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ECONOMIC ANALYSIS OF THE PHOTOVOLTAIC INSTALLATION USE POSSIBILITIES IN FARMS

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ABSTRACT

The aim of the study was to conduct an economic analysis of the possibilities of using photovoltaic (PV) installations in selected farms. Two selected online PV calculators were used for the analysis. The research included 15 farms located in the Małopolskie Province. For a PV installation estimated using Calculator 1, Hewalex, the payback period ranged from 5.5 to 7 years for the 40% subsidy option and from 9 to 11 years without the subsidy, respectively. On the other hand, the payback period estimated with the use of the SmartekDom calculator ranged from 6 to 8 years for the option with 40% subsidy. However, without the subsidy, the period ranged from 7 to even 13 years.

Introduction

Even a decade ago, photovoltaic (PV) micro-power installations in Poland were not common. A micro-power installation is a renewable power source installation with an installed capacity of up to 50 kW. It is connected to the grid with a rated voltage under 110 kV or with a total installed thermal capacity under 120 kW (Janczak and Trzmiel, 2015). The first 40 PV micro-power installations were installed in 2013. Since then, the situation has changed significantly. In 2017, the number of PV micro-power installations was approx. 28,000, while in 2018 there were already 55,105 of them (www.brasit.pl/elektrownie-fotowoltaiczne/slonce-w-polsce/).

There are many types of PV panels available on the market, mainly based on monocrystalline, polycrystalline and quasi-monocrystalline silicon, as well as photocells made of amorphous silicon, or using the CdTe or CIGS technology.

Monocrystalline panels are made of large single crystals of dark blue, almost black silicon. Very often, this type of panels has rounded corners because the cross section of a silicon crystal is circular. These installations are known for their very high efficiency (15-19%) and are characterized by the highest power drop with temperature increase. The cost of such an installation is the highest per watt of installed power (compared to panels made in a different technology) (Szymański, 2017).

On the other hand, polycrystalline modules are made of many smaller silicon crystals. The cells from which the panels are made are easily recognizable by their light blue color and the square or rectangle shape. Their efficiency is lower than that of the monocrystalline modules (approx.14-16%). It is estimated that the construction costs are on average 8-15% lower than those of monocrystalline panels (Góralczyk and Tytko, 2016).

Panels made of amorphous silicon are classified as thin-film modules. They are made of amorphous, i.e. not yet crystallized silicon and their efficiency is 10%. The price of these installation modules is low, therefore, such solutions are often found on the roofs of public buildings (Sibiński and Findek, 2016).

Panels made of CIGS and CdTe cells are relatively rarely used. CIGS modules were named after their composition: a mixture of copper, indium, gallium and selenium. Together with amorphous panels, they are classified as thin-film modules. CIGS panels are characterized by low efficiency, approx. 14% (Szczerbowski, 2011), and low price. They can well manage the low-energy diffused radiation, which distinguishes them for use in the winter season (Jaskółowski, 2016).

CdTe cells are made with cadmium telluride, a compound characterized by a very good absorption of sunlight, which allows reducing the use of semiconductors to a minimum. Unfortunately, building such an installation is much more expensive than of its silicon counterpart, which significantly curbs its popularity on the PV market.

A study conducted in Turkey, grid-connected PV modules using thin-film amorphous silicon photovoltaic systems, agribusiness consumer behavior and environmental conditions have revealed the conclusion that the most appropriate hardware (Yalçın, 2010).

A literature review by Jamil et al. (2012) on the techno-economic feasibility analysis of solar photovoltaic power generation revealed the very important advantages of solar photovoltaic power generation systems. A study conducted in Nigeria, a saving of 48% is achievable over the total net present cost (TNPC) and Cost of Energy with zero emissions. The result obtained show the benefits of replacing diesel generators with renewable energy sources such as PV-battery systems in farming applications (Babatunde et al., 2020). A study conducted in Turkey, in the case Photovoltaic Solar System towards making the installation and internal agricultural mechanization used in energy consumption in recognition of the movement, has revealed that an important source of energy that can be used in the agricultural enterprises of Photovoltaic Solar System (Durmaz et al., 2017). A study conducted in Algeria revealed that solar energy can meet all the energy needs of dairy farms (Nacer et al., 2016). Solar DC Nano Grid technology is also recommended for lower energy consumption areas (Sajeeb et al., 2015). Das et al. (2016) proposed a PV/Wind/Battery Hybrid Energy System for Rural Bangladesh.

The ability to properly use the intensity of solar radiation can bring many benefits, mainly economic. The use of PV panels brings significant savings and allows the farm's independence of the oscillating electric power fees. For farmers, such an investment becomes much more profitable than even for producers or service providers. They can exercise their right to a 23% VAT deduction and, in the case of organic farming, they are also entitled to a 25% land tax refund. There are numerous subsidy programs for PV installations, and low-interest loans are available for ecological farmers. With such discounts available, the payback period of the investment is up to five years. The key argument for using renewable energy sources is no environmental pollution and reduced power consumption from the polluting, coal-fired power plants. An additional advantage of using PV installations on farms is that they ensure additional electric power supply in the event of a grid failure (Ligus, 2015).

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In 2001, the EU officially recognized the need to promote Renewable Energy Sources (RES) as a priority measure for environmental protection and sustainable development and also for meeting Kyoto protocol targets quicker. With the European Council act 7224/1/07 (EC, 2007) European countries have promoted the use of RES, target in an objective of a 20% contribution of RES on the total European energy production in 2020 (Dusonchet, 2010).

On the investment stage, a PV installation is a costly undertaking, but the system's operation generates negligible costs. The purchase price of a PV system includes the costs of PV modules, system components (battery, inverter, controller, wiring, etc.), its design, transport and installation (Klugmann-Radziemska, 2010; 2011). On the other hand, the prices of PV systems vary significantly depending on several factors, including the size of the system, its location, the possibility of connecting to the power grid, and technical specification including the costs of all installation elements (Ceran and Szczerbowski, 2017).

The continuous development of the PV sector allows achieving an increasing efficiency and steadily decreasing investment costs, which causes the number of installed PV systems to grow constantly.

The aim of the study was to conduct an economic analysis of the possibilities of using photovoltaic (PV) installations in selected farms. Two selected online PV calculators were used for the analysis. The usefulness of non-commercial online calculators as tools supporting investment in PV installations was also assessed.

Material and methods

The scope of the work included research on 15 farms located in the Małopolskie Province, the owners of which were willing to invest in PV installations.

The research was conducted in 2019, in the form of interviews with the farm owners. The interviews allowed collecting information and data later adopted as project assumptions for the economic analysis of investment opportunities in PV installations calculated with online PV calculators. The information and data presented in Table 1 are: annual power consumption, building orientation, type of roofing, as well as direct power consumption. Please note that in all studied buildings the roof slope was 45°. For illustrative purposes, the area of each farm's agricultural land area is also given.

Table 1.
Information and data from the researched farms

No.	Agricultural land area	Annual electric power consumption	Building orientation	Type of roof covering	Direct power consumption
-	(ha)	(kWh·year^{-1})	(-)	(-)	(%)
1	2.11	5210	south	tile	40
2	3.15	3800	south-east	steel tile	60
3	3.34	5150	south-west	tile	55
4	3.91	4100	south	tile	50
5	4.02	3150	south	tile	45
6	4.24	3780	south	tile	60
7	4.91	5280	south-west	steel tile	70
8	5.14	4010	south-east	steel tile	65
9	5.54	2400	south-west	steel tile	70
10	5.89	4300	south	tile	45
11	6.79	2250	south-east	tile	50
12	7.02	2560	south-west	steel tile	55
13	9.74	6000	south	steel tile	70
14	16.82	6230	south-east	tile	60
15	33.36	4500	south	tile	45

According to the authors, the PV online calculators are to be helpful for the potential investor at the initial decision-making stage in making an informed estimate.

Two such online PV calculators were used in the work: Hewalex and SmartekoDom. Each of them required entering individual parameters to calculate the results for the two options adopted in this study.

Calculator 1 - Hewalex (https://www.hewalex.pl/fotowoltaika/kalkulator)
Option W1A - 45° slope, 40% subsidy
Option W1B - 45° slope, no subsidy

Calculator 2 - SmartekoDom (https://www.smartekodom.pl/kalkulator-fotowoltaika)
Option W2A - 45° slope, 40% subsidy
Option W2B - 45° slope, no subsidy

The data for calculations performed with the use of the two calculators and the calculation stages are compared in Table 2.

Table 2.
Data used for calculations performed with the two calculators and the calculation stages

No.	Calculator 1 - Hewalex	Calculator 2 - SmartekoDom
1	The farm's annual power consumption ($kWh \cdot year^{-1}$).	The farm's annual power demand ($kWh \cdot year^{-1}$).
2	User data (personal data, province, residential building), solar radiation energy ($kWh \cdot m^{-2} \cdot year^{-1}$) adopted depending on the selected province.	The proposed size of the photovoltaic installation (calculated after determining the annual demand).
3	Building parameters: – orientation (east, west, south, south-east, south-west), – type of roof covering (metal tile, ceramic tile, seam metal tile, trapezoidal metal tile), – roof slope (<15°, 30°, 45°, 60°).	Building parameters: – orientation (east, west, south, south-east, south-west), – type of roof covering (metal tile, ceramic tile, seam metal tile, trapezoidal metal tile), – roof slope (<15°, 30°, 45°, 60°).
4	Installation parameters: – annual decrease in the PV module's efficiency (0.6 - 1.1%) - 0.7% (adopted), – selecting a PV module, e.g. JAM 60S01-300 / PR, 300W capacity, – change of installation size (~~yes~~/no), – total no. of panels (pcs).	Total annual power production - own consumption
5	Calculation results: the installation's peak power (in kWp), required unshaded area of the roof (in m^2), meeting the power demand (in%).	Economic analysis The 40% subsidy from the Prosument Program was adopted as the foundation for economic analysis, i.e. calculating the installation's payback rate of the (in years), selecting the investment of the financing method and the remaining required amount.
6	Economic analysis Price of the PV installation set with assembly – parameters of the set (no. of panels, inverter type, peak power, meeting the power demand, gross price of the set), – The 40% subsidy from the Prosument Program was adopted as the foundation for economic analysis, i.e. selecting the investment of the financing method and the remaining required amount. – additional assumption (direct consumption of PV power) - 40-70% (adopted).	Additional assumptions: – direct consumption of PV power - 40 to 70% (adopted), – installation inspection costs, PLN 200, – annual increase in electric power prices - 2% (adopted).

No.	Calculator 1 - Hewalex	Calculator 2 - SmartekoDom
7	Total summary (calculations) – Value of the PV installation investment – Power generated by the PV* installation – Value of direct power consumption* – Return on investment (ROI) – Net profit (income minus investment costs)*	Total summary (calculations) – Value of the PV installation investment – Power generated by the PV* installation – Value of direct power consumption* – Return on investment (ROI) – Net profit (return minus investment costs)*

Please note: * - for a 25-year service life (under warranty)

Different forms of financing for RES (and specifically PV systems) have been defined and put into effect in the last decade and the most popular in Europe are the feed-in tariffs (FIT) system and the quota system regulation in combination with a tradable green certificates (TGC) market. The analysis is based on the calculation of cash flow and the NPV and IRR indices (Dusonchet, 2010). What is the most favorable for the owner of a PV installation is that the produced power is consumed immediately, i.e. to power household appliances connected to the same phase as the inverter. The savings coming from not consuming grid power include not only the power fee, but also the distribution fees.

Power fees must be taken into account when calculating the payback period. Based on perennial statistics, it can be predicted that the price of 1 kWh will increase regularly. As a result, the amounts of savings will also grow every year, thanks to free power from the private installation.

According to various sources, it is estimated that the increase in prices will range from 1 to 5% annually. Therefore, an additional assumption has been made in the calculations (an annual increase in power fees, 2%).

Results and discussion

Table 3 compares the results for the 15 researched farms for the W1A and W1B options based on Calculator 1- Hewalex, i.e. the number of panels, peak power of the installation, the required areas of unshaded roof and meeting the power demand.

Results regarding the number of PV panels in the researched farms ranged from 7 (minimum value) to 19 (maximum value). The average peak power of the installations was 4.07 kWp. The required area of the unshaded roof was 22.04 m² on average (minimum 11.82 m² and maximum 32.08 m²). The planned PV installations met 102.38% of power demand on average. This index reached the lowest value at 97.48% and the highest at 111.45%.

The calculated investment costs, subsidy amounts and the net profit are presented in Table 4. In addition, for comparison, the financial values of power produced by the PV installation and power used in direct consumption in the assessed farms are presented.

Table 3.
Summary of results for a photovoltaic installation options W1A and W1B

No.	No. of panels	Peak power of the installation	Required area of unshaded roof surface	Meeting the power demand
-	(pcs.)	(kWp)	(m^2)	(%)
1	16	5.04	27.01	103.83
2	13	4.10	24.95	111.45
3	16	5.04	27.01	99.58
4	13	4.10	21.95	107.00
5	10	3.11	16.88	105.45
6	11	3.47	18.57	97.68
7	16	5.04	27.01	97.70
8	13	4.10	21.95	105.88
9	8	2.52	13.51	107.88
10	13	4.10	21.95	102.02
11	7	2.21	11.82	99.15
12	8	2.52	13.51	99.58
13	18	5.65	30.39	101.23
14	19	5.99	32.08	99.83
15	13	4.10	21.95	97.48
Minimum	7	2.21	11.82	97.48
Mean	12.93	4.07	22.04	102.38
Maximum	19	5.99	32.08	111.45
Stand. dev.	3.53	1.11	6.01	4.16

The value of PV installation investments in the researched facilities ranged from PLN 12,852 to PLN 32,379, PLN 23,212.9 on average. The subsidy amounts ranged from PLN 5,100 to PLN 13,100 (PLN 9,300 on average). The installation was able to generate average power of 97.8 MWh per farm. The minimum value was 52.1 MWh and the maximum was 141.4 MWh. In direct consumption, the average value of power consumed is PLN 39,790.2, the upper limit was PLN 70,494.4, and the lower was PLN 18,915.7.

In the W1A option (45° slope, 40% subsidy), profits are higher than in the W1B option (45° slope, no subsidy). The estimated profits in the W1A option ranged from PLN 26,296 to PLN 76,172, while in the case of W1B, the profits ranged from PLN 21,196 to PLN 63,872. On average, this is PLN 50,566 and PLN 40,937, respectively.

Figure 1 demonstrates the estimated payback periods for the option with a 40% subsidy (W1A) and without one (W1B). The payback period for the W1A option was 6.2 years on average and was 4 years shorter than in the case of W1B. The longest payback period for the installation is 7 years, and the shortest 5.5 years (for the subsidized option). Without financial support, the minimum payback period is 9 years and the maximum is 11 years.

Table 4.
Cost breakdown for W1A and W1B options

No.	Value of the PV installation investment	Power generated by the PV* installation	Value of direct power consumption	Subsidy amount, option W1A	Net profit (return minus investment costs), with subsidy, option W1A	Net profit (return minus investment costs), without subsidy, option W1B
-	(PLN)	(MWh)	(PLN)	(PLN)	(PLN)	(PLN)
1	28049.0	123.3	35684.1	11100.0	61555.9	50455.9
2	24371.0	96.7	40905.9	9700.0	48051.3	38351.3
3	28049.0	118.3	47247.2	11100.0	61223.7	50059.3
4	24716.0	100.2	35950.7	10000.0	49995.3	39995.3
5	17329.0	77.1	24999.5	6900.0	39014.5	28623.0
6	18440.0	84.8	36947.7	7300.0	45513.1	38213.1
7	27624.0	118.3	60132.8	11100.0	64225.8	53125.8
8	24371.0	96.7	45268.4	9800.0	50197.6	40397.6
9	14895.0	59.1	29617.0	6000.0	30876.5	24876.5
10	24716.0	100.2	32705.9	10000.0	49969.0	39969.0
11	12852.0	52.1	18915.7	5100.0	26296.3	21196.3
12	14895.0	59.1	23623.6	6000.0	30161.3	24191.3
13	30791.0	138.7	70494.4	12300.0	76173.0	63873.0
14	32379.0	141.4	61611.1	13100.0	75191.4	62091.4
15	24716.0	100.2	32749.1	10000.0	50054.4	38646.3
Minimum	12852.0	52.1	18915.7	5100.0	26296.3	21196.3
Mean	23212.9	97.8	39790.2	9300.0	50566.6	40937.7
Maximum	32379.0	141.4	70494.4	13100.0	76173.0	63873.0
Stand. dev.	5889.3	26.8	14325.7	2369.5	14702.6	12641.5

Please note: Net profit, i.e. return minus investment costs for the 25 year (warranted) life.

For comparison, Gradziuk (2016) analyzed five facilities, in which the expected payback period was as long as 18 to 40 years, and only in two facilities it was under the adopted lifetime of 25 years. With current power fee levels and a functioning support system for renewable power production in the period analyzed by the author, the investment in PV installations had little economic justification. Gradziuk also stated that taking into account the trends on the PV components market and comprehensive services in this area, as well as the increase in power fees in the long term, it should be assumed that in the near future the payback period will be cut to less than 10 years. The calculation results obtained in this study confirm this hypothesis.

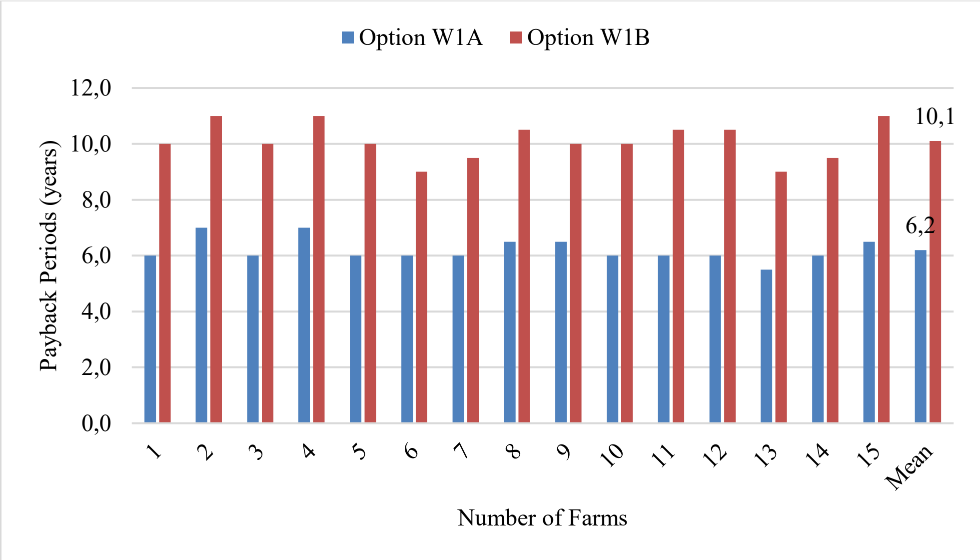

Figure 1. Payback periods for options W1A and W1B (years)

In turn, Soliński and Kała (2017) emphasize that the use of a micro-power installation on a farm without applying for a subsidy is unprofitable. Only the subsidy makes the investment interesting for the prosumer, and the simple payback period is approx. 9 years then.

The results of calculations using Calculator 2, SmartekoDom, for the W2A and W2B options are presented in Table 5. The results are: the proposed size of the installation, the annual power production, the amount of power used for direct consumption and how much power is stored in the grid.

Based on the obtained results, it can be concluded that the installation has a minimum size of 2.77 kWp, and a maximum size of 7.66 kWp (5.14 kWp on average). Annual power production was 4,622.28 kWh on average. The lowest recorded value was 2,399.7 kWh, and the highest 6,823.7 kWh. Power stored in the grid and used for direct consumption amounted to an average of 2,024.9 kWh and 2,597.1 kWh, respectively.

Installation costs and the value of subsidies for the adopted W2A and W2B options are presented in Table 6. Additionally, for comparison, the financial values of power received from the grid and of power used in direct consumption were compared. The minimum installation costs for options W2A and W2B were PLN 13,850, and the maximum cost was PLN 38,300. On average, it was PLN 25,710. On the other hand, the subsidy value ranged from PLN 5,540 to PLN 15,320 (PLN 10,284 on average). In turn, the value of power received from the grid amounted to PLN 1,157.7, and the value of power consumed immediately amounted to an average of PLN 1,431.8.

The profit estimated after deducting investment costs for the adopted 25-year operating period of the installation was varied significantly. Higher profits were characteristic of farms that could receive a 40% subsidy for a PV installation (W2A). The minimum amount in the W2A variant is PLN 20098.3, while the maximum amount is as much as PLN 68,723.5. On average, it was PLN 43,229. The W2B option offers slightly different amounts, ranging from PLN 14,546.5 to PLN 52,750.0. Calculated for 15 farms, it was PLN 33,643.7 on average.

Table 5.
Summary of results for a photovoltaic installation, options W2A and W2B

No.	Proposed size of the installation	Annual electric power production	Power stored in the grid	Power used for direct consumption
	(kWp)	(kWh)	(kWh)	(kWh)
1	6.4	5926.8	3556.1	2370.7
2	4.7	4045.8	1618.3	2427.5
3	6.3	5580.4	2511.2	3069.2
4	5.0	4660.1	2330.1	2330.1
5	3.9	3578.3	1968.1	1610.2
6	4.7	4299.5	1716.8	2579.7
7	6.5	5721.4	1716.4	4005.0
8	4.9	4271.0	1494.9	2776.2
9	3.0	2600.7	780.2	1820.5
10	5.3	4891.3	2690.2	2201.1
11	2.8	2399.7	1223.9	1175.9
12	3.2	2777.0	1249.6	1527.3
13	7.4	6823.7	2047.1	4776.6
14	7.7	6636.1	2654.4	3981.7
15	5.5	5122.4	2817.3	2305.1
Minimum	2.8	2399.7	780.2	1175.9
Mean	5.1	4622.3	2025.0	2597.1
Maximum	7.7	6823.7	3556.1	4776.6
Stand. dev.	1.5	1345.0	710.5	967.5

Table 6.
Cost analysis for W2A and W2B options (PLN)

No.	Installation costs	Value of subsidy	Power received from the grid	Power used for direct consumption	Profit minus investment costs, with subsidy, option W2A	Profit minus investment costs, without subsidy, option W2B
1	32050.0	12820.0	2052.9	1320.6	59907.8	46022.0
2	23350.0	9340.0	922.4	1335.1	37228.5	27888.5
3	31650.0	12660.0	1431.4	1688.1	53795.8	41135.8
4	25200.0	10080.0	1328.1	1281.5	44921.5	34841.5
5	19350.0	7740.0	1121.8	885.6	33375.8	25635.8
6	23250.0	9300.0	980.3	1418.8	40828.3	31528.3
7	32450.0	12980.0	978.4	2202.8	41878.0	41660.3
8	24650.0	9860.0	852.1	1526.9	39484.0	29624.0
9	14750.0	5900.0	444.7	1001.3	22099.0	16199.0
10	26450.0	10580.0	1533.4	1210.6	47530.0	36950.0

No.	Installation costs	Value of subsidy	Power received from the grid	Power used for direct consumption	Profit minus investment costs, with subsidy, option W2A	Profit minus investment costs, without subsidy, option W2B
11	13850.0	5540.0	697.6	646.7	20098.3	14546.5
12	15750.0	6300.0	721.0	840.0	24158.0	17858.0
13	36900.0	14760.0	1181.8	2660.8	68723.5	52750.0
14	38300.0	15320.0	1513.0	2189.9	64393.5	49073.5
15	27700.0	11080.0	1605.9	1267.8	50022.0	38942.0
Minimum	13850.0	5540.0	444.7	646.7	20098.3	14546.5
Mean	25710.0	10284.0	1157.7	1431.8	43229.6	33643.7
Maximum	38300.0	15320.0	2052.9	2660.8	68723.5	52750.0
Stand. dev.	7405.3	2962.1	408.1	536.9	14271.6	11411.3

Please note: Net profit, i.e. return minus investment costs for the 25 year (warranted) life.

Changes in the payback period of investments in PV installations in the 15 researched farms, for options W2A and W2B, respectively, are shown in Figure 2. They were the foundation for determining the average payback period.

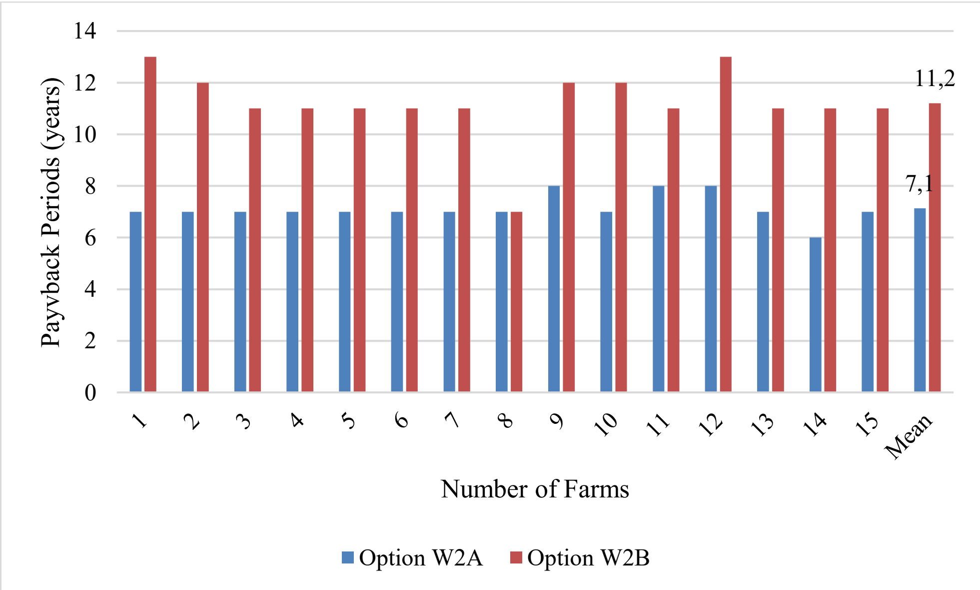

Figure 2. Payback periods for options W2A and W2B (years)

The payback period for the W2A and W2B options differed on average by 4.1 years (W2A - 7.1, W2B - 11.2). The maximum value obtained with the subsidy option is 8 years and the minimum is 6 years. For W2B, the payback period ranged from 7 to 13 years. For comparison, according to Szczerbowski (2013), the subsidy makes investment in a PV micro-installation interesting for the prosumer, and the simple payback period is in this case approx. 7 years. In turn, in the study by Maśnicki and Lisowski (2017), the expected payback period was from 8 to 15 years.

Conclusions

1. The applied PV calculators turned out very helpful tools for the economic analysis of investments in PV installations in selected farms. However, they should be treated only as an advisory and not a decision-making tool.
2. The number of panels estimated using Calculator 1, Hewalex, for options W1A and W1B was 13 pcs on average, and the peak power of the installation was 4.07 kWp on average.
3. Upon comparing the possible profits in the adopted 25-year lifetime of the installation, estimated with the use of Calculator 1, the average amounts are PLN 50,566.6 for the W1A option and PLN 40,937.7 for the W1B option. On the other hand, the payback period for a PV installation investment was from 5.5 to 7 years for the option with 40% subsidy and a 45° slope, and from 9 to 11 years without the subsidy, respectively.
4. The proposed installation size for the W2A and W2B options, according to calculations based on Calculator 2, SmartekoDom, was 5.14 kWp on average. In turn, the annual power production ranges from 2,399.74 to 6,823.73 kWh in the W2A and W2B options.
5. The possible profits within the adopted 25-year lifetime of the installation, estimated with the use of Calculator 2, are PLN 43,229.6 on average for the W2A option and PLN 33,643.7 for the W2B option. The payback period for a PV installation investment was from 6 to 8 years for the option with 40% subsidy and a 45° slope. However, without the subsidy, the period ranged from 7 to even 13 years.
6. Taking into account the analysis results and the shorter payback period, as well as the possibly higher profits for a potential investor in a PV installation for variants W1A and W1B, the use of Calculator 1, Hewalex, can be recommended for the economic analysis. However, please remember that the assumptions and input data play a very important role in this type of calculations.

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ANALIZA EKONOMICZNA MOŻLIWOŚCI ZASTOSOWANIA INSTALACJI FOTOWOLTAICZNEJ W GOSPODARSTWACH ROLNYCH

Streszczenie. Celem pracy była analiza ekonomiczna dotycząca możliwości wykorzystania instalacji fotowoltaicznej w wybranych gospodarstwach rolnych. Analiza została wykonana z wykorzystaniem wybranych dwóch kalkulatorów internetowych PV. Zakres pracy obejmował badania w 15 gospodarstwach położonych na terenie województwa małopolskiego. Okres zwrotu inwestycji w instalację fotowoltaiczną oszacowany z wykorzystaniem kalkulatora 1 – Hewalex wynosił od 5,5 roku do 7 lat dla wariantu z dofinansowaniem 40%. Bez dofinansowania odpowiednio od 9 do 11 lat. Natomiast okres zwrotu inwestycji oszacowany z wykorzystaniem kalkulatora 2 – SmartekDom wynosił od 6 lat do 8 lat dla wariantu z dofinansowaniem 40%. Natomiast bez dofinansowania to okres od 7 do nawet 13 lat.

Słowa kluczowe**:** instalacja fotowoltaiczna, kalkulator PV, dofinansowanie, okres zwrotu