



# The Importance of Renewable Energy Sources in Poland's Energy Transformation Process Using the Example of PGE

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<https://doi.org/10.29227/IM-2025-02-04-030>

Submission date: 18-12-2025 | Review date: 30-12-2025

## Abstract

*Energy transition is one of the key calls for contemporary global economies, and renewable energy sources play a significant role. The article presents the importance of RES in the context of their impact on energy security, the economy, the environment, and society. It analyses global as well as national development trends in renewable energy. It focuses on the example of the Polish Energy Group (PGE), which is implementing an ambitious strategy for the development of low- and zero-emission sources. Advantages such as the reduction of greenhouse gas emissions and the creation of jobs are presented, as well as challenges such as production instability or spatial constraints. The aim of the article is to show the role of RES in the process of Poland's energy transformation and the importance of measures taken by enterprises.*

**Keywords:** *renewable energy sources, energy transition, climate policy, energy security*

## 1. Introduction

The energy sector is currently undergoing a dynamic change, which can be observed in both the domestic and global markets. Today's economy faces many challenges such as climate change and the need to reduce greenhouse gas emissions. Renewable energy sources play a key role in the energy transition. This article discusses the characteristics and definition of renewable energy sources, their impact on energy security, current development trends both globally and in Poland, the benefits of their use, as well as the challenges associated with their implementation. The Polish Energy Group was presented as an example of energy transformation to increase the use of RES in energy production. It is the largest company in the Polish electricity system, which is actively pursuing the development of renewable energy sources and moving away from fossil fuels.

## 2. Renewable energy sources – characteristics and definitions

Renewable energy sources can be defined as energy sources that complement (or renew themselves) in a natural way. These include, among others, solar, water or tidal energy [17]. According to the Renewable Energy Sources Act of 20 February 2015, renewable energy sources are renewable, non-fossil energy sources including wind energy, solar energy, aerothermal energy, geothermal energy, hydrothermal energy, hydro-power, wave, current and tidal energy, ambient energy, energy obtained from biomass, biogas, agricultural biogas, biomethane, bioliquids and renewable hydrogen [15]. Renewable energy sources have many advantages, one of which is environmental friendliness, which is related to the fact that they are intricately linked to natural processes caused by the activity of the sun, moon and earth [7]. Among renewable energy sources, the following types are distinguished:

- electromagnetic radiation from the sun
- wind energy;

- energy of water fall;
- geothermal energy;
- biomass energy;
- tidal and wave energy.

## 3. Energy security and development of RES

### 3.1. Definition of energy security

According to the Act of 10 April 1997, energy security is a state of the economy that makes it possible to cover the current and prospective demand of consumers for fuels and energy in a manner that is technically and economically justified, while maintaining the requirements of environmental protection [14]. Energy security is an important element of the state security system. It is influenced by systems such as the type and quantity of energy resources held by the state, the degree of diversification of energy carriers, the origin of supply sources, the level of reserves held, the level of development and use of renewable energy sources, enterprise ownership in the energy sector, supply system state, the level of supply and transport infrastructure development, the manner and quality of state supervision of energy production and distribution processes, the planning and implementation quality of innovative solutions, and domestic and international stability. [8].

### 3.2. Impact of RES on energy security

Renewable sources are playing an increasingly key role in shaping energy security. Increasing their share in the energy system can contribute to energy security. This is especially true in areas of improved energy supply in areas with underdeveloped energy infrastructure [1].

According to the Energy Policy 2040, activities that focus on the development of RES serve, as well as diversifying the structure of energy generation, additionally lead to a reduction in the intensity of fossil fuel use and reduce the country's dependence on fuel imports, which in the long term will improve energy security [10].

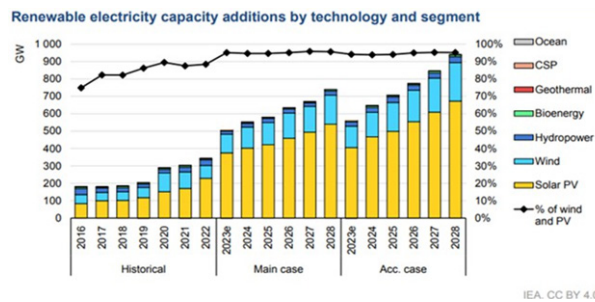


Fig. 1. Renewable energy capacity with estimated values Source [4]

Rys. 1. Moc energii odnawialnej wraz z szacowanymi wartościami Źródło: [4]

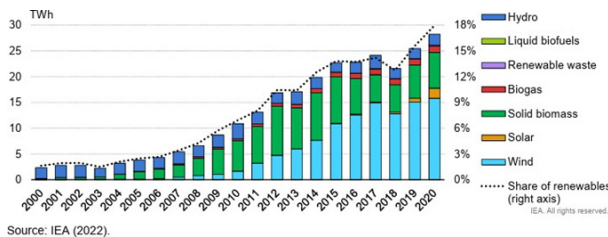


Fig. 2. Renewable energy in electricity generation in Poland Source: [3]

Rys. 2. Energia odnawialna w produkcji energii elektrycznej w Polsce Źródło: [3]

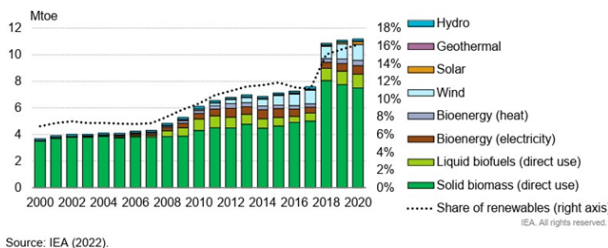


Fig. 3. Share of renewable energy in total final energy consumption Source: [3]

Rys. 3. Udział energii odnawialnej w całkowitym zużyciu energii końcowej Źródło: [3]

#### 4. Development trends of renewable energy sources

In recent years, there has been a dynamic increase in the share of renewable energy sources in the energy mix of countries. More and more countries are concertededly investing in the development of renewable energy sources focusing primarily on the construction of photovoltaic installations and wind power plants.

Referring to global market trends, according to a report by the International Energy Agency (IEA), the growth of renewable energy capacity reached an estimated 507 GW in 2023, almost 50% more compared to 2022. In Fig.1, you will find a graph showing the growth of RES capacity by technology and segment from 2016 to 2028. It includes historical and 2028 data.

In Poland, noticeable changes can also be observed in the production of electricity from renewable energy sources, mainly related to climate change policy. Figure 2 shows the production of electricity from renewable energy sources in Poland between 2000 and 2020, broken down by individual technologies. The right axis of the graph also shows the share of RES in total electricity production in Poland. In 2000, the share of renewable sources of electricity in Poland was about 2%, while in 2020 it was over 16%. The level of production from RES between 2010 and 2020 almost tripled from 10.9 TWh to 28.2 TWh.

Between 2000 and 2020, there was also a gradual increase in the share of renewable energy in total final energy consumption in Poland, as shown in Figure 3. In 2000, RES accounted for about 5% of final energy consumption, while in 2020 this share increased to around 17%. In the early 2000s, biomass accounted for the largest share of energy consumption. Since 2010, there has been an increase in the share of other energies such as wind power. In 2015, a significant increase in the share of solar energy can also be observed.

#### 5. Benefits resulting from the development of renewable energy sources

The development of renewable energy has many benefits, which can be considered on many levels. Firstly, the development of RES contributes to environmental protection. There are also many other benefits, both economic and social, which include the creation of new jobs and increased energy price stability and energy security. An increase in the use of renewable energy sources can result in a decrease in wholesale energy prices and a reduction in emission costs, both in terms of charges per unit of energy produced and environmental and health costs [10].

An increased share of renewable energy sources in the energy mix leads to environmental improvements through, among other things, a reduction in emissions to air and wa-

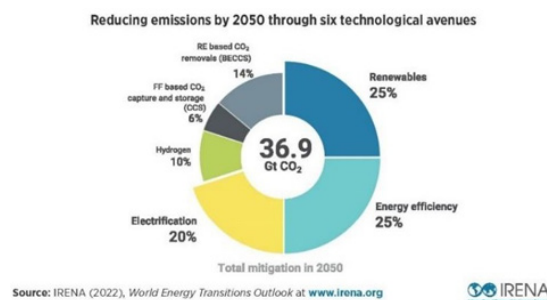


Fig. 4. Emission reductions by 2050 Source: [2]  
Rys. 4. Ograniczenie emisji do 2050 roku Źródło: [2]

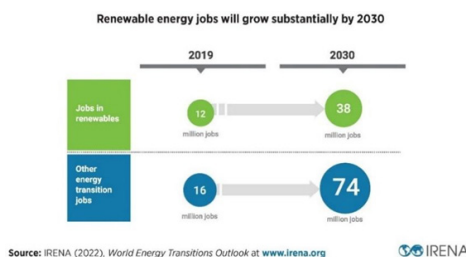


Fig. 5. Projected number of jobs in the renewable energy sector Source: [2]  
Rys. 5. Prognozowana liczba miejsc pracy w sektorze energetyki odnawialnej Źródło [2]

ter, as well as a reduction in the volume of waste generated [1]. According to the International Renewable Energy Agency IRENA, the share of renewable energy sources will account for 25% of carbon dioxide emission reductions by 2050, as shown in Fig.4. Together with energy efficiency, which also accounts for 25% of carbon dioxide emission reductions, renewable energy sources are one of the most effective ways to achieve climate neutrality.

Among the economic benefits, one of the biggest positives is the increase in employment. The construction of wind farms and photovoltaic projects is creating new jobs. From an economic and employment perspective, renewable energy is attractive because of its localisation. Most of the investment is in the development and construction of projects, and any operating costs such as landowner fees benefit the local community [16]. According to the International Renewable Energy Agency IRENA, employment levels in the renewable energy sector will increase significantly, as shown in Figure 5. The number of jobs in the RES sector in 2019 was twelve million. This number is projected to increase significantly to around thirty-eight million.

## 6. Challenges in developing renewable energy sources

Despite its numerous benefits and the increasing sophistication of renewable energy technologies, this energy generation technique also has certain limitations [8]. One of these is that replacements in the form of renewable energy sources should be as cheap as fossil fuels, as electricity is an essential element for living on a decent footing and few people can afford expensive energy sources [5].

An additional problem with an energy system based on renewable energy sources is the variability of renewable energy generation from wind and solar over time. The instability of energy generation from these sources is due to an inherent feature of weather phenomena, the primary source of which

is the Sun. The sun's rays heat the Earth unevenly. This results in winds that blow unevenly. This is due to the variability of the heated surface [6].

Another challenge that renewable energy sources face is that they are not condensed energy sources. Solar, wind, photovoltaic and hydroelectric installations cover a much larger area compared to fossil fuel power plants of comparable capacity [5].

The use of RES is also limited by environmental and spatial factors. In the case of environmental constraints, this is area-based nature and environmental protection, as well as species protection. Spatial barriers are related to restrictions on the locational freedom of the planned energy investment, which is conditioned by the existing or planned function of the area [9].

## 7. Polska Grupa Energetyczna as an example of energy transition

An example of a Polish company following global trends in energy transformation is Polska Grupa Energetyczna, Poland's largest company in the electricity sector. The company is actively pursuing the development of renewable energy sources, abandoning fossil fuels.

PGE Group's main strategy is to achieve climate neutrality. In its original version, the company aimed to achieve this goal by 2050 [11]. However, the strategy was updated in 2023, according to which PGE wants to achieve 100% clean energy for customers in 2040. The company is also to achieve carbon neutrality [13]. The company plans to achieve this by making investments in low- and zero-carbon energy sources and grid infrastructure.

Polska Grupa Energetyczna aims to reduce the environmental impact of its operations by pursuing the following objectives [12]:

- development of offshore wind farms - building 2.5 GW of capacity by 2030 and at least 7.0 GW by 2040, considering the participation of partners;

- development of onshore wind farms - achieving 1.5 GW of capacity by 2030;
- development of photovoltaic farms - achieving 3.0 GW of capacity by 2030;
- construction of gas-fired power plants - 2.2 GW of capacity to be built in CCGT units (Gryfino and Rybiki) by 2030, as well as further conversion of units to green hydrogen or equipping them with carbon capture facilities
- construction of battery-based energy storage facilities - achieving a storage capacity of up to 1.2 GWe by 2030;
- development of pumped storage power plants - achieving 2.5 GWe of capacity by 2035;
- development of heat storage and electrode boilers - achieving 1.0 GWt of capacity by 2035;
- development of electrolysis plants - building 300 MW of electrolyzers by 2035 and achieving 10,000-15,000 tons of green hydrogen production;
- development of district heating to achieve 40-50 per cent renewables and electricity by 2030, with the decommissioning of coal-fired installations by 2030 and 80 per cent renewables and electricity by 2040. The plans and targets implemented by PGE are an example of an ambitious energy transition.

The adopted strategy will contribute to increasing the country's energy security through diversification of energy generation methods and a gradual departure from fossil fuels. The actions undertaken by PGE are part of both the European Union's climate and energy policy and the implementation of the commitments under the Paris Agreement, which sets the objective of limiting the global average temperature in-

crease to well below 2°C and striving to halt the temperature increase at 1.5°C.

## 8. Summary and conclusions

The energy transition in both the global and domestic markets is primarily based on increasing the share of renewables in electricity generation. This transition is a key element of sustainable development, which is expected to bring numerous benefits to the economy, environment, and society.

The use of renewable energy sources has many environmental, social and economic benefits. One of the main ones is the re-education of greenhouse gas emissions. The development of the RES sector contributes to the creation of new jobs. In addition, one of the positive aspects of increasing the share of RES in energy systems is that it promotes diversification of energy sources, which directly contributes to the country's energy security.

The energy transition is also associated with the need to face a number of challenges, among which are high investment costs, the instability of RES energy production especially when using wind or solar technology. Spatial and environmental constraints are also challenges.

An example of a company that is successfully implementing the energy transition is the Polska Grupa Energetyczna. Numerous investments such as the development of offshore wind farms, photovoltaic installations, gas-fired power plants and gas technology show that the company has ambitious goals.

In conclusion, the development of renewable energy sources is not only a necessity resulting from the implementation of the energy and climate policy, but also an opportunity to build a modern, safe, and competitive economy based on sustainable energy solutions.

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## *Znaczenie odnawialnych źródeł energii w procesie transformacji energetycznej Polski na przykładzie PGE*

*Transformacja energetyczna stanowi jedno z kluczowych wyzwań dla współczesnych światowych gospodarek, a istotną rolę odrywają odnawialne źródła energii. W artykule przedstawiono znaczenie OZE w kontekście ich wpływu na bezpieczeństwo energetyczne, gospodarkę, środowisko oraz społeczeństwo.*

*Dokonano analizy globalnych jak również krajowych tendencji rozwojowych w zakresie energetyki odnawialnej. W szczególności skupiono się na przykładzie Polskiej Grupy Energetycznej (PGE), która wdraża ambitną strategię rozwoju źródeł nisko oraz zeroemisyjnych. Przedstawiono korzyści takie jak redukcja emisji gazów cieplarnianych, tworzenie miejsc pracy, jak również wyzwania, m.in. związane z niestabilnością produkcji czy ograniczeniami przestrzennymi. Celem artykułu jest ukazanie roli OZE w procesie transformacji energetycznej Polski oraz znaczenia podejmowanych przez przedsiębiorstwa działań.*

**Słowa kluczowe:** *odnawialne źródła energii, transformacja energetyczna, polityka klimatyczna, bezpieczeństwo energetyczne*