THE INFLUENCE OF PHOTOVOLTAICS ON THE IMPLEMENTATION OF THE CLIMATE AND ENERGY PACKAGE ON THE EXAMPLE OF THE RZESZÓW FUNCTIONAL AREA

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Abstract

The aim of the study is to show the impact of investments in photovoltaic installations carried out by local government units on the implementation of the objectives of the climate and energy package in the Rzeszów Functional Area (ROF). It has been shown that such an important problem as the need to increase the share of renewable energy sources (RES) in electricity production is also solved locally. The methods of in-depth interview, case study and desk research were used. The application of modern technologies in the field of energy production with the use of photovoltaic cells in the ROF area is to contribute in 2019-2035 to the reduction of CO2 emissions; to the increase in the production of electricity from RES, and to the reduction of the use of fossil fuels for the production of electricity. Diversification of energy sources, also at local and individual level, can be beneficial not only for the environment, but also for the budget of energy consumers.

Key words: energy management strategy, energy efficiency, RES, photovoltaics, climate and energy strategy

Introduction

Increasing the ecological awareness of society, progressive climate change and the absolute necessity of adaptation to it, as well as restrictions in access to fossil fuel resources, make it necessary to search for new, environmentally friendly energy sources. In addition, from the point of view of the consumer, a very important issue is the rising cost of electricity, which, together with the increasing consumption of electricity, cause an increase in the maintenance costs of residential and public buildings.

The members of the ROF Association seek to meet these challenges by: increasing the energy efficiency of public utility buildings (deep thermo-modernisation); supporting heat exchange; supporting installation of renewable energy sources (RES) – photovoltaic cells in selected public utility buildings and properties of ROF residents. The measures taken are part of the implementation, adopted by the European Commission, of the objectives of the climate and energy package planned to be achieved by 2020, i.e.:
20% reduction of greenhouse gas emissions (relative to the level of 1990);
20% share of energy produced from renewable sources in total EU energy consumption;
increasing energy efficiency by 20%.

Definitions

a) Photovoltaic cells – devices in which solar energy is directly converted into electricity (Sarniak 2008: 28). These are devices made of semiconductor materials containing a p-n connector in their structure.
b) Insolation – the energy of solar radiation, also called irradiance, reaching a unit of surface within a specified time: an hour, a month, a year. The physical dimension of this size is J/m^2 or kWh/m^2 (Wolańczyk 2011: 21).

c) Sunshine – this is the total time in which direct solar radiation reaches the surface of the Earth in a given place, i.e. the solar disc is directly visible. The unit of sunshine is the time. Sunshine in Poland equals 1200÷1700 h (Wolańczyk 2011: 21).

Rzeszów Functional Area (ROF)

The ROF is the Municipal Functional Area of Rzeszów defined in the Development Strategy for the Voivodeship – Podkarpackie 2020 (adopted by Resolution No. XXXVII/697/13 of the Sejmik of the Podkarpackie Voivodeship in Rzeszów of 26 August 2013) covering the area of municipalities forming the ROF Association: the Municipality of Rzeszów, the Municipality of Boguchwała, the Municipality of Chmielnik, the Municipality of Czarna, the Municipality of Czudec, the Municipality of Głogów Małopolski, the Municipality of Krasne, the Municipality of Lubenia, the Municipality of Łańcut, the City of Łańcut, the Municipality of Świlcza, the Municipality of Trzebownisko, and the Municipality of Tyczyn.

The Rzeszów Functional Area was established in line with the desire to ensure the sustainable and long-term development of the cities and municipalities concentrated in the ROF and to strengthen partnership-based local government cooperation, and taking into account the opportunities defined by the European Commission within the 2014-2020 financial perspective for effective use of aid funds directed at the development of urban areas and increasing the involvement of cities and their functional areas in the management of EU structural funds – within the financial instrument of Integrated Territorial Investments (ITI). The ROF is a key area for the development of the entire Podkarpackie voivodeship and its mission is defined (at the level of the operational plan) by three development objectives:

I. Development objective ZIT 1 – Increase in the competitiveness of the economy by creating conditions for the development of innovative enterprises;
II. Development objective ZIT 2 – Improving the quality of life in the ROF through increasing access to modern public services and revitalisation of public space;
III. Development objective ZIT 3 – Improvement of the natural environment and support of the region's energy efficiency.

Within the scope of the third objective, the municipalities, in accordance with the Low-Emission Economy Plans developed and adopted by them, aimed at reducing particulate and CO_2 emissions and increasing energy efficiency (including: deep thermo-modernisation: reduction of demand for heat and electricity, installation of renewable energy sources), undertook joint actions in installing renewable sources of electricity (photovoltaic cells) on public utility buildings and real estate (including buildings) of the residents. Within the framework of this study, only those investments which have been implemented by ROF municipalities under joint ZIT projects have been included, and it should also be noted that the members of the ROF Association implemented and will certainly implement independently other projects which are part of the activities aimed at executing the assumptions of the climate and energy package.

Solar energy potential in Podkarpackie voivodship

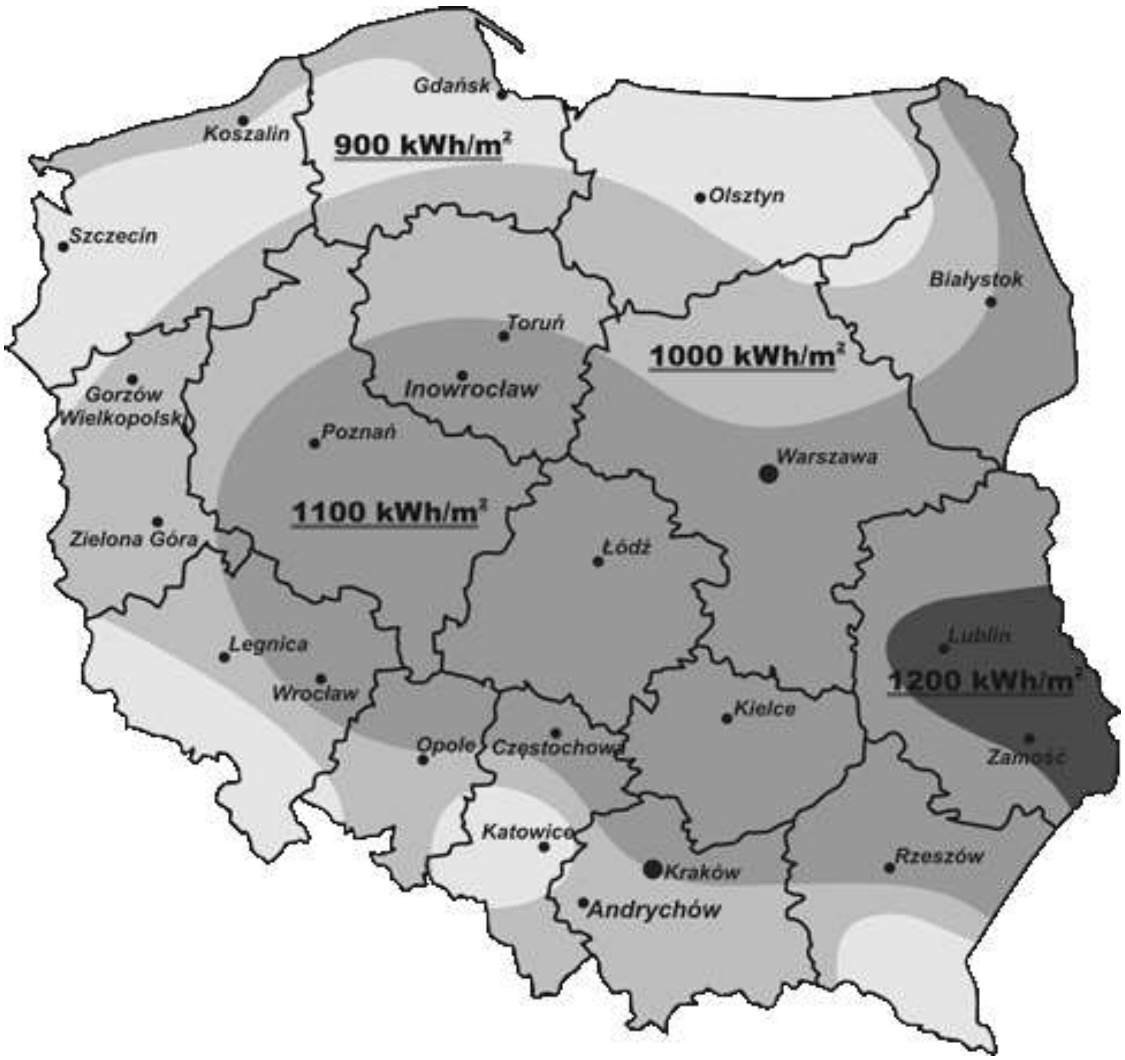
The dominant component of the Earth's energy balance is solar radiation (Jastrzębska 2013: 25). The solar energy potential exceeds the total global energy demand by as much as 15,000 times.

As can be seen from the map of the average insolation values (Figure 1), Poland insolation ranges from 900 kWh / m^2 to 1200 kWh / m^2. The Rzeszów Functional Area is located in an area of 1100 kWh/m2 of insolation. This places the ROF in second place in terms of irradiance in Poland.

Taking into account the map of average sunshine values (Figure 2), Poland is in the range of 1400 h to 1700 h. In the Rzeszów Functional Area, sunshine values are in the range of 1500 - 1550 h.

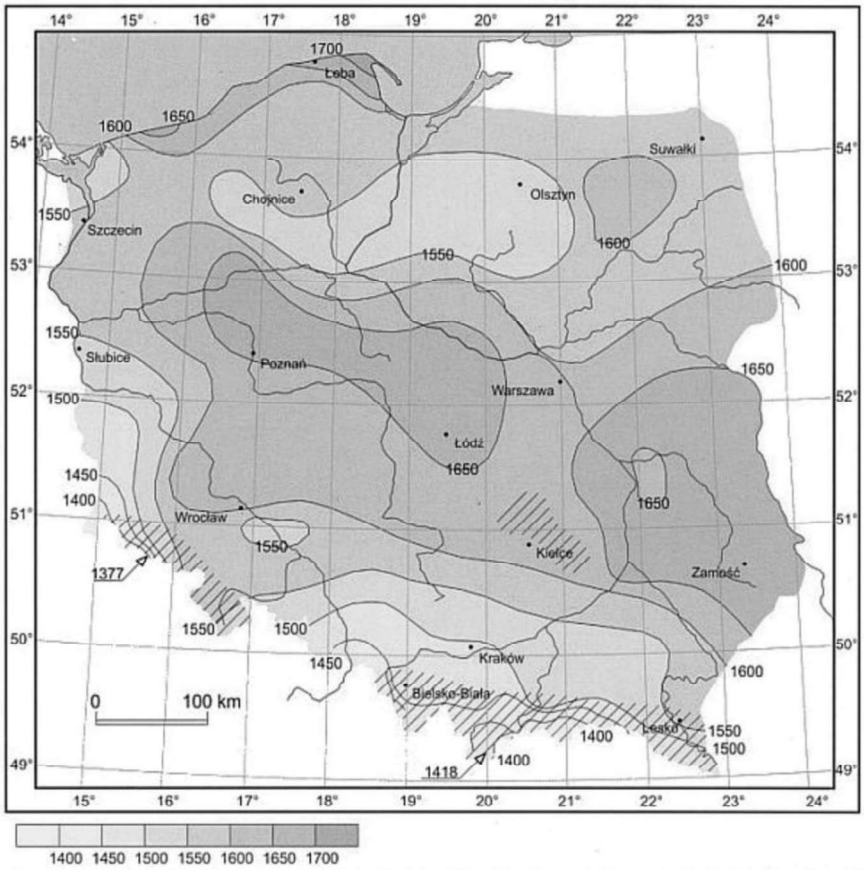
The above analysis of solar energy potential shows that the Rzeszów Functional Area has good solar conditions, therefore the development of solar energy in its area is a purposeful and appropriate measure to achieve the objectives of the climate and energy package, while having a positive impact on the operation of power grids and stimulating their essential modernisation.

Figure 1: Map of average insolation values in Poland



Source: http://azenergia.pl/dla-domu/fotowoltaika-turbiny-wiatrowe/mapa-naslonecznienia/

Figure 2: Map of average sunshine values in Poland



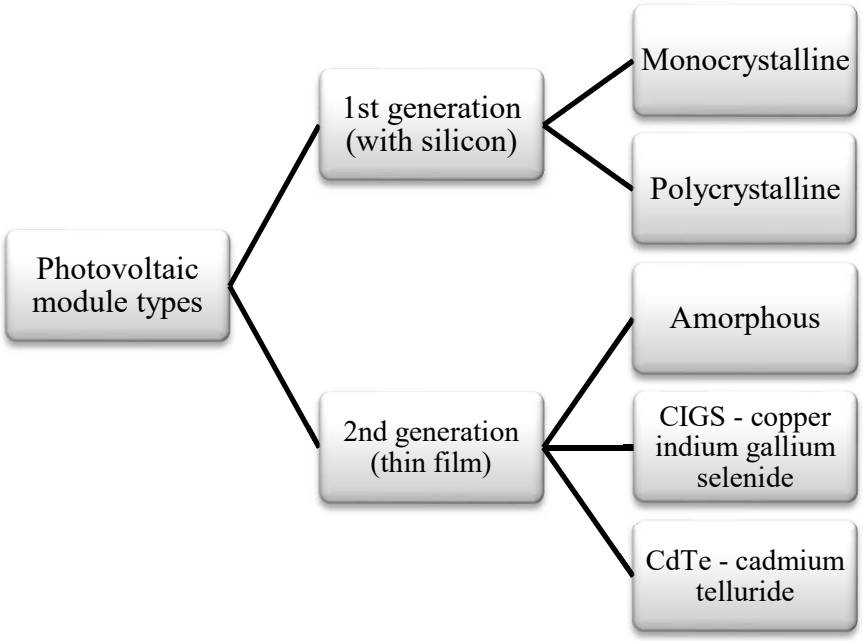
Source: Lorenc H, Atlas klimatu Polski., Instytut Meteorologii i Gospodarki Wodnej, Warsaw 2005.

Types of photovoltaic cells to be installed in the ROF area

Currently, several generations of photovoltaic cells are available on the market. In the ROF area, within the framework of projects, co-financing was and is provided for the purchase of both monocrystalline and polycrystalline cells, i.e. first generation silicon photovoltaic cells (Figure 3), creating installations of various capacities ranging from 3 kW (households) to over 1.2 MW (the Urban Water and Sewerage Enterprise Ltd. in Rzeszów). Mono- and polycrystalline cells are produced by cutting out elements from monocrystal and polycrystal with a thickness of approximately 200 μm (Purgał, Orman 2012: 73). Currently, more than 90% of produced photovoltaic modules are mono- and polycrystalline cells. In the ROF area, the installation of monocrystalline cells prevails. The main advantages of monocrystalline cells are greater power per unit area, and their smaller size and greater efficiency in comparison to polycrystalline cells.

Considering the price aspect, polycrystalline cells are cheaper but have a lower power output per unit area and larger sizes. The selection of the cell should be personalised to the technical specification of the object/building and the function it performs.

Figure 3: Types of photovoltaic cells



Source: Own calculations based on [1, 2, 5] .

Problems related to the functioning of photovoltaics in the ROF area

The application of RES solutions based on photovoltaic cells on an individual as well as public scale does not seem to present any technological problems related to the installation and operation of the installation. Of course, it is still difficult to store the energy produced on a massive and long-term scale due to financial (very high price) and technological reasons. It is to be expected that this problem will soon be resolved as technology advances. At present, the role of buffer and storage for generated and unused electricity is played by the energy grids, whose continuous development and modernisation is indispensable for efficient use of RES. Importantly, in the case of residents, educational facilities and public utility facilities, it is possible to balance accounts with energy suppliers by including energy produced and discharged to the grid in the settlement of consumed electricity – resulting in a reduction of incurred costs. For other entities it remains to sell excess energy. Both solutions are regulated by law in Poland, giving a certain stability in the long-term perspective.

System support for the installation of photovoltaic installations in the Rzeszów Functional Area within the ZIT ROF

Poland is obliged to increase the share of energy produced from renewable sources in the energy balance to 20% by 2020. Achieving this goal requires a significant and immediate increase in the number of projects in this sector. Therefore, the development of investments in photovoltaics seems to be advisable and justified. For this goal to be achievable, strong incentives such as favourable legal solutions, but also significant financial support (especially for residents) are necessary.

On 1 January 2019, the *Act of 9 November 2018 amending the Act on Personal Income Tax and the Act on Lump-sum Income Tax on Certain Income Generated by Individuals* (Journal of Laws Dz.U. of 2010, No. 33, item 259, as amended) entered into force. 2246), which

includes thermal modernisation relief concerning personal income tax payers, and those paying tax according to the tax scale and paying a lump sum on registered revenues, being the owners or co-owners of single-family residential buildings in which thermal modernisation has been performed (including installation of photovoltaic installations). This relief consists in the deduction from income of expenses related to the implementation of thermomodernisation projects. The maximum limit of deduction per one time will be 53 000 PLN. However, the possibility of using the right to discounts when balancing the energy produced by the installations and unused energy in the long-term perspective, is also provided by the *Act of 22 June 2016 amending the Act on Renewable Energy Sources and certain other acts* (Journal of Laws 2016: 925). According to this law, it is possible to recover from 0.7-0.8 the value of energy produced by the installations, but not yet used and fed into the power grid.

It is worth noting that the effective co-financing for photovoltaic investments in the ROF area from the ZIT instrument exceeds 70% on average (VAT is not an eligible cost and is not subject to co-financing), which seems to be a sufficient incentive for both public entities and residents to undertake such investments. The table below (Table 1.) shows that the EU co-financing of projects is high (for the project: "Support for RES development in the ROF – umbrella project" it amounted to PLN 35.64 million, and for the project: "Increasing the share of energy from renewable sources in the ROF" it amounted to PLN 12.09 million). This level of co-financing at current energy prices means that the investment should pay for itself within a period of about 4 years, which, with a minimum of 15 years of installation life, is an additional incentive. The announced and unavoidable increases in electricity prices in the coming years will only accelerate the return on investment and increase its profitability.

Table 1: List of RES projects within the ZIT ROF

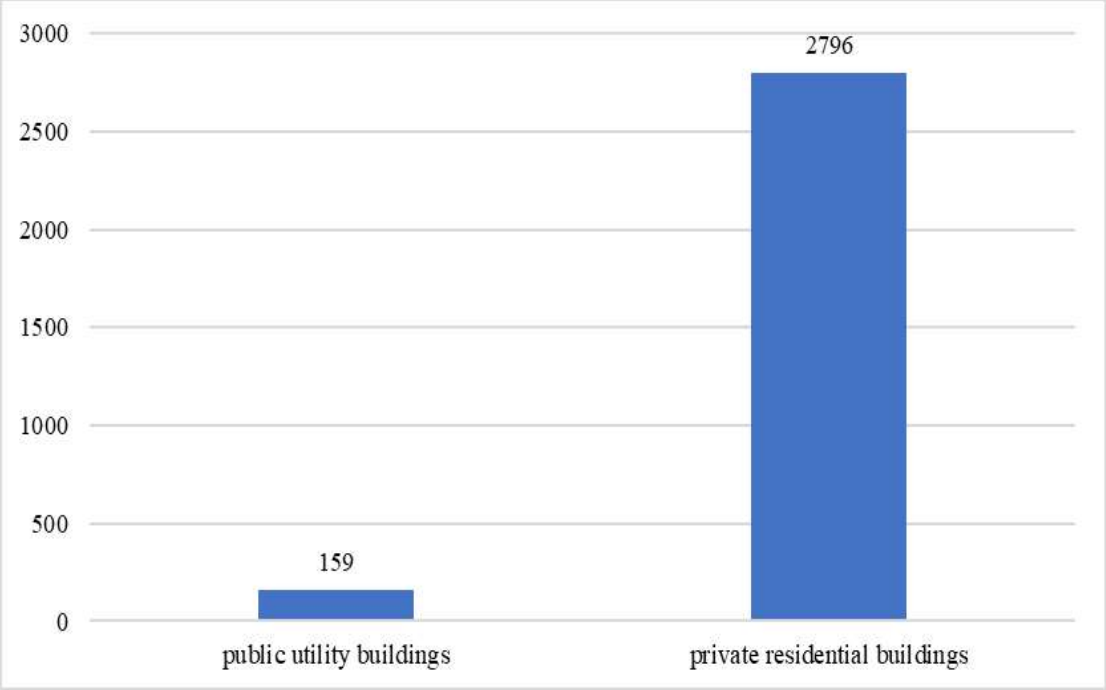
Project title	Beneficiary title	Project value (in PLN)	Value of EU co-financing (in PLN)	EU co-financing rate (in percent)
Support for RES development in the area of ROF – „umbrella project”	ROF ASSOCIATION	45.41 M	35.64 M	up to 85% of eligible costs
Increasing the share of renewable energy in the area of ROF		22.53 M	12.09 M	

Source: Own elaboration based on [2].

Analysis of the impact of the use of photovoltaic cells in the ROF area

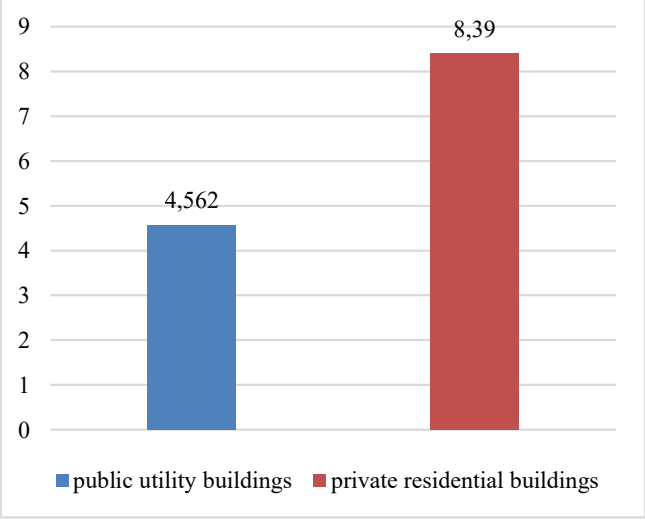
Taking into account the quantity and capacity of photovoltaic installations already installed and planned in the following years (Figure 3.) on public buildings and properties (including buildings) of the inhabitants in the ROF area, only in the framework of joint activities of ROF municipalities (including their municipal companies) within ZIT in 2018-2021 the total initial electricity generation capacity will exceed 12 MWe (Figure 4.).

Figure 3: Number of photovoltaic installations planned to be installed in 2018-2021 in the Rzeszów Functional Area within ZIT ROF



Source: Own calculations based on [1, 2, 5] .

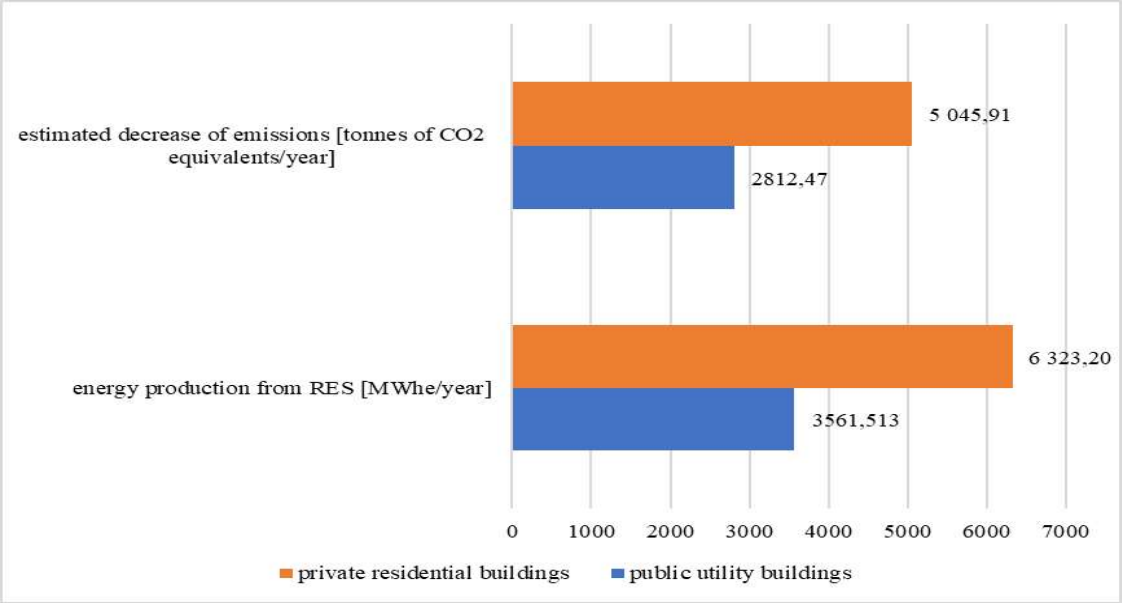
Figure 4: Total initial electricity generation capacity in [MWe], by installations planned to be installed in 2018-2021, in the Rzeszów Functional Area within the ZIT ROF



Source: Own calculations based on [1, 2, 5] .

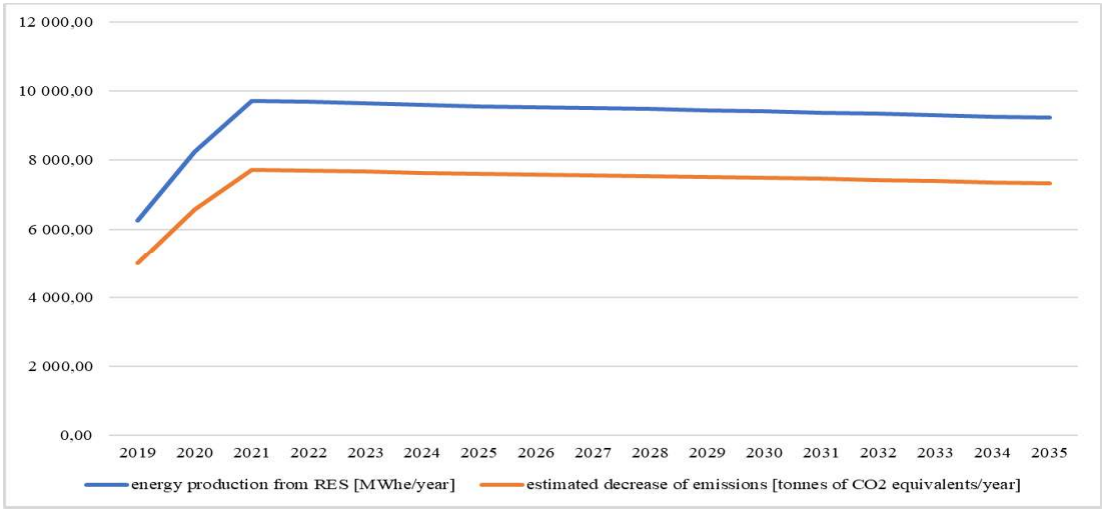
Taking into account the investment process spread over the years 2018-2020 and the assumed and natural decrease in cell efficiency over time (the annual decrease in installation efficiency was assumed to be 0.3 or 0.4% per annum), the amount of renewable energy sources possible to generate electricity was estimated and the corresponding decrease in CO_2 emissions by 2035 (Figure 5, Figure 6). Both parameters undoubtedly confirm that the measures taken will directly increase renewable energy production and reduce greenhouse gas emissions, as well as improve energy efficiency by reducing the need for fossil fuels.

Figure 5: Total initial decrease in CO_2 emissions and production of electricity from RES (for installations planned to be installed in 2018-2021) in the Rzeszów Functional Area within ZIT ROF.



Source: Own calculations based on [1, 2, 5] .

Figure 6: Estimated decrease in CO_2 emissions and planned production of electricity from RES in 2018-2035 in connection with the installation of photovoltaic installations in the Rzeszów Functional Area within ZIT ROF



Source: Own calculations based on [1, 2, 5] .

Summary

It is worth noting that it is still necessary to provide systemic support (mainly grants – non-refundable aid) for RES implementation activities, because only well-thought-out incentives at this stage seem to be the best factor stimulating further investments, although undoubtedly the reduction of maintenance costs is equally important and certainly in the coming years it may prove to be an important argument for many investors in itself. As a result of the implementation of the first stage of the "Umbrella Project" and the "Increasing the share of energy from renewable sources within the ROF" project, applications from 2,796 private residential buildings and 159 public buildings for co-financing the installation of photovoltaic cells qualified until 2021. At current prices of photovoltaic installations, the payback time (from energy savings) for RES is still too long and the economic aspect related to the impact on the environment and its degradation on local communities is insufficiently motivating. The application of modern strategies for diversification of energy sources with the use of photovoltaic cells in the ROF area will contribute in the years 2019-2035 to:

1) reduction in CO2 emissions by 124,547.95 tonnes of CO_2 equivalent;
2) increase in electricity production from RES by 156,619.76 MWhe;
3) reducing the use of fossil fuels to produce electricity by increasing its production from RES.

In this context, it is advisable to continue the implementation of the RES implementation strategy in the ROF and to monitor the effects achieved in subsequent years. The multidimensional and multifaceted approach to the RES implementation strategy will allow the actual energy and environmental effects to be verified. It is to be hoped that in the near future cheap and efficient RES energy storage will also be available, because at the moment electricity generated from most RES is not available on demand, as is possible with conventional power engineering. Undoubtedly, it is important that measures (including investments) related to the use of RES should be inspired and carried out at the supra-regional, regional and local levels. This also applies to all measures aimed at improving energy efficiency in all areas of life. It is very important that investment activities are accompanied by, and often preceded by, activities raising institutional and civic awareness, emphasising the changes taking place and showing the necessity and inevitability of adaptation to the changes taking place.

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