

# THE EXPERIENCES OF THE REALIZATION OF PV POWER PLANTS AFTER IMPLEMENTATION OF THE PROSUMERS STATUS

## ISKUSTVA REALIZACIJE FOTONAPONSKIH ELEKTRANA NAKON UVOĐENJA STATUSA KUPAC-PROIZVOĐAČ

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### ABSTRACT

*The amendment of the Law on Energy and the adoption of the new Law on Renewable Energy Sources enabled a sudden increase in the installed capacity of photovoltaic (PV) power plants in the Republic of Serbia in 2022. Thanks to the new modality called prosumers, interest in the construction of PV power plants has increased, both with households and with commercial entities. The general situation in the world, crises, pandemics and wars have caused a drastic increase in the price of energy products, and therefore electricity. To contribute to the reduction of the negative impact of climate change, it is an ideal opportunity to use the production of electricity from one's own power plant to compensate for an increased cost of energy. The most affordable and simplest is the construction of the PV power plant because solar energy reaches every roof. This paper describes the possibilities of building PV power plants in the status of prosumers from the technical and legal aspects. In addition to examples from practice, the current state of installed capacities of PV power plants in the Republic of Serbia in the status of prosumers is given.*

**Keywords:** photovoltaic power plants; prosumers status; agriculture.

### REZIME

*Izmena Zakona o energetici i donošenjem novog Zakona o Obnovljivim izvorima energije omogućilo je nagli porast instalisanih kapaciteta fotonaponskih (FN) elektrana u Republici Srbiji u 2022. godini. Zahvaljujući novom modalitetu koji je nazvan kupac-proizvođač, pojačan je interes za gradnju FN elektrana, kako od strane domaćinstava, tako i od privrednih subjekata. Opšte stanje u svetu, krize, pandemije i ratovi su prouzrokovali drastično povećanje cene energenata, pa samim tim i električne energije. Za doprinos smanjenju negativnog uticaja klimatskih promena, idealna je prilika da se za kompenzaciju povećanih troškova za energente iskoristi proizvodnja električne energije iz sopstvene elektrane. Najpristupačnije i najjednostavnije je izgradnja FN elektrane, jer sunčeva energija dopire do svakog krova. U radu se opisuju mogućnosti izgradnje FN elektrana u statusu kupca-proizvođača sa tehničkog i pravnog aspekta. Pored primera iz prakse dat je i presek trenutnog stanja instalisanih kapaciteta FN elektrana u Republici Srbiji u statusu ukupca-proizvođača.*

**Ključne reči:** fotonaponske elektrane; status kupac-proizvođač; poljoprivreda.

### INTRODUCTION

In the close period after the Law on Energy has been changed and the Decree on privileged power producers (renewable energy sources), between 2010. and 2016., approximately 10 MW of PV power plants had been built (Ministry of Mining and Energy). Since the decree has limited the quotation for the privileged power producer status to exactly the same amount (10 MW), and was therefore filled further interest in the installation of PV power plants somewhat died out. The Decree was still in effect, but without a new quotation, it was ineffective in securing further interest from investors in this market, since effectively this meant that there were no incentive measures for solar energy. Additionally, between 2016. and 2021. with no measures and lower feed-in rates in general, the investment in PV power plants became unjustifiable (unprofitable). A similar situation can be noticed for the wind power plants as well, but with a much higher quote, it was less obvious. On the other hand, biogas facilities do not have the quote limitation and the investment in that area practically continued.

The majority of the investors have been patiently waiting for new legislation in order to start investing in photovoltaic (PV) power plants. After the long wait, when political conditions have been met and new concepts of incentive measures have been agreed upon, the wait was over. In 2021. the new Law on the use of renewable energy sources has been adopted and the

appropriate Law on energy was changed. The change in legislation prompted the alteration of other laws, decrees, procedures and methods for different subjects not only within the power industry but also within the local administration responsible for issuing the appropriate permits.

### MATERIAL

The Republic of Serbia is a country in the southeast of the continent, meaning that compared to most other European countries it has better solar potential. With moderately continental climate conditions and more than 2000 sunlight hours per year, available PV technology and positive legislation all proper conditions have been met for maximal utilization of solar energy.

The irradiance conditions  $G_{\text{hglobal}}$  in the Republic of Serbia, during a clear day, range from  $400 \text{ W/m}^2$  in the winter up to  $1000 \text{ W/m}^2$  in a summer day. Figure 1 shows a daily variation of solar irradiation for a typical meteorological year (TMY). Total yearly global radiation for the horizontal plane in Serbia ranges from  $1200 \text{ kWh/m}^2$  and  $1500 \text{ kWh/m}^2$ , based on the PVGIS estimate (PVGIS Online Tool). This amount of solar energy makes the specific system production range from  $1100 \text{ kWh/Wp}$  to  $1300 \text{ kWh/kWp}$ . This amount will vary depending on the micro-location, type of the system (roof or ground), orientation (elevation and azimuth angles) and average losses in the system, not considering the shading.

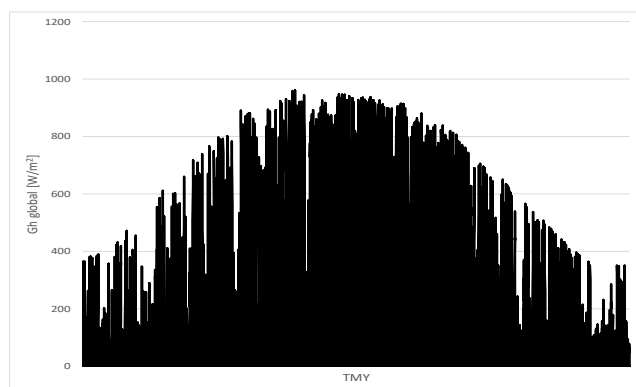


Fig. 1. Global horizontal irradiance

Together with solar irradiation, the power generation from the PV power plant system will be significantly influenced by air temperature, wind and precipitation.

The improved Law on energy and the new Law on the use of renewable energy sources modified the incentive measures in regard to previous legislation. The types of incentives were designed as market premiums (through an auction system) and feed-in tariffs, while the photovoltaic systems also saw an introduction of the prosumer status.

New law for the first time defines energy production or self-consumption, called the prosumer status, where previously passive power consumers become active members in the energy market with the possibility of energy management based on the available production and consumption (*Ministry of Mining and Energy*). This particular incentive has made it possible to have a massive installation of PV power plants in households, industries and agricultural subjects. Almost simultaneously, the Republic of Serbia has made it possible to have a 50 % subsidy for the PV power plant of 6 kW for households (*Ministry of Mining and Energy*).

Law on the use of renewable energy sources defines the prosumer status as an end-buyer who has connected their own facility for generating electricity from renewable energy sources to the internal installations, where the generated electricity is used for own consumption, and the surplus generated electricity is delivered to the transmission system, distribution system or closed distribution system. When calculating the energy, net metering is defined to be applied to households and net calculation is applied to all other final consumers (Čorba et al., 2022).

Activities, in order to obtain the prosumer status, are defined by the power company (distribution company) of Serbia and are considered in two distinct groups:

- Households with direct measurements and objects that are not households and residential communities with installed power up to 10,8 kW (Elektro distribucija Srbije1),
- objects that are not household and residential communities with installed power from 10,8 kW up to 50 kW (Elektro distribucija Srbije2).

These two categories, unlike previously, do not have the obligation to acquire the permits from the local administration, but it is enough to just address the distribution network operator and electrical power industry of Serbia.

For the installed power is higher than 50 kW for the subject that aims at becoming a prosumer the procedure is unchanged, where investors address both the distribution network operator and local administration.

From a technological standpoint, the connection of both 50 kW power plants up to 160 kW power plants is simple. The power plant is connected to the internal electrical energy

distribution (cabinet) of the consumer, with a designated power plant cabinet.

The power plant distribution cabinet in general has the following equipment:

- disconnecting circuit breaker (main circuit breaker)
- protective relay to ensure system and islanding protection triggering the main circuit breaker,
- overcurrent and short-circuit protection for the PV power plant 0.4 kV cable and inner installation of the system
- residual current device for single-phase short circuit protection
- surge protection.

All elements of the PV power plant need to be in accordance with SRPS EN 50160:2012 which defines the quality of electrical energy and SRPS EN 50549-1:2020 which defines the requirements for parallel connection of generating units to the distribution system of electrical energy.

## DISCUSSION

The comparative analysis of the developed project in prosumer status, for household and agricultural subjects will be presented. Net metering for households meant that the surplus of the delivered quantity of electrical energy within the month will reduce the net measurement of electrical energy during the following month. The net calculation that is reserved for industry subjects means that the surplus of the delivered quantity of electrical energy is calculated within one month and charged based on the contract between the prosumer and guaranteed supplier.

The exemplary household within the manuscript has a higher-than-average consumption in regard to the national average in the Republic of Serbia. This is due to the heating system that constitutes the heat pump heating and ventilation system, reaching yearly energy consumption of 12398 kWh. The monthly average achieved 1033,2 kWh, while the new prosumer status offered the possibility of financial benefits since the heat pump consumption is usually in the winter months when PV system production is the lowest.

Due to net calculation, done every 12 months, it is necessary to keep the consumption and production balanced. All energy surplus is lost after the final calculation; thus, it is important to estimate the possible installed power of the power plant as best as possible, considering the PV panel number and orientation. The specific example considers 10,7 kWp, roof orientation (with panels) is -20° azimuth and elevation angle of 7°.

The consumption of the household, the estimated production of the PV power plant and the monthly net energy are shown in Figure 2. The estimated production of the PV system is set at 12042 kWh, with a clear and significant surplus in the period of May – September. This surplus of 4766 kWh energy is delivered to the electricity distribution system to be used later within winter months when the consumption is higher. Therefore, by summarizing the energy balances between the household and the PV system, one can observe that the PV system of 10,7 kWp will produce an annual surplus of 356 kWh of electrical energy in total.

The example of agricultural prosumer status is presented for a pig farm in Vojvodina with an installed power of 150 kW. The estimated production for this powerplant annually is 211,9 MWh. Monthly production and consumption (in the higher tariff - HT) is shown in Figure 3. Total consumption in the higher tariff is 819,8 MWh, while the complete energy needed for the farm annually is 1165,8 MWh.

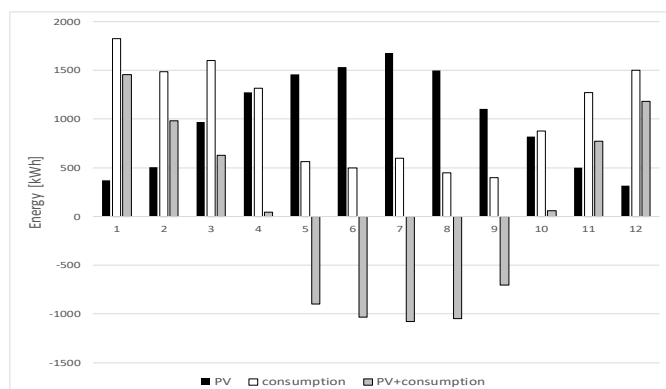


Fig. 2. Energy balance for household

Considering only HT consumption, even with the PV power plant the farm will still need 607,9 MWh of electrical energy. If total consumption is considered, the required part of the energy would increase to the 954 MWh approximately.

Figure 3 shows the balance of electrical energy, considering HT, where it is clear that a PV power plant with the installed power of 150 kW would not have surplus energy provided to the DSEE.

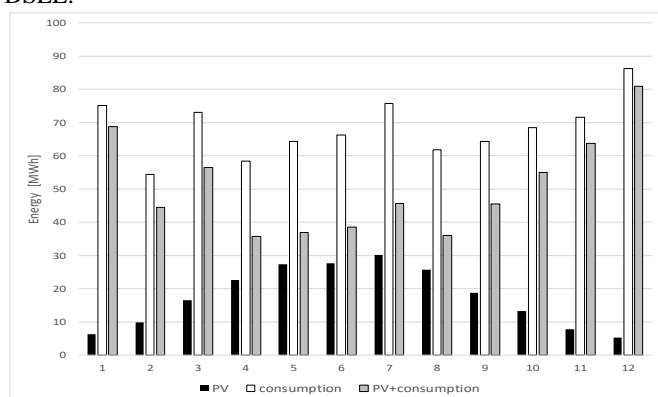


Fig. 3. Energy balance for livestock farm

## CONCLUSION

The previously untapped potential of solar energy in the Republic of Serbia can now be utilized by the widest variety of people, although, truth be told, due to the system's inertial and different interpretation of the legislation there are some inconsistencies and hurdles for full utilization. For example, for PV power plants with the installed power of more than 150 kW the cost of connection is increasing significantly, making the systems up to 500 kW practically unprofitable. However, even with some obstacles already after one year the new incentives have been proven effective.

In order to achieve the full effects of the prosumer status, the most important thing in the long term is the balance between consumption and the production of electrical energy. This is

easily achieved for households, where the available roof surface is sufficient for the installation of the PV system capable of covering the consumption. With industrial subjects, the consumption is usually much higher than the production of the PV system since the rooftop surface is not sufficient for the necessary power plant capacity.

With all the things considered, since the prosumer status was introduced, by the end of February of 2023, in the Republic of Serbia there were 6185,4 kWp of PV power plants installed for the households, while non-households installed 5340,3 kWp in total. Consequently, in little over a year, the total installed capacity of PV power plants in prosumers status surpassed the capacity of privileged producer status power plants in the last ten years.

Now, it can be concluded that in a few years, the Republic of Serbia will join European countries that utilize renewable energy resources abundantly. Together with the PV power plants with lower installed power in the prosumer status, the installation of larger PV power plants, wind power plants and continuous installation of biogas power plants is planned.

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