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Prosumer Energy — a Benefit or Loss for Beneficiaries in the Light of the Act on Renewable Sources of Energy

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Abstract

For selected photovoltaic installations generating 3 and 10 kW power, operating in the on-grid system, the amount of electric power that can be generated has been calculated. Next, business analysis has been conducted based on static and dynamic methods, such as: SPBT, PBP, NPV, IRR and CCE. Calculations were made for three options — i.e., the system investment costs are born in their entirety by the investor, or the installation is purchased in the framework of the "Prosument" programme run by the National Fund for Environment Protection and Water Management. As a result of the calculations made it has been found that despite support instruments and attractive purchase prices of the energy generated, the electric power generation is not profitable with the current level of investment expenditure for the construction of such an installation if we take into considerations the running and depreciation costs. Taking advantage of the 40% investment co-financing in the 10 kW "Prosumer" programme will enable only to minimise losses.

Keywords: prosumer energy, photovoltaic micro-installation, renewable energy sources, business analysis.

Introduction

One of the key directions in the development of the electric power market, both worldwide, in Europe and in Poland, can turn out to be going away from the so-called system energy and shifting to local, distributed production; here the main change driver is the behaviour or active energy consumers — the prosumer — with special attention paid to investments into small-scale renewable generation. In Poland the prosumer energy sector is discussed while discussing generation from renewable sources of energy. Renewable sources of energy sources, in compliance with the Energy Policy for Poland until 2030 as adopted by the Polish government, are to constitute 20% of all the energy produced in Poland. At a global scale, it is estimated that prosumers will generate about 10% of supplies but it may vary between regions and the figure can be much higher in some of them. Market participants will themselves decide whether they want to purchase energy from the grid or produce it for their own consumption.

The Act on Renewable Sources of Energy,[1] which is an implementation of the Directive on the use of energy from renewable resources[2] and energy efficiency[3] introduces rules and conditions for running operations in the field of electric power generation from renewable sources of energy as well as specifies mechanisms and instruments supporting the production of electric power from renewable sources of energy. The term "micro-installation" has been defined — i.e., an installation

1. See: Ustawa z dnia 20 lutego 2015 r. o odnawialnych źródłach energii. DzU z 2015 r., poz. 478.
2. See: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (1). Official Journal of the European Union, L 140, Volume 52, 5 June 2009, doi:10.3000/17252555.L_2009.140.eng.
3. See: Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (1). Official Journal of the European Union, L 315, Volume 55, 14 November 2012, doi:10.3000/19770677.L_2012.315.eng.

of renewable energy source of total installed capacity not exceeding 40 kW, connected to the grid (ON-GRID) with nominal voltage lower than 110 kV. In accordance with the provisions of the Act, an entity generating electric power from renewable sources in a micro-installation, who is natural person and does not run a business subject to the Act on free business operations[4], who generates electric power for own consumption, can sell the unused electric power generated by oneself in the micro-installation and feed it into the distribution grid. The generation and sale of electric power from renewable sources of energy does not constitute business operations in the understanding of the Act on free business operations. In compliance with art. 14 of the Act on natural persons income tax, revenue from the sale of electric power from a micro-installation are subject to taxation, therefore when calculating annual revenue from that title one must add 18% of income tax on the energy sold.[5]

Micro-installations connected to the power grid will have to meet the operational and technical requirements specified in art. 7a, para. 1 and 2 of the Energy Law (Law 1997).[6]

The Act determines the method of settlements between the consumer (prosumer) and the energy supplier (seller) as the difference between the amount of electric power collected from the grid and the power fed into the grid in a given half-year period. This settlement is made based on the actual readings of the measuring and settlement devices. The seller is obliged to purchase electric power from newly built installations of the renewable energy source — i.e., from the energy generating entity in its micro-installation at a specified fixed unit price, which in the case of photovoltaic installations amounts to: PLN 0,75 for 1 kWh in installations generating up to 3 kW and PLN 0,65 for 1 kWh for installations generating between 3 and 10 kW respectively.[7] The seller is obliged to buy electric power from a renewable energy installation, as specified above, in the course of the successive 15 years as of the day of commissioning the installation for use.

Provisions of the Act on Renewable Energy create a new, it might seem attractive possibilities for an average energy consumer to lower the electricity bill; it could also constitute a source of the additional revenue from the sale of surplus energy generated. Additionally, the fact that promoting renewable energy systems by the National Fund for Environmental Protection and Water Management (further referred to by its Polish acronym NFOŚiGW) it might be encouraging. In the "Prosument" Programme it introduced support mechanisms for investors who want to purchase a photovoltaic micro-installation. Natural persons can apply for co-financing in the form of a loan write-off in the amount of 40% in 2015 (since 2016 the co-financing will be reduced to 30%). Theloan interest rate has been pre-defined by the Fund at 1%. The amount of the co-financing received gives rise to income tax payment obligation, in the amount of 18% of the amount borrowed. The maximum financing time is 15 years. The subsidy can be used only to cover eligible investment costs (the purchase and assembly of the photovoltaic system).

Despite a number of encouraging actions, the basic condition determining whether one will install a specific energy system remain the economic calculations. The energy analysis cannot be in practice the factor determining the selection of the solution. A prospective user who might want to install a photovoltaic mico-installation should evaluate both the technical and business aspects of every system taken into consideration and chose the very one, which in the perspective of its entire life will be the most advantageous. This is why the objective of this paper was to determine the profitability of mounting some selected photovoltaic installations producing 3 kW or 10 kW, for which the Act guarantees a fixed level or purchase prices of the electric power generated. The scope of this paper will include estimating annual electric power production by the proposed installations, specifying the energy generated surplus that can be sold to the grid by the household (energy consumer) as well as business analyses made based on the static and dynamic methods such as: SPBT, PBP, NPV, IRR and CCE. Calculations were made in three options: the system

4. See: Obwieszczenie Marszałka Sejmu Rzeczypospolitej Polskiej z dnia 24 kwietnia 2013 r. w sprawie ogłoszenia jednolitego tekstu ustawy o swobodzie działalności gospodarczej. DzU z 2013 r., poz. 672 ze zm.

5. See: Ustawa z dnia 26 lipca 1991 r. o podatku dochodowym od osób fizycznych. DzU z 1991 r., nr 80 poz. 350.

6. See: Ustawa z dnia 10 kwietnia 1997 r. — Prawo energetyczne. DzU z 1997 r., nr 54 poz. 348.

7. [In the journal European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). — Ed.]

investment costs are born in their entirety by the investor, or the installation is purchased in the framework of the NFOŚiGW "Prosument" programme and the write-off (redemption) value is 30 or 40% of the investment expenditure.

1 Assumptions for the calculations

Calculations were made for an average agricultural holding from the Małopolska region. According to the data of the Polish Central Statistical Office,[8] unitary use of electric power in the countryside, including the consumption for agricultural production in 2013 amounted to 2 796 kWh/holding. The holdings settled their accounts based on the G11 tariff prices. In the analysed area the grid operator is TAURON Dystrybucja. In compliance to the tariffs for the electric power in 2015, with the assumed electric power consumption, the gross unit price for 1 kW of electric power is PLN 0,58. According to the provisions of Act on Renewable Sources of Energy, in order to obtain the guaranteed price for the sale of surplus electric power generated to the network, a photovoltaic micro-installation of a consumer who is not an entrepreneur, should have the power of 3 kW (gross price for the energy is PLN 0,75) or 3,01 to 10 kW (the energy gross price is PLN 0,65). In relation to the above-said, there are two variants of power to be considered in the calculations (i.e., installation of 3 kW and 10 kW). Next, the amount of energy obtained from photovoltaic modules was calculated for the average multi-annual conditions near Krakow. The energy produced in individual months was calculated by means of software called Selfa kalkulator PV,[9] however, due to the fact the assumed life time of a micro-installation is 25 years, the calculations supposed that the conversion efficiency will decrease by 0,8% per every year of installation operation (Knaga, Nęcka, and Szul 2013). Calculation results have been shown on figure 1.

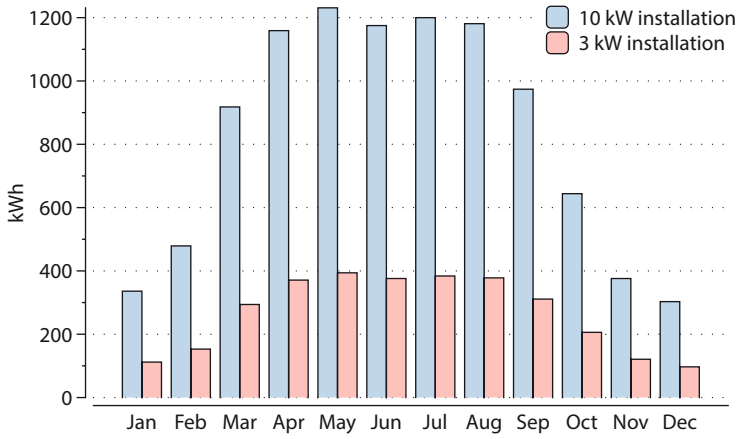

Fig. 1. Electric power generation in 2013

Average annual production of electric power for a 10 kW installation amounts to 8 798 kW, while for a 3 kW installation is is at the level of 2 874 kW. The greatest insolation is in the summer period, from April till September. In these months there is the highest profit from the energy produced. In the remaining months the profits can be even four times smaller. An average agricultural holding with a 10 kW photovoltaic installation can sell about 6 000 kWh per year, while one with a 3 kW installation the annual surplus of electric power generated amounts to just about 80 kWh.

In order to estimate the investment expenditure, a request for quotation was sent to ten companies specialising in the distribution of photovoltaic systems that meet the operational and technical requirements compliant with the provisions of the Energy Law. The question referred to 3 kW and 10 kW micro-systems, including their mounting both on a sloped roof and on the ground. Based on the offers obtained, the investment expenditure was defined as the average value of the proposed

8. Data published in year 2015 at GUS Bank Danych Regionalnych website, [@:] http://stat.gov.pl/bdl/.
9. See: http://www.selfa-pv.com/.

amounts. Investment expenditure can be covered by investor's own means, the investor can also use the co-financing by the NFOŚiGW in the framework of the "Prosument" programme. In this case two thresholds for the redemption of the preferential loan were assumed to be 40% and 30% for 2015 and 2016 respectively. Taking into consideration the interest on the loan, the financing time up of to 15 years and the fact that one has to pay income tax on the subsidy obtained (18%), the actual subsidy was calculated. It amounts to 28% (with the assumed redemption of 40%) and 19% (with the redemption of 30%).

Apart from the costs of the installation's assembly, every investor finds operating (running) costs important: these are service or maintenance costs. We took into consideration also the costs of the installation insurance. It was assumed that these costs will constitute 1.5% of investment expenditure annually. Nevertheless an important cost, frequently omitted in calculations, is the depreciation of the photovoltaic micro-generator. Our assumptions talk about straight-line depreciation spread over 25 years. Individual power variants and the methods of investment financing have been labelled as follows:

- $PV3$ — 3 kW photovoltaic micro-installation financed entirely by the investor's own funds
- $PV3_{d40}$ — 3 kW photovoltaic micro-installation purchased in the framework of the "Prosument" programme with a 40% loan write-off
- $PV3_{d30}$ — 3 kW photovoltaic micro-installation purchased in the framework of the "Prosument" programme with a 30% loan write-off
- $PV10$ — 10 kW photovoltaic micro-installation financed entirely by the investor's own funds
- $PV10_{d40}$ — 10 kW photovoltaic micro-installation purchased in the framework of the "Prosument" programme with a 40% loan write-off
- $PV10_{d30}$ — 10 kW photovoltaic micro-installation purchased in the framework of the "Prosument" programme with a 30% loan write-off

The business assumptions for the calculations, together with the estimated annual benefit value (labelled here as WRK) flowing from the use of the photovoltaic micro-installation have been presented in table 1. Depending on the installed capacity of the photovoltaic micro-power plant, the user can obtain financial benefit in the amount of about PLN 660 per year with a 3 kW system, while in the case of a 10 kW system the figure is PLN 2 130 per year.

Tab. 1. Basic assumptions for business calculations (in PLN)

	Power variants					
Specification	***PV3***	***PV3$_{d40}$***	***PV3$_{d30}$***	***PV10***	***PV10$_{d40}$***	***PV10$_{d30}$***
NI — investment expenditure	18 800	13 500	15 200	50 900	40 100	45 200
n — total number of years in operation	25 years					
o — costs of servicing, maintenance/ repairs and insurance, 1,5% of investment costs (annually)	280			760		
a — photovoltaic installation depreciation	750			2 030		
(gross) unit price of energy according to the operator's tariff	electric power, tariff G11 (0,58 per Wh), electric power purchase price by the supplier: – from a 3 kW micro-installation (0,75 per kWh) – from a 3,01–10 kW micro-installation (0,65 per kWh)					
i — discount rate	3%					
Pb — annual revenue on energy sale (including the avoided costs of electric power purchase) before taxation	1 770			5 640		
Z — annual profit on energy sale after taxation	1 690			4 920		
Ke,o — annual installation operating costs ($o + a$)	1 030			2 790		
WRK — annual benefits value ($Z - Ke,o$)	660			2 130		

2 Ratio for business evaluation of photovoltaic micro-installations

The choice of a specific system should be based on objective selection criteria. It is commonly believed that such a criterion is the surplus of effects (advantages) over expenditure (Bartnik and Bartnik 2014; Bławat 2001). Business analysis was made on the basis of simple and complex methods for material investment evaluation, based on the interest (discount) rate and taking into account the time value of money.

These methods are (Bartnik and Bartnik 2014; Bławat 2001):

- SPBT (simple pay-back period) — the quotient of investment expenditure and the total value of savings (benefits)

$$\text{SPBT} = \frac{\text{NI}}{\text{WRK}} [\text{years}] \tag{1}$$

- discounted period of expenditure return, the PBP (pay-back period) — a period in which the discounted cash flow covers the incurred investment expenditure; the pay-back period takes into consideration the variable value of the invested amount in time

$$\text{PBP} = \frac{\ln\left(\frac{1}{1 - \frac{\text{NI}}{\text{WRK}} \cdot i}\right)}{\ln(1+i)} [\text{years}] \tag{2}$$

- the undertaking's NPV (net present value) — this is a sum of all future revenue for the life cycle of the investment calculated for the present year and reduced by the incurred investment expenditure

$$\text{NPV} = \sum_{n=1}^{n=t} \frac{\text{WRK}_n}{(1+i)^n} - \text{NI} \text{ [in thousands of PLN]} \tag{3}$$

- internal rate of return of the investment expenditure, the IRR (Internal Rate of Return) — this is such a value of the discount rate, for which the net present value (NPV) equals zero. A profitability condition of for investment is meeting the following criterion: IRR $> i$

$$\sum_{n=1}^{n=t} \frac{\text{WRK}_n}{(1+\text{IRR})^n} - \text{NI} = 0 \tag{4}$$

- the CCE (Cost of Conserved Energy) — if the cost of the conserved energy is smaller or equal to the price paid for the energy, there are premises for the investment to be profitable

$$\text{CCE} = \frac{\text{NI} \cdot \frac{i}{1-(1+i)^{-n}} + Ke,o}{\Delta E} [\text{PLN/kWh}], \tag{5}$$

where:

NI — initial costs (the cost of installation purchase and launching its operations) (in thousands of PLN)
Ke,o — annual installation operational costs (servicing/maintenance, insurance and depreciation of the installation)
t — successive year of the installation operation
i — discount rate
n — (range from 1 to 25) successive cost year ($n = 25$ the assumed number of years of the installation life cycle)
WRK — annual benefits value (in thousands of PLN)
ΔE — annual energy conservation (in kWh)

3 Analysis of the test results and conclusions

The calculations made based on the business evaluation ratios have made it possible to define the rationalisation of investing in photovoltaic micro-installations for holdings who would like, additionally, to sell to the grid the surplus of energy produced by them. The results of the business analyses made for individual options have been shown in table 2. Analysing the results obtained one can come to the conclusion that an investment in a photovoltaic micro-installation operating in the on-grid system is economically unjustified and unprofitable. This is confirmed by the values of all business ratios.

Tab. 2. Results of business analysis for specific options

	Power variants					
Specification	***PV3***	***PV3$_{d40}$***	***PV3$_{d30}$***	***PV10***	***PV10$_{d40}$***	***PV10$_{d30}$***
SPBT (years)	29	21	23	24	19	21
SPBT (years)	65	32	41	43	28	34
NPV (PLN)	−7 300	−2 000	−3 700	−13 800	−3 100	−8 100
IRR (%)	–	1,61	0,64	0,35	2,31	1,3
CCE (PLN/kWh)	0,74	0,63	0,66	0,64	0,58	0,6

The investment of own funds for the purchase and mounting of such generators, depending on the installed capacity (3 or 10 kW) will altogether result in a loss of about PLN 7 000 to PLN 14 000. Taking into consideration the change of money value in time, the return period for the expenditure incurred would be about 43 years (10 kW) up to 65 years (3 kW). Also the cost of the energy conserved, which would amount from 0,64 to 0,74 PLN/kwh is much higher than the purchase price of energy in the G11 tariff. If the investor takes advantage of the "Prosument" programme by National Environmental Protection Fund and takes a preferential loan to finance the investment, there will still be a loss of about PLN 3 thousand (for 10 kW), even with 40% investment expenditure write-off. The return on the funds invested exceeds the assumed 25 of the system's operation. The cost of the energy conserved in the case of the 40% co-financing of the investment for 10 kW is equal to the purchase price of electric power from the grid. This shows that also here there are no premises to endorse the profitability of such a solution. The financing amounting to 30% as proposed by the NFOSiGW in the form of a write-off of the preferential loan after 2016 is not at all able to compensate the losses that a prospective investor might incur due to the operation of his/her photovoltaic micro-installation. The purchase price guaranteed for the electric power, promoted in the Act on Renewable Energy and amounting to the gross amount of 0,75 PLN/kWh for 3 kW installation in the context of the business analysed made, even with the maximum subsidy from the NFOŚiGW will bring the investor the highest losses. All business ratios show that the 3 kW photovoltaic system should not be taken into consideration at all in any investment plans of persons who are planning a photo-voltaic micro-power plant.

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