii i Gospodarki Wodnej – Państwowy Instytut Badawczy, Available at <https://blog.meteomodel.pl/uslonecznienie-w-warszawie/>

Due to the natural conditions of insolation the solar energy is mainly used:

- for generating electricity using solar batteries,
- for preparation of hot utility and technological water using solar collectors,
- for supporting heating.

On the one hand it can be stated that solar energy is widely used by final consumers. On the other hand, the opinion that there is plenty of room for additional solar installations is true as well. This is because production of electricity from solar energy has many advantages in Poland, but it also has its disadvantages (Table 1).

Table 1 Advantages and disadvantages of solar energy in Poland

Advantages of solar energy	Disadvantages of solar energy
Solar radiation is present virtually in all environmental conditions, even when it is raining, or it is cloudy	As solar energy production is highly dependent on weather conditions, the use of net-metering system or indulgences specially designed for this purpose is required in order to balance the use of stored energy.
Technology to produce solar energy is universal, trouble-free, maintenance-free and can be installed almost everywhere.	Due to relatively low energy flux density, photovoltaics require the use of large area to produce a large amount of energy, which sometimes may be challenging (depending on the local terrain conditions).
Solar energy costs are much lower than energy produced in a conventional energy plant.	Initial investment is high and instable, unclear legal and administrative regulations placing investors from the solar energy sector in precarious position.

Source: own work based on: Czaja, Rajski, 2002; Bartnikowska, Olszewska, Czekala, 2017; Najda-Janoszka, Gancarczyk, 2019; Dubel, Trela, 2019.

Wind energy arising as a result of differences in heating of lands and seas, poles and the equator, i.e., by the difference in pressure between individual thermal zones, is an inexhaustible source of energy. In addition, wind energy is characterized by repeatability and speed, therefore terrain and climate conditions are important for its use. In Poland, wind energy, one of the most dynamically developing technologies of renewable energy resources, faces a lot of challenges. The most troubling ones are social protests (Biniek, 2017), economic uncertainty (Fieducik, 2018) and unclear legal (administrative and fiscal) provisions making investments almost impossible (Makuch, 2017; Rauba, Zimińska, 2018).

Table 2 Advantages and disadvantages of wind energy in Poland

Advantages of solar energy	Disadvantages of solar energy
Wind is present almost in all environmental conditions on the territory of Poland, although the seacoast is a preferred area	Influence on landscape values, people's anxiety resulting in unfavorable social attitudes
Allows for wasteland management	High noise level
Small maintenance costs	High initial investments

Source: own work based on: Mroczek, Kurpas, 2014; Makuch 2017; Fieducik, 2018; Bieniek, 2019

Geothermal energy is stored in groundwater, which is heated by warmth from inside of the Earth. Some of the hot water that escapes to the surface as hot

springs or geysers can be used as a renewable source of energy. In Poland, the largest geothermal resources are located in Podhale and Western Pomerania. These geothermal resources contribute to the increase in the number of hotels and spas in the regions.

Table 3 Advantages and disadvantages of geothermal energy in Poland

Advantages of solar energy	Disadvantages of solar energy
Hot water as a source of energy is available unconditional to weather	Transportation of hot water is unprofitable on long distances
No influence on the landscape	Possibility of environmental pollution through harmful gases and minerals
Small maintenance costs and an economic opportunity for local communities	High initial investments and high risk of unprofitability

Source: own work based on: Barbacki, Pająk, 2017; Cichy, Siodłak, 2017; Świerszcz, Ćwik, 2017; Zalewski, 2017; Sala, 2018

Biomass energy comes from the biodegradable fraction of products, waste and biological leftovers from agriculture (cultivation and husbandry), forestry, and related industrial sector. It is used in the form of pieces, straw bales and sawdust doses as briquettes or pellets (Tytko, 2019). The literature indicates that in Poland this renewable source of energy can be used as a fuel in domestic heating boilers mainly due to its physiochemical characteristics (Roman, 2018; Bala-Litwiniak, 2019).

Table 4 Advantages and disadvantages of biomass energy in Poland

Advantages of solar energy	Disadvantages of solar energy
Biomass resources are waste from agricultural production thus there are a stable and predictable source of energy	Relatively low density of biomass hindering its transportation, storage and dosing; seasonal availability of biomass
Usage of waste from the agricultural, forestry and food processing sector has no influence on the landscape, allows for wasteland management	NO _x , dioxins and furans emission in case of burning biomass contaminated with pesticides,
Initial investments are not much higher than traditional energy devices	Lack of a stable support system for households and small and medium enterprises investing in power plants and heating systems

Source: own work based on: Borycka, 2004; Dzikuć, 2014; Ligus, 2014; Kozłowski, 2018; Janas, Zawadzki, 2018

From the above-described categories of energy produced from renewable sources, (as of 30.06.2019) 84,5% of renewable energy came from wind plants, while 5,9% from biomass and only 0,2% from solar radiation (Urząd Regulacji Energetyki, 2019). Economic analyses show that biomass energy has the biggest potential to exceed break-even point in the sense of short-term marginal cost, although it does not guarantee stable source of energy in the long turn, i.e. untill 2030 (Instytut Energetyki Odnawialnej, Ministerstwo Gospodarki, 2013). On the other hand, it is expected that solar energy, wind energy as well as biomass energy will quickly be moving towards a sustainable competitive advantage on the Polish energy market as it is expected that these sources will become the cheapest energy sources.

BARRIERS TO THE DEVELOPMENT OF RENEWABLE ENERGY RESOURCES

In Poland, although analyses indicate competitiveness in the future, at present the use of systems utilizing renewable energy resources is economically irrational in many cases at present. Technologies using renewable energy resources may be divided into three groups based on the energy production costs:

- (1) technologies with costs comparable to those of conventional energy carriers (e.g. solar air collectors),
- (2) technologies that produce energy at a cost higher than average national prices (e.g., large network wind farms), but that can be competitive when:
 - a. using preferential loans or subsidies or
 - b. located in regions with the highest prices of energy from conventional sources
- (3) other technologies at a cost higher than average national prices (e.g., agricultural biogas plants), which cannot be competitive even if a subsidy of 50% of the total investment expenditure is granted.

Despite of the economic constraints, there are a number of barriers that limit the development of renewable energy resources (Kariuki, 2018):

- political and regulatory,
- technical,
- social-cultural,
- market-related,
- geographical and ecological,
- economic and financial.

The lack of clear policies and regulations tailored to the needs of renewable energy technologies, among them legislation favoring the development of these energy sources, diminishes the interest of potential investors. Technical barriers to renewable energy development include inadequate technology and/or infrastructure as well as the lack of trained personnel to support the improvements in industrial science related to renewable energy sources. The difficulties in adjusting the employment structure to the needs of renewable energy industry, lack of knowledge (education) can be mentioned as examples of social and cultural barriers (Franke, Neumann, Buhler, Cocron, Kerms, 2012; Mroczek, Kurpas, 2014). The market entry barrier together with high and fluctuating prices of renewable energy drastically limit the marketability of renewable energy sources. Conflicts of new technologies with nature or landscape protection are difficult to avoid due to lack of appropriate methods. A geographical location with unfavorable natural conditions can be a form of geographical and ecological barriers. Finally, economic barriers are mainly arising from the high initial capital cost of renewable energy technology adoption. Hence, financial mechanisms addressed directly to producers of energy from renewable sources are insufficient.

The above-mentioned barriers influence all interested parties: energy consumers, energy producers, and potential investors. Because of it, the

development of renewable energy technologies requires external interventions, mainly in the financial sphere. It seems that when a financial hurdle is eliminated and educational issues are addressed (Hoffman, Henn, 2008; Hąbek, Biały, Livenskaya, 2019), the people's reluctance to this form of energy may be significantly reduced as other obstacles may be eliminated gradually.

FINANCING OPPORTUNITIES FOR RENEWABLE ENERGY RESOURCES IN POLAND

It seems that stable financial means are the main support tools for renewable source energy development. The National Fund for Environmental Protection and Water Management (NFEP&WM), established in 1989, is the pillar of the Polish system for financing environmental protection (www.nfosigw.org.pl). The fund concluded many contracts for co-financing projects from its own funds and from European Union funds between 1998 and 2004 (Figure 3).

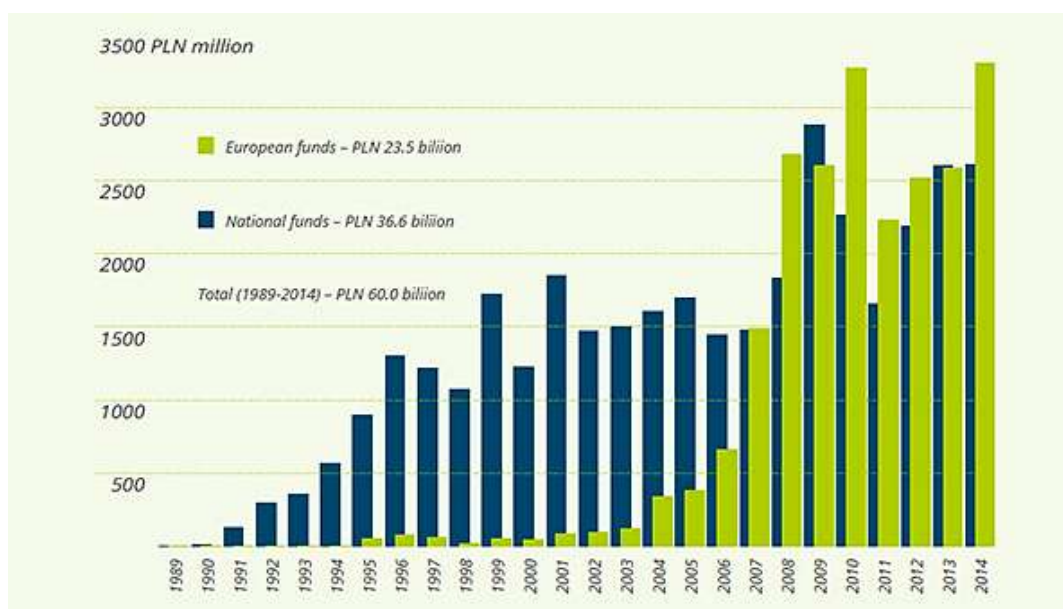


Fig. 3 Financing the environmental protection and water management by NFEP&WM (1998-2014)

Source: <http://nfosigw.gov.pl/en/nfepwm/financing-environmental-protection/>

Figure 3 indicates that the European Union's and national funds are important sources of financing for environmental protection. When analyzing the subsidies related to certain groups of renewable energy sources, it can be observed that solar energy financing prevails (Figure 4).

In general, financing is provided in the terms of:

- interest-bearing loans,
- subsidies for interest rates on loans,
- partial repayment of bank loans
- surcharges to the price or interest on the purchase of bonds,
- subsidies for the dismantling of end-of-life vehicles.

In detail, NFEP&WM serves priority programs addressed to Polish families (e.g. Prosumpt program), Norway Grants (2014-2021) and LIFE Capacity

Building Programme. Previous practice shows that the above-mentioned programs can be used for renewable resource energy production (Table 5).

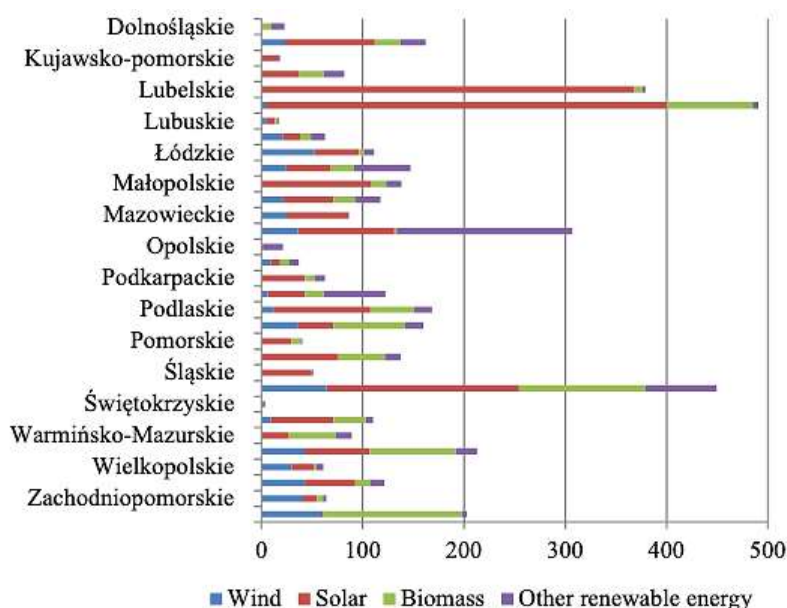


Fig. 4 The support for investments in renewable energy provided under regional operational programs in the period 2007-2013 and 2014-2020

Source: Ptak, 2017

Table 5 Examples of the usage of NFEP&WM funds for renewable energy resources

Applicant name	Project title	Total cost of the project	Co-financing
EC BREC Institute for Renewable Energy	Mobile demonstration line for the production of electricity from renewable sources of micronized biomass	12 776 723	5 302 335
Polish Society for Protection of Birds	Facilitating Aquatic Warbler (<i>Acrocephalus paludicola</i>) habitat management through sustainable systems of biomass use	12 164 810	1 315 512
FU-WI sp. z o. o.	A demonstration installation for the production of electricity and thermal energy from sewage and RDF factors, aimed at reducing the storage area at small and medium municipal landfills.	10 496 700 PLN	1 566 932 PLN
Institute of Environmental Protection – National Research Institute	Models of low-carbon waste management as a source of renewable energy	7 793 945 PLN	1 895 943 PLN
EC BREC Institute for Renewable Energy	Renewable energy sources on farms and smart networks	3 607 988	1 607 902

Source: own work based on: www.nfosisgw.gov.pl

Grants offered by NFEP&WM are available for private and public entities as well as non-governmental organizations established legally in Poland. The intergovernmental organizations operating in Poland are eligible participants as

well. Investment priorities encompassed by financial assistance include (Ptak, 2017):

- promoting the production and distribution of energy derived from renewable sources,
- promoting energy efficiency and renewable energy use in entities,
- supporting energy efficiency, smart energy management and renewable energy use in public infrastructure,
- promoting low-carbon strategies for all types of territories,
- developing and implementing smart distribution systems that operate at low and medium voltage levels,
- promoting the use of high-efficiency co-generation of heat and power based on useful heat demand.

Further, the analysis of the prior literature dealing with profitability or efficiency of investments in renewable energy resources clearly indicates that with no subsidies the return is at high risk (Instytut Energetyki Odnawialnej, Ministerstwo Gospodarki, 2013; Rutkiewicz, 2016; Dominiak, Oleszczyk, 2019). For example, Dubel and Trala (2019) analyzed financial efficiency of photovoltaic plants and pinpoint that support systems are inevitable for the profitability of investments. They also indicate the uncertainty of the legal system in Poland and hence the structure of future support system raise additional risk of photovoltaic investments. Solar energy was the subject of Gradziuk (2017) investigation indicating that the level of financial aid exceeded 72% of investment expenses. Furthermore, Zapałowska (2012) inclines that financial support is crucial for the development of biogas plants and suggests that domestic funds may not be enough thus European aid should be combined together with the local funds. Other authors also point out that economics are not priorities when achieving the emission goals as other factors should be taken into consideration (subsidies among others) when deciding about profitability (Hadryjańska, 2006; Górczyńska, Szczepaniak, 2011; Ligus, 2011; Gostomczyk, 2014; Mielcarek, 2014; Jarczewski, Huculak, Dej, 2015; Kramek, 2016).

CONCLUSIONS

The analysis of present structure of renewable energy sources together with the presentation of possible financing sources indicate that the existing support policy can be used as a framework to achieve the European Union's goal, but it needs to be strengthened. Examples of tools to be implemented in order to eliminate cost barriers include (Ecofys, 2017):

- an increase of funds for the implementation of thermo-modernization of heating in homes,
- increased volumes of auctions for renewable electricity that would provide additional "green" energy,
- actions aimed at reducing the gap in implementation of the renewable energy target in the transportation sector.

Further, it is suggested that additional, non-financial actions are required to eliminate social and environmental barriers in the development of renewable energy resources usage. On the one hand Poles are convinced that energy from renewable sources is inevitable due to the need to reduce CO₂ emissions, placing solar energy on the first place with the greatest chance of increasing the number of installations in Poland. On the other hand, equally important is the long-term predictability of legal (including fiscal) regulations of renewable energy investments, financing based on the European Union Funds and national increase of funds that correspond to a coherent domestic environmental protection policy (Wojciechowska-Solis, Soroka, 2018).

To sum up, in Poland, the environment for renewable energy resources development is still at its initial phase and should be quickly improved in order to definitely speed up and catch up with other countries. Although certain activities have already been undertaken (and these should be kept valid, e.g., exemption from excise duty on energy produced from renewable sources), there is still a room for new stimulating actions. With regard to financing, new instruments are needed which are not only dedicated to households but also to small and medium enterprises that constitute the largest group of entrepreneurs in Poland.

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Abstract.

As Poland is considered a coal country, renewable energy resources still do not have a significant share in energy production. Further, 14% contribution of renewable energy to total primary energy production in 2020 is endangered. Thus, in order to speed up with renewable energy sources new actions should be stimulated. The aim of the article is to describe the most popular renewable energy installations in Poland and further to search for a case study indicating that an investment in renewable sources is profitable without financial support. The results indicate that prior literature does not present any analysis of profitable renewable energy investment without financial support. It states the need for regulators to implement additional financial support not only on the European Union level but also on the national one.

Keywords: renewable energy sources, financing environmental protection, profitability of renewable energy