Hanna KOSHLAK
Daria WOŹNIAK
Marta ZEGAREK
Kielce University of Technology, al. Tysiąclecia Państwa Polskiego 7, 25-314 Kielce, Poland
Corresponding author: sevvixia@gmail.com

Doi: 10.53412/jntes-2024-1-3

RENEWABLE ENERGY SOURCES IN POLAND: SUPPORT MECHANISMS, BENEFITS, BARRIERS FOR PROSUMERS AND PRIVATE INVESTORS

Abstract: *The purpose of our study is to characterize and classify the mechanisms that stimulate the introduction of renewable energy sources in Poland, as well as to assess the possibility of developing renewable energy sources in accordance with current trends in the energy sector.*

Keywords: *energy infrastructure, renewable energy sources, subsidy programs, photovoltaic (pv) and heat pump installations*

Introduction

Electricity generation is now central to many aspects of modern society. Although power generation technologies are one of the world's leading sources of CO_2 emissions, it is also the sector that is leading the transition to net zero emissions through the rapid deployment of renewable energy sources such as solar and wind power. The world's transition to a safer, more affordable and low-carbon energy system requires massive investment in low-carbon energy, as well as continued investment in oil and gas as alternative fuels increase their share of the energy mix.

The tone for accelerated clean energy development in this decade in advanced economies is set by new policy packages and government plans and goals, particularly those set out in the Inflation Reduction Act (United States); RePowerEU plan, the Renewable Energy Directive III, and the Fit for 55 package (European Union); Climate Change Bill (Australia); and GX Green Transformation (Japan).

Further climate change is projected to lead to increased use of renewable energy sources and increased electrification of numerous end-users, from transport to industry, which will lead to a massive increase in demand for electricity, as well as the need to generate as much of the electricity as possible from renewable sources. This scenario involves a deep transformation of existing energy systems with the production of electricity from fossil fuels and a reorientation of the generation systems to renewable energy sources [1].

Implementing the assumptions contained in Directive III on Renewable Energy will be particularly difficult for Poland, as it has been lagging behind European countries in terms of the share of renewable energy in the energy market for many years, and electricity generation in percentage terms is still mainly based on coal, accounting for almost 70% of the electricity generation market in the country (Fig. 1b) [2, 3].

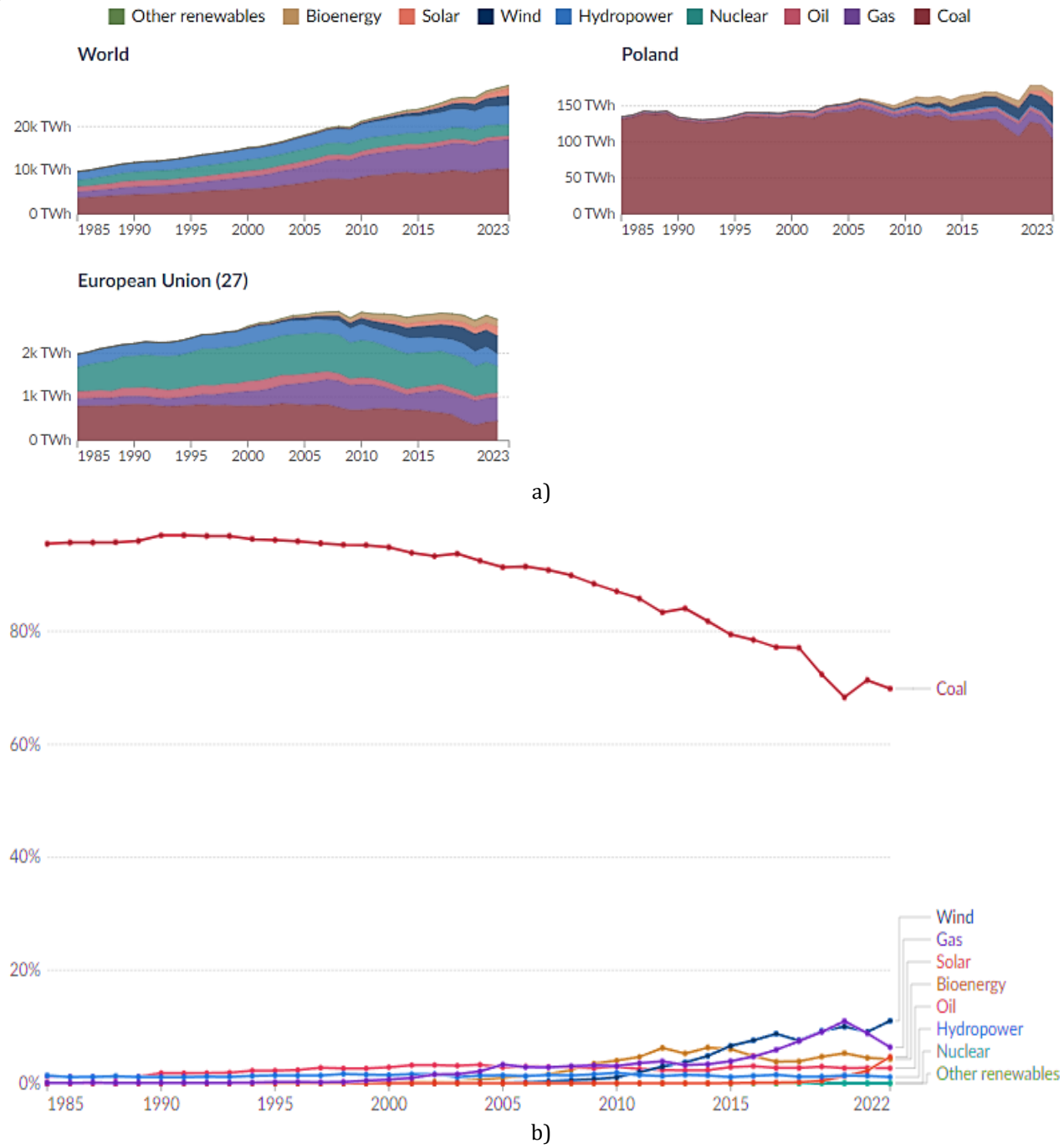

Figure 1. *Production of electricity by source [2]: a) world electricity production by source; b) share of electricity production by source in Poland*

The Polish Energy Policy 2040 (PEP2040) presents the country's vision for its energy transition strategy and provides a strategic decision regarding the selection of technologies used to establish a low-emission energy system. The policy takes into account the scale of the challenge of adapting the domestic economy to EU regulatory considerations related to the 2030 climate and energy targets, the European Green Deal, the COVID pandemic recovery plan, and the pursuit of climate neutrality in line with national capabilities as a contribution to the Paris Agreement. According to forecasts, Poland will strive to be able to cover its electricity needs using its own resources. The main indicators that will allow achieving the PEP2040 goal are shown in Figure 2 [4].

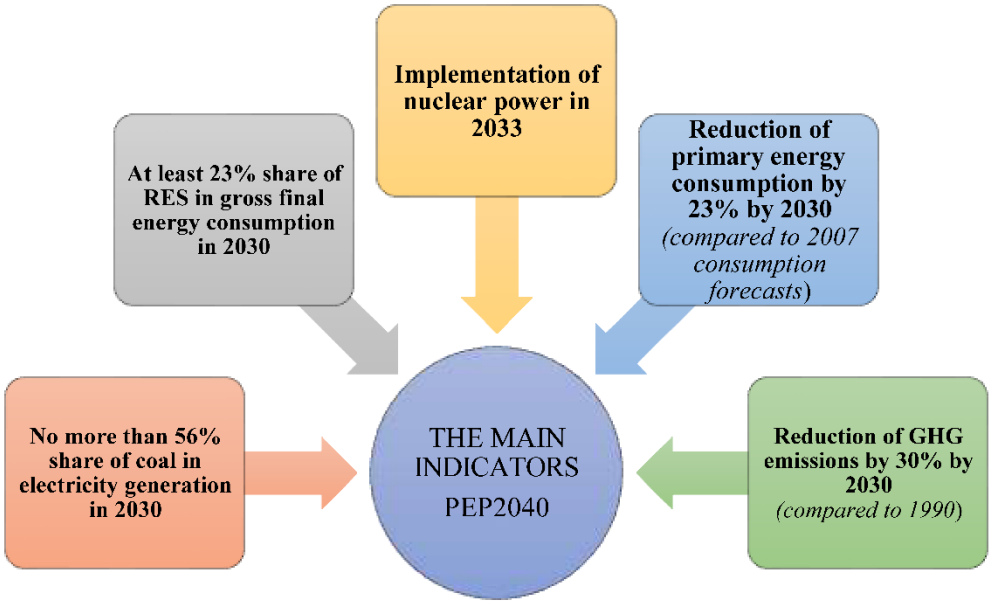

Figure 2. *The main indicators PEP2040 [4]*

PEP2040 assumes a gradual increase in energy demand in Poland. Table 1 shows that domestic coal reserves will remain an important element of Poland's energy security, but the growth of the demand for energy resources will be covered by sources other than traditional coal plants [5].

Table 1. *Fuel-probable gross electricity generation forecast [TWh] – according to CO_2 emission allowances balanced price scenario [5]*

Energy resources	2025	2030	2035	2040
Lignite	50.4	49.9	27.5	17.3
Coal	72.3	63.1	53.2	45.7
Gas fuels	15.3	20.7	31.3	38.4
Heating oil	1.9	1.9	1.8	1.7
Nuclear energy	0	0	20.4	30.6
Solar energy	4.5	6.8	10.8	14.8
Wind energy on land	23.7	23.8	24.2	24.6
Wind energy at sea	2.7	14.5	21.7	30.6
Biomass	9.7	11.6	11.4	10.3
Biogas	2.7	3.9	5	5.8
Hydropower	2.9	3	3	3.1
Energy from pumped water	0.8	0.9	1.2	1.5
Inorganic industrial and municipal waste	0.9	1.1	1.2	1.3
Sum	**187.9**	**201.2**	**212.7**	**225.8**

Renewable sources will play an increasingly important role – their level in the structure of net national electricity consumption will reach at least 32% in 2030, which, first of all, will allow the development of photovoltaic energy and offshore wind power plants, which, due to economic and technical conditions, have the greatest development prospects [5].

Assuming a scenario of sustainable increases in the prices of CO_2 emission allowances, renewable energy sources will constitute a total share of 40.17% in electricity production in 2040. Fulfilment of the assumptions requires the development of nuclear energy and offshore wind farms. According to the 2040 analysis of the Energy Policy 2040, it is accepted that nuclear energy will be implemented in 2033 (a total of 6 nuclear power units with a total capacity of 6-9 GW will be built), which will strengthen the foundation of the system and reduce emissions in the industry. Furthermore, to reduce pollutant emissions in the energy sector, low-efficiency generating units will be gradually decommissioned and replaced with more highly efficient ones (including cogeneration units). The vision is to have a nearly new power grid built by 2040, with a strong base of low- and zero-emission systems [4, 5].

In the current situation, the role of prosumer installations in increasing the share of renewable energy in the energy market and achieving the goal of distributed energy is emphasized. The concept of prosumer refers to producers of electricity that consume it; therefore, they have installations that generate energy for their own needs [5]. In Poland, the number of microinstallations connected to the power grid (grid installations) is growing every year, as shown in Figure 3.

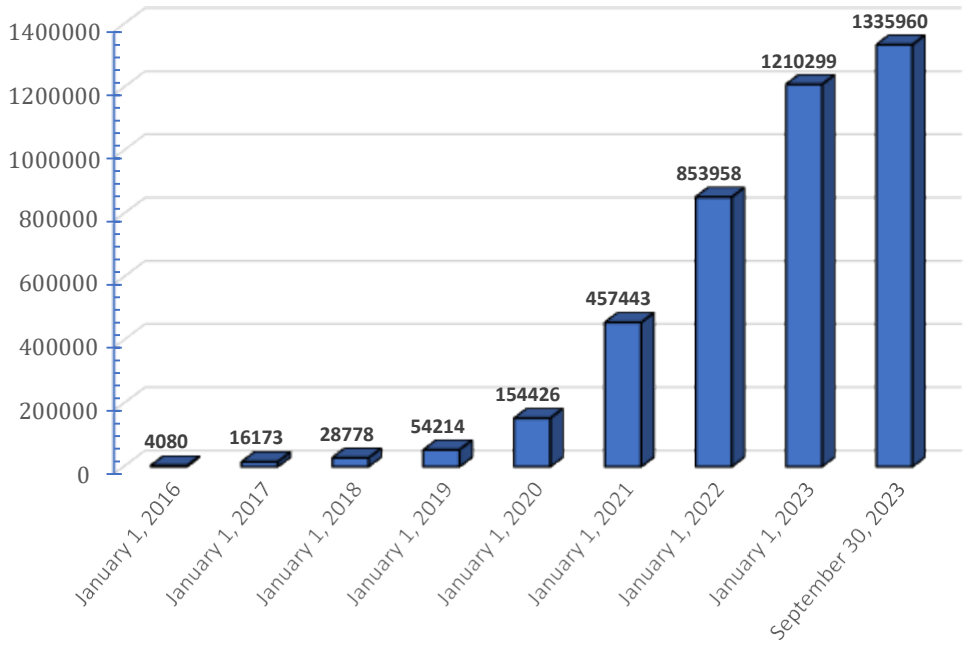

Figure 3. *Total number of micro-installations connected by the OSD [7]*

One of the main factors blocking the entry of renewable energy installations into the consumer market for their own needs is the initial installation costs, which, depending on the type and size, range from several to several hundred thousand zlotys. Due to the high initial costs, financial forms of support for prosumers are very popular in Poland, including various subsidies, benefits, and loans. Another form of support could be the so-called 'floating tariffs' for electricity, the value of which depends on the amount of consumption and energy savings for the average consumer.

Financing programmes for prosumers and private investors and their impact on the development of renewable energy in Poland

One of the largest financial support programs for renewable energy producers is the 'Mój Prąd' [My Electricity] program, which was implemented in 2019 in Poland. Initially, it included photovoltaic installations with a capacity of 2 kW to 10 kW, with an established budget of PLN 131.9 million. The installed capacity of the photovoltaic modules registered in the programme was 162 MW. The first edition turned out to be a success, so it was continued. In December 2023, the 5th edition of the programme ended, the budget of which has been increased from PLN 100 million allocated for co-

financing to PLN 950 million. This edition covered not only photovoltaic installations but also heat pumps, energy storage, and energy management systems [8, 9]. Figure 4 shows on the map of Poland the power of the installation that was co-financed from the 'Mój Prąd' program and the number of subsidies paid. Additionally, estimated data on the reduction of CO_2 emissions resulting from the introduction of the 'Mój Prąd' subsidy system were made available, which showed a reduction of 2.373 billion kilograms of CO_2 per year [6].

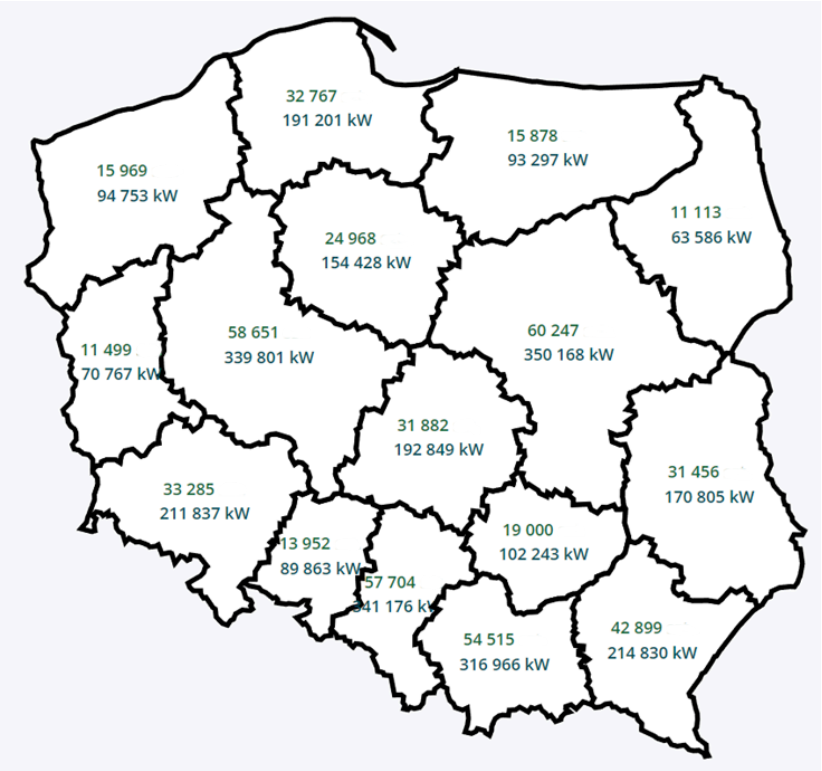

Figure 4. *Power of the installation that was co-financed from the 'Mój Prąd' program in kilowatts and the number of subsidies paid – data as of 12/04/2024 [8]*

The great interest in cofinancing for photovoltaic installations resulted in the preparation of the sixth edition, the details of which are currently unknown. Information provided by NFOŚiGW spokespersons indicates that this edition will focus particularly on subsidizing energy storage facilities [8, 10].

Another large initiative aimed at encouraging investments in renewable energy sources, as well as improving the energy efficiency of buildings, is the 'Czyste powietrze' [Clean Air] programme [11]. The programme is based on the receiving of financial assistance to partially cover the costs of replacing the heat source. The programme will operate for 10 years until the end of 2029. The expected final effect is a reduction in residential PM10 and PM2.5, and other pollutants compared to 2017. The main goal of the programme is to replace ineffective heat sources in single-family buildings and to co-finance the thermal modernisation of the building. Additionally, the program can also settle a photovoltaic installation, and the subsidy amount may be higher than in 'Mój Prąd'. This programme is particularly profitable for the lower- income households because it is divided into funding thresholds depending on the applicant's income. The new version of the program 'Czyste Powietrze' 3.0 was launched by the Polish government on January 3, 2023 [12]. This version of the programme contains additional conditions for comprehensive thermal modernisation projects – to ensure a reduction in useful energy consumption for heating to no more than 80 kWh/m^2 per year or by no less than 40%. Despite its advantages, Czyste Powietrze imposes restrictive requirements on the future beneficiary, which may be the reason for the influx of much fewer applications than expected at the beginning of the programme in 2018. To date, Czyste Powietrze has received more than 807,000 applications totalling PLN 24.5 billion, which is approximately 24% of the total programme budget [11].

Rising energy prices and motivation to invest in renewable energy sources

According to the Energy Regulatory Authority and the Energy Market Agency, electricity prices for residential consumers in 2023 increased by almost 29% compared to 2022 [6, 13]. This means that the average individual energy consumer certainly has felt the change, despite government action to mitigate the impact of rising electricity prices. With the constant increase in prices for electricity and traditional fuels, Polish households, wanting to ensure greater stability, opted for individual installations with renewable energy sources. In addition, the most popular installations were photovoltaic installations for generating electricity and a heat pump for providing the building with thermal energy.

Energy Infrastructure in Poland

Technical challenges include adapting existing infrastructure to new solutions related to the connection of renewable energy installations, both in the field of large-scale renewable energy sources (wind and photovoltaic power plants) and at the consumer level. It is necessary to expand and modernise medium and low voltage power grids, as well as build power plants. However, achieving these goals requires significant financial costs, which will mainly fall on the shoulders of distribution companies. Although they can rely on support from EU funds in this area, these costs will place a significant burden on the operating budgets of the companies involved and this may result in future costs being passed on to consumers, i.e. recipients of energy. Distribution and transmission network operators note that the very limited control capabilities of renewable energy sources pose challenges in managing their systems [14].

Another serious problem is the overproduction of energy from RES at the time of lowest demand. This makes it necessary to disconnect some generating units to prevent network overload. The solution that should be implemented is energy storage facilities capable of storing surpluses and using them at a later time, but these are additional costs that must be incurred.

Photovoltaic installations

An undoubted obstacle to the development of solar energy is the price of installing a photovoltaic installation. EU and government support programs aimed at encouraging prosumers to install this type of installation have addressed this problem. The programmes have fulfilled their purpose, but over the years their profitability and availability have decreased. An additional problem is the location of the roof slope or the lack of available, unshaded area for PV installations.

Energy storage

When installing photovoltaic power, it is also energy efficient to use energy storage. However, currently available technology does not allow for the profitable and effective use of energy storage for individual prosumers [15]. Energy storage that would support the power grid is also not a popular solution due to high investment costs.

Profitability analysis of heat pumps

Heat pumps are less popular than photovoltaic installations, mainly due to their price. Air heat pumps are the most advantageous in this respect; however, they are associated with the lowest efficiency and higher operating costs. Ground heat pumps, despite their greater efficiency, are characterised by a higher price due to the need to use a vertical or horizontal ground heat exchanger. Although ground pumps generate lower operating costs, compared to investment and operating costs over a 20-year period, it turns out to be more economical to install an air heat pump [15]. Figure 5 shows a comparison between ground and air heat pumps.

Figure 5. *Comparison between air and ground heat pumps*

Another factor limiting the development and popularity of heat pumps is their use of electricity – in order to reduce operating costs, it is necessary to use a photovoltaic installation.

Conclusion

Poland, as a country with an electricity generation sector based on coal and imported gas, must make significant efforts to decarbonise its economy. Active implementation of renewable energy sources is impossible without additional funding due to the still high cost of this type of investment. In this context, the legal mechanisms and government support programmes for renewable energy sources are key tools for the development and active implementation of renewable energy sources in Poland. Such support should also include power producer groups (system producers, commercial producers and prosumers), because appropriate use of Poland potential in the field of renewable energy sources requires investment of hundreds of billions of zlotys. However, the costs incurred will be offset by lower prices for electricity and heat, increased energy independence, and security. Therefore, it is necessary to properly stimulate and support their actions in this direction.

References

[1] IEA (2022), *World Energy Outlook 2022*, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022, License: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A).

[2] Ritchie H., Roser M., Rosado P.: *Energy*. Published online at OurWorldInData.org., 2022. Retrieved from: 'https://ourworldindata.org/energy' [Online Resource].

[3] Koshlak H.: *Development of renewable energy source in Poland*. Journal of New Technologies in Environmental Science. 2023, Vol. 7 (4). pp. 129-133.

[4] Załącznik do uchwały nr 22/2021 Rady Ministrów z dnia 2 lutego 2021 r. Polityka Energetyczna Polski do 2040 r. Warszawa 2021.

[5] Mazanek Ł., Świat M.: *Polityka energetyczna Polski do 2040 roku – perspektywy oraz wyzwania*, Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk 1(110). Zagadnienia surowców energetycznych i energii w gospodarce krajowej. Energetyka krajowa a europejski Zielony Ład. DOI: 10.24425/140525, s. 51–63.

[6] Urząd Regulacji Energetyki. URE. [Access date 20.03.2023]. https://www.ure.gov.pl/ [Online Resource].

[7] Polskie Towarzystwo Przesyłu i Rozdziału Energii Elektrycznej. [Access date 20.03.2024]. http://www.ptpiree.pl/ [Online Resource].

[8] Olczak P., Matuszewska D., Kryzia D.: *"Mój Prąd" as an example of the photovoltaic one off grant program in Poland*. Energy Policy J. 2020, 23, 123–138. [Google Scholar] [CrossRef].

[9] Mój Prąd [Access date 20.03.2024]. https://mojprad.gov.pl/ [Online Resource].

[10] *Globenergia. Mój Prąd 6.0 i montaż samego magazynu energii? Co z datami kosztów kwalifikowanych?* [Access date 20.03.2024]. https://globenergia.pl/moj-prad-6-0-i-montaz-samego-magazynu-energii-co-z-datami-kosztow-kwalifikowanych/ [Online Resource].

[11] *Czyste Powietrze* [Access date 20.03.2024]. https://czystepowietrze.gov.pl/ [Online Resource].

[12] Nowa Edycja Czyste Powietrze 3.0. [Access date 20.03.2024]. https://czystepowietrze.gov.pl/od-3-stycznia-2023-r-rusza-nowa-wersja-programu-czyste- powietrze/ [Online Resource].

[13] Agencja Rynku Energii S.A. ARE. [Access date 20.03.2024]. https://www.are.waw.pl/ [Online Resource].

[14] Kryszk H., Kurowska K., Marks-Bielska R., Bielski S., Eźlakowski B.: *Barriers and Prospects for the Development of Renewable Energy Sources in Poland during the Energy Crisis*. Energies. 2023; 16(4):1724. https://doi.org/10.3390/en16041724.

[15] Kappner K., Letmathe P., Weidinger P.: *Optimisation of photovoltaic and battery systems from the prosumer-oriented total cost of ownership perspective*. Energ Sustain Soc 9, 44 (2019). https://doi.org/10.1186/s13705-019-0231-2.

[16] Trela M., Dubel A.: *Net-Metering vs. Net-Billing from the Investors Perspective – Impacts of Changes in RES Financing in Poland on the Profitability of a Joint Photovoltaic Panels and Heat Pump System*. Energies 2022, 15, 227. https://doi.org/10.3390/en15010227.