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Comparative analysis of the profitability of private investors and enterprises in the photovoltaic investment in the light of the amended RES Act in Poland

***Abstract**. The article presents a comparison of the profitability of entering a photovoltaic investment from a private inverter and an entrepreneur point of view. The analysis was presented in the light of the amendment to the RES Act in 2021 and has been obligatory since April 1, 2022 in Poland. Factors that significantly affect the assessment of investment profitability are given. In the article, the authors presented the legitimacy of entering into such an investment depending on the level of self-consumption of electricity, support mechanisms guaranteed by the legislator and the level of energy demand in a household or in a company. The profitability comparison was carried out using the DCF (discounted cash flow) method, which allows for the market calculation of the investment value with the assumed boundary criteria. Also, using the IRR (internal rate of return) method, a comparison of the economic efficiency of the investment in relation to the alternative management of capital in treasury bonds was presented.*

***Streszczenie.** Artykuł przedstawia porównanie opłacalności wejścia w inwestycję fotowoltaiczną dla potrzeb inwertora prywatnego i przedsiębiorcy. Analiza została zaprezentowana w świetle nowelizacji ustawy o OZE, której zmiany zostały dokonane w 2021r i która obowiązuje od 1 kwietnia 2022r w Polsce. Podano czynniki, które znacząco wpływają na ocenę rentowności inwestycji. W artykule autorzy przedstawili zasadność wejścia w taką inwestycję w zależności od poziomu autokonsumpcjii energii elektrycznej, mechanizmów wsparcia zagwarantowanych przez ustawodawcę oraz poziomu zapotrzebowania na energię w gospodarstwie domowym lub w firmie. Porównanie opłacalności zostało przeprowadzone z wykorzystaniem metody DCF (discounted cash flow), która pozwala na rynkowe wyliczenie wartości inwestycji przy założonych kryteriach brzegowych. Przedstawiono również z wykorzystaniem metody IRR (internal rate of return) porównanie efektywności ekonomicznej inwestycji w stosunku do alternatywnego zagospodarowania kapitału w obligacje skarbowe (**Analiza porównawcza opłacalności w inwestycję fotowoltaiczną inwestorów prywatnych i przedsiębiorstw w świetle zmienionej ustawy OZE w Polsce**)*

Keywords: renewable energy, photovoltaic power, cost-effectiveness of investment.
Słowa kluczowe: energia odnawialna, fotowoltaika, opłacalność inwestycji.

Introduction

In the period 2019 to 2022, the share of solar energy production increased by more than 5.2 - 5.7 GW, i.e. from 0.5 percent to almost 3 percent of total energy production in Poland. For example, in 2018 there were 28,000 photovoltaic installations, while at the beginning of 2022 about 1 million such installations with a total capacity of 10 GW [1,2] This is related to the systematic decrease in the prices of photovoltaic installations, which significantly decreased over the years 2010 and the beginning of 2022 after taking inflation into account. It is estimated that Poland ranked second behind Germany in terms of the increase in the installed capacity of solar power in the European Union. Photovoltaics in Poland, unlike many countries in Europe, is currently prosumer in nature [3].

The requirements of the EU RED II Directive [4] impose on Member States, from 1st January 2024, the obligation to introduce a system enabling separate settlement of electricity which is put into the grid and energy taken from the grid. Takin into account the above-mentioned reasons, the Polish legislator decided to change the discount rules, which are available currently for prosumers, allowing for the production of electricity, transferring surpluses to the energy system and with a certain consumption factor in periods of greater demand.

On October 29, 2021, an amendment to the Act on Renewable Energy Sources [5] was made in Poland, which, together with its update of 27th January 2022 [6] significantly changes the rules of the settlement system for new prosumers who joined the system after April 1, 2022. Pursuant to the amendment to the Act, the discount system is replaced by the Net-billing system.

Research methodology

The research adopted the same research methods and techniques as in the article [7]. These include: the DCF, NPV and IRR methods [8–13]. This article presents the rates of return for various levels of self-consumption with the curve of long-term changes in core inflation.

Analysis criteria

For the purposes of the analysis and comparing the cost-effectiveness estimation, it was assumed that the power of the photovoltaic installation for examplary private investor and an investor who is an entrepreneur classified as an SME will be the same and amounts to 9.765 kWp. According to calculations [14], the initial average annual energy production for such an installation is 10294.36 kWh.

Table 1. Estimated installation costs and parameters for the private investor and entrepreneur (they are almost identical

Description	Private investor	Enterprise
	Value	
Initial and the total costs of entry into the RES installation	8889.80 EUR (with 8% TAX and co-financing)	8919,40 EUR (without TAX)
Peak power of the photovoltaic installation	9.765 kWp	
Average annual initial energy production	10294.36 kWh	
Total losses in the system	19.6%	
Forecasted average annual decrease in energy production	1%	
Average annual price index of consumer goods and services (inflation)	4,54%	
Interest rate on 10-year bonds EDO632	1.25% + inflation	

Total losses in the system were assumed, which were estimated at 19.6%, the average annual decrease in energy production to 1%. For the purposes of estimation, the average annual price and service index for the 20-year

trend was also adopted and was estimated at 4.54%. On this basis, the interest rate of 10-year bonds was assumed, which is 1.25% + inflation. The only difference is the initial cost and the total cost of entry into a photovoltaic installation, which for a private investor and for an entrepreneur is as shown in Table 1. It should be noted that a private investor purchases an installation with 8% VAT and co-financing, while it comes to entrepreneur, despite the fact that VAT in Poland is 23%, in that case there is the option of deducting it from the income of his business activity, similar to the prices of electricity, and for this reason, the applicable prices were adopted without tax. It was also assumed that the entrepreneur is also unable to obtain co-financing and subsidies to the investment.

Table 2 presents fees and costs charged by PGE resulting from the use of appropriate tariffs by a private investor and enterprises. Electricity prices for a private investor covered by the G11 tariff including VAT and it should be emphasized that as regulated prices they are in total much lower than for a company operating with the C11 tariff, in which electricity used for the needs of business activity can be included in the costs and for the purposes of the analysis of is in VAT simulations. On the other hand, an enterprise pays much more for active electricity, almost three times more than a private enterprise.

Table 2. PGE electricity prices G11 tariff for a private investor and C11 for the entrepreneur in July 3, 2022.

PGE electricity prices	**Private investor**	**Enterprise**
	Value	
Tariff	G11	C11
Average price for active energy 1 kWh of energy	0.10950 EUR (including TAX)	0.31935 EUR (without TAX)
Qualitative rate of 1 kwh of energy	0.00251 EUR (including TAX)	0.00204 EUR (without TAX)
Variable component of the grid rate of 1 kWh of energy	0.05880 EUR (including TAX)	0.03748 EUR (without TAX)
Fixed component of the network 3-phase counter for 1 month	1.41075 EUR (including TAX)	0.96774 EUR (without TAX)

Table 3. Monthly market prices of electricity quoted on the Polish Power Exchange (price are converted at the fixed PLN/EUR exchange rate for the period: June up to September 2022).

No.	Month	Value (***EUR/1MWh*** without TAX)
1.	June	139.389 EUR
2.	July	171,241 EUR
3.	August	219,153 EUR
4.	September	153,101 EUR
Average RCEm Price:		**170,721 EUR**

The analysis also assumed the same monthly market prices of electricity RCEm quoted on the Polish Power Exchange for 1 MWh, which for the months from June to September 2022 are presented in Table 3. Prices have been converted at a fixed exchange rate of PLN/ EURO as published by the National Bank of Poland on June 13, 2022. Due to the short reporting period of monthly RCEm prices, the average index for these months was adopted in the simulation.

The analysis also takes into account the consumer price index at the level of 4.54% annually. This indicator was calculated for the period of the last 25 years of inflation in Poland, i.e. from 1996 to 2021 [15]. Although inflation is variable, it is included in both discounted electricity prices and EDO bond discounting. Thus, the same rate of inflation as a parameter affects the interest and energy price discount. This is a major simplification that will be used for further analysis. The cumulative dynamics of changes in the consumer price index in Poland and the cumulative changes in the average annual energy price for households and companies in the EU in 2007-2021 are presented in Figure 1. Calculations will be based on data for Poland.

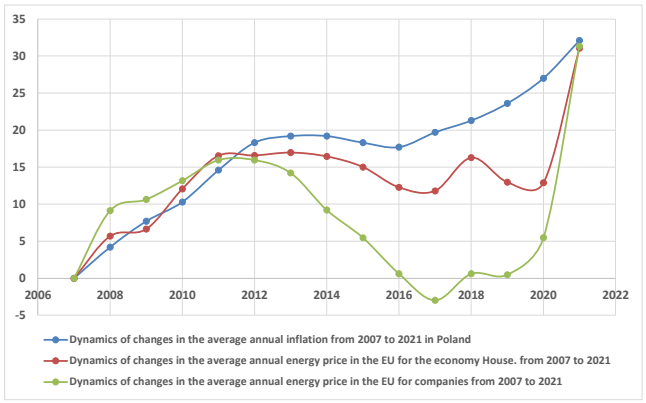


Fig.1. Cumulative annual dynamics of changes in prices of goods and services and cumulative annual dynamics of changes in electricity prices for households and businesses [15]

Results of model – simulation

Fig. 2 and 3 present individual cases of self-consumption from 5% to 60%. The figures show the values of return on capital in the given annual time intervals in which the return on investment analysis was carried out. As the presented figures show, with lower self-consumption, the payback period should be longer for both the private investor and the enterprise. When it comes to individual cases of self-consumption (from 5% to 60%) for a private investor, it can be seen that the payback period for all levels of self-consumption does not differ much (Fig. 2 and 4a). The payback period for all analyzed levels of self-consumption occurred around the sixth year investment. In the analyzed case of a private investor and for 5% of self-consumption, the payback period occurred in 6.3 years of investment. Then, for 10% of self-consumption, the payback period occurred in 6.2 years of investment, for 20% - in 6.1 years, for 30% and 40% - in 6 years, and for 50% - in 5.9 years of investment. On the other hand, the fastest payback period is for self-consumption equal to 60% (Fig. 4.a.), which will occur exactly in 5.8 years of investment.

Such a small difference in payback time for different levels of self-consumption of electricity results from several reasons, which include:

- very high monthly average prices of electricity at which it was purchased from a private investor on the Polish Power Exchange;
- fixed and rigidly maintained electricity price in the G11 tariff in 2022. This price is not a market price and any change to it by the energy company must be agreed with the Energy Regulatory Office (ERO). In addition, ERO reserves the right to interfere in the prices of energy sold to private consumers;
- the method of energy settlement, which until July 1, 2024, consists in setting average monthly sales prices (RCEm) and not hourly prices. The analysis of hourly quotations of electricity prices allows for the observation of significant differences in the prices of this energy in the noon periods when production from solar sources occurs and in which hours the prices are much lower than the prices in the afternoon and evening hours.

The factors listed above limit the impact of self-consumption of electricity and, in the analyzed case, makes the payback period to approximately 6 years.

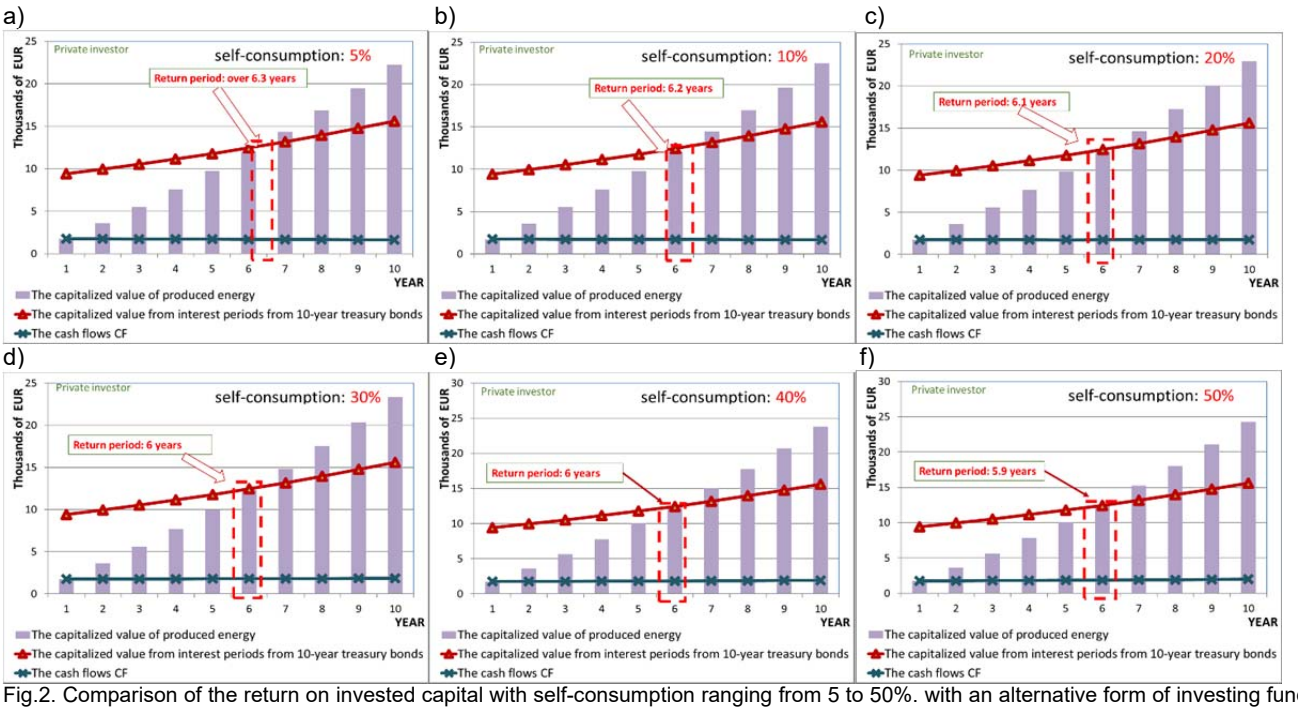


Fig.2. Comparison of the return on invested capital with self-consumption ranging from 5 to 50%. with an alternative form of investing funds in 10-year treasury bonds: (a) self-consumption assumed at 5% to 50%.

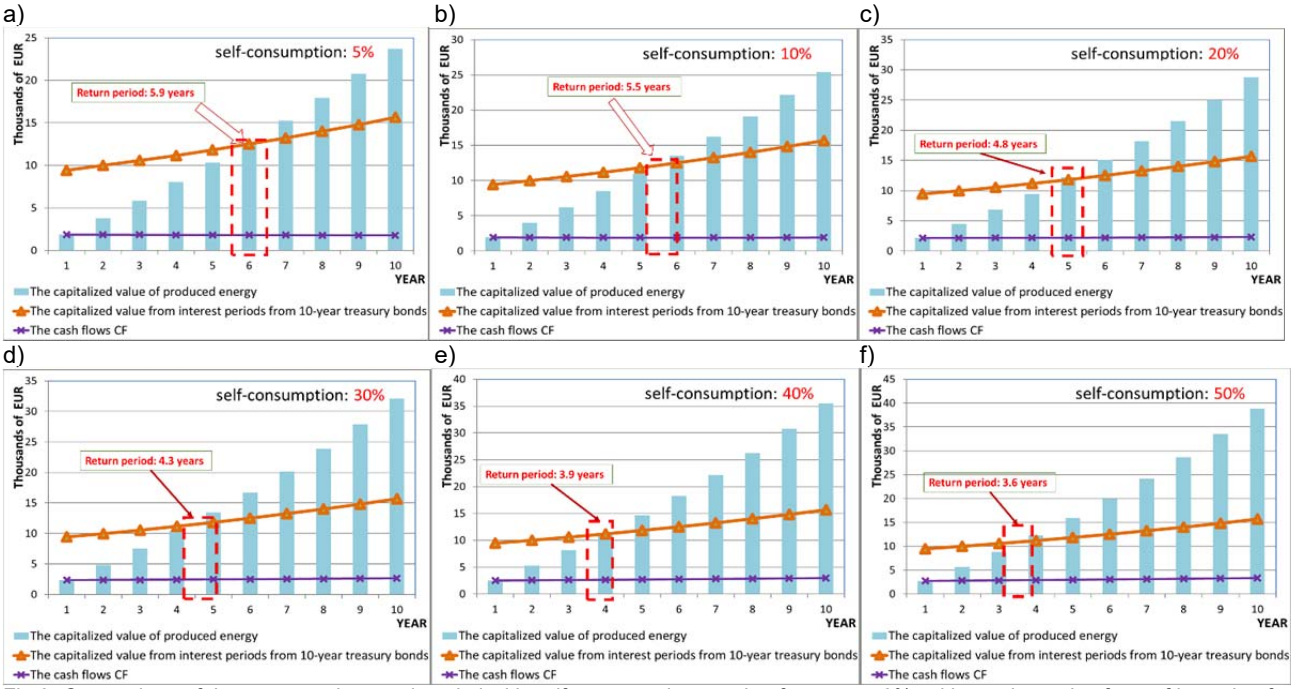


Fig.3. Comparison of the return on invested capital with self-consumption ranging from 5 to 50%. with an alternative form of investing funds in 10-year treasury bonds: (a) self-consumption assumed at 5% to 50%.

Detailed figures (Fig. 3.) concerning self-consumption by enterprises do not show a similar tendency as in the case of a private investor. Of course, similarly to a private investor, the payback period is longer with lower self-consumption. However, unlike in the case of a private investor, self-consumption strongly affects the payback period here. For example, with auto-consumption of 60%, the payback time is 3.3 years, while with auto-consumption at 5%, this time is significantly longer and amounts to less than 6 years. The percentage difference in payback time is therefore close to 79%.

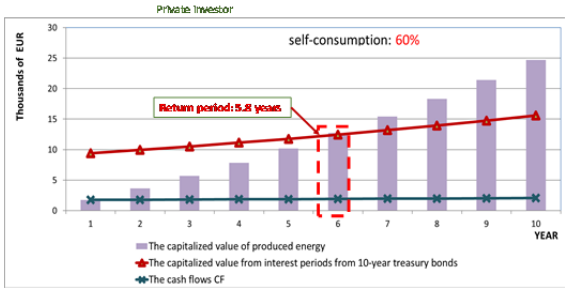
In addition, comparing all payback periods with the investment of a private investor, it can be observed that they are also shorter at particular levels of self-consumption. And so, for auto-consumption equal to 5%, the payback period is the longest and occurred in 5.9 years of investment (i.e. the payback period is similar to the investment in the case of a private investor, but shorter by 0.4 year), for 10% it is 5.5 years (period shorter by 0.7 years), for 20% it is 4.8 years of investment (period shorter by 1.3 years), for 30% it is 4.3 years of investment (period shorter by 1.7 years), for 40 % is 3.9 years of investment (by 2.1 years), for 50% it is 3.6 years of investment (by 2.3 years). On the other hand, the fastest payback period is for self-consumption equal to 60% (Fig. 4.b.), which will occur exactly in 3.3 years of investment, i.e. it covers a shorter payback period by 3.9 years than for an individual investor. Analyzing the difference in the return on investment of a private investor and an entrepreneur with the same level of

self-consumption equal to 60%, it can be indicated that it amounts to 75.7%, and for 5% of self-consumption is 6.7%.

Analyzing the results obtained for an investor who is an entrepreneur, the following conclusions occur:

- opposite to a private investor case, electricity purchase prices in the C11 tariff are based on market principles. The prices are very high and in the second half of 2022 they will be almost 3 times higher than the prices in the beginning of 2022. In addition, energy purchase prices in the C11 tariff are much higher than the average monthly prices of energy (RCEm) resold to the producer's deposit;
- an energy settlement mechanism, which (until July 1, 2024) take into account the average monthly sales prices, not hourly prices.

a)



b)

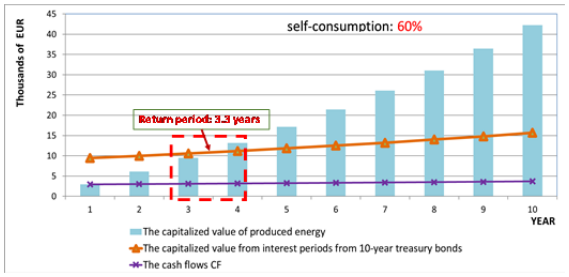


Fig.4. Comparison of 60% return on invested capital with self-consumption (ROI) on invested capital with an alternative form of investing funds in 10-year treasury bonds (the most favorable case in large scale). a) private investor, b) the company is the investor

Conclusions

The article presents a comparative analysis of the profitability of a photovoltaic investment by private investors and enterprises in the light of the amended RES Act in Poland. The impact of the level of self-consumption on the rate of return on investment for the adopted prices and electricity billing rules that were provided in the assumptions was presented.

The following conclusions follow from the simulations:

- both for a private investor and for an investor who is a company, investing in a photovoltaic installation is very profitable (assuming that the conditions are maintained as in 2022).
- the payback period for the private investor for all the analyzed levels of self-consumption occurred around the sixth year of the investment. However, for an enterprise (as opposed to a private investor), self-consumption strongly affects the payback period. For example, with auto-consumption of 60%, the payback time is 3.3 years, while with auto-consumption at 5%, this time is significantly longer and is less than 6 years. The percentage difference in payback time is therefore close to 79%.
- after analyzing the results obtained for an investor who is an entrepreneur and a private investor, the obtained results and differences in rates and payback times result from different prices of electricity purchased by the investor. Contrary to a private investor, electricity purchase prices by the company in the C11 tariff are based on market principles. These prices are very high and in the second half of 2022 they will be almost 3 times higher than the prices from the beginning of 2022. In addition, the purchase prices in this tariff are much higher than the average monthly prices of energy (RCEm) resold to the producer's deposit. The given differences have a strong influence of this self-consumption on the obtained results.

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