The Use of Photovoltaic Technology in Albania

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Abstract

Over the past decade, technological advances have led to the development of more economically feasible photovoltaic systems. These systems are ideal for areas where there is no electricity. Due to growing environmental concerns, new energy sources have been developed that are more sustainable and economically feasible. This means that photovoltaic energy will play a vital role in the production of electricity in industry. The purpose of this study is to understand more about the use of photovoltaic energy in Albania, the installation costs of a photovoltaic energy production system, are these systems assembled and installed according to the IEC 62116 standard. The objective of this study is to identify the models of photovoltaic energy systems that

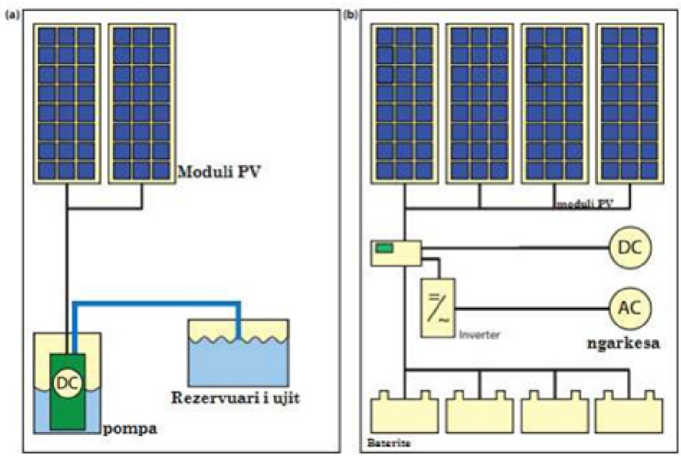
are marketed in Albania, if these systems are according to the European standard IEC 62116, to show the types and installation costs of these systems as well as to understand the amount of annual energy generated by a photovoltaic system that is used in Albania. The methodology used in this study is that of a qualitative and quantitative descriptive research. Descriptive research includes surveys and fact-finding investigations of various kinds. We used the qualitative description when we talked about the types of systems, when we talked about the use of PV systems in Albania, but also when we talked about the use of systems according to the European standard IEC 62116. We used the quantitative description when we calculated the costs of installing the PV system in Albania but, and along the calculation of the amount of annual energy generated by a PV system that is used in Albania.

Keywords: *Photovoltaic (PV) systems, Photovoltaic inverters, Active method, Passive method, Utility level methods, IEC 62116.*

Types of PV systems

A simple PV system consists of a single module and a load. For example, in this case, we are getting the energy needed to run a water pump, which only works when the sun is shining.

FIGURE 1*:* A brief introduction to a DC-to-PV system powering a water pump. b) A more complicated system, including batteries and charging in AC and DC "Planning and installation of PV generation"



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A home that requires energy must have a functional PV system that runs day and night. It can also provide backup power, which can be used to supplement AC and DC loads. Before we talk about the different types of PV systems, let's first discuss their configuration. An off-grid PV system can operate smoothly and provide power even when it is not connected to the electricity distribution network. Sometimes, a battery is required to store the energy the panels produce. A standard ON-GRID system connects the inverter to the electricity distribution network. This type of system requires batteries as excess energy from the panels is used to generate electricity to the grid, which then activates the energy meter in the other direction. This type of system works as long as it is connected to the network. It is simple to install and has a lower cost.

FIGURE 2: Presentation of an ON GRID system "Planning and installation of PV generation"

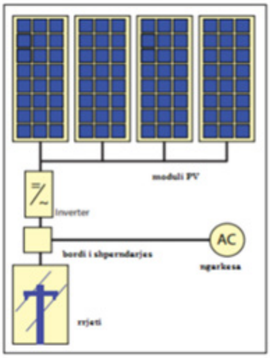

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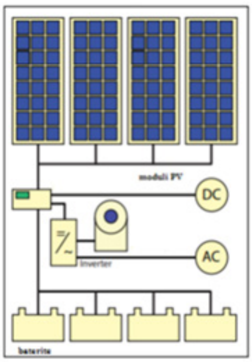
FIGURE 3: Presentation of a HYBRID system "Planning and installation of PV generation"



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A hybrid system consists of a battery and a photovoltaic panel and requires a connection to the grid. Excess power from the panels is then stored in batteries and once they are fully charged, the remaining power is transferred to the grid.

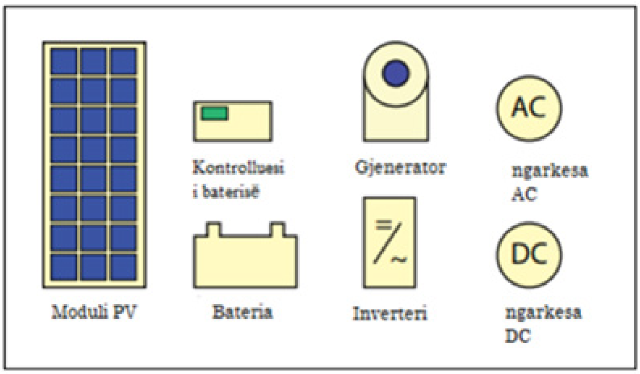
Although the basic elements of photovoltaic systems remain the same, they can be modified to meet specific requirements.

Components of a PV system

A solar cell can convert the energy it produces into electricity. Since it can handle a limited amount of power, it can be used for devices that require fixed current or voltage conditions. To make solar panels, several solar cells must be connected. Although solar panels are the main components of a PV system, other parts are also needed to operate it. These are referred to as Balance of System components and are located in the system we use. Some of these components are part of the ON Grid system, while others are part of the Off Grid system. The most important components of BOS (Balance Of System) are:

1. ***Rising structure*** - used to adjust the direction of the module so that it is directed by the sun.
2. ***Energy storage (battery)*** - is an important part of the OFF Grid system because it enables energy supply at night.
3. ***DC-DC converter*** - used to convert the output of the module, which will have a different voltage depending on the time, day, and weather conditions.
4. ***DC-AC inverter*** - used to convert DC to AC which can then feed the grid.
5. ***Cables*** - connect components (thickness should be sufficient to avoid losses).

FIGURE 4: A schematic representation of the components of a PV system "Planning and installing PV generation"



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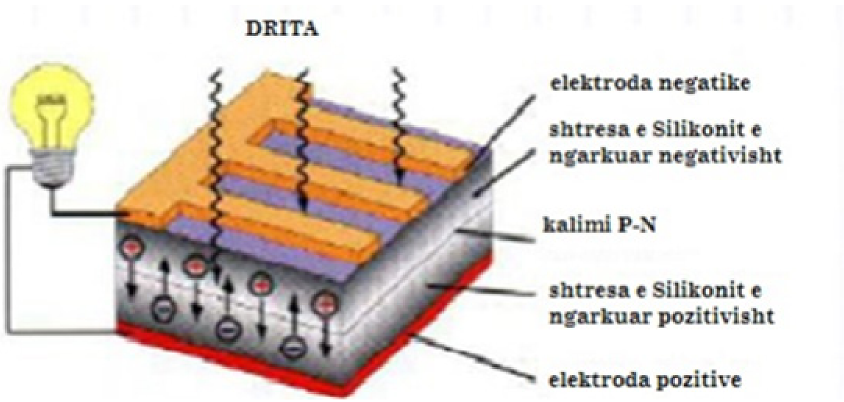
Types of panels and their characteristics

Design and operation of a crystalline silicon solar cell

A solar cell consists of two layers of silicon, both of which are charged. One of them faces the sun and the other is made of phosphorus. The bottom layer is made of boron and is also positively charged. An electric current is then created between the two layers. Through this field, electrons can be created in the layers of a solar cell. Conductors are then connected to both layers to receive energy from the sun. The contact layer, which is made of aluminum, is placed at the bottom. An anti-reflective coating is then added to the top layer. The top layer of a solar cell is designed to absorb as much radiation as possible. This layer has the characteristics of a structure or network. When light hits a solar cell, it creates an electric field by separating holes and electrons. If the two layers are connected, then an electric current can be generated.

FIGURE 5: Schematic representation of the parts of a solar cell "Solar Energy, Fundamentals, Technology, and Systems"



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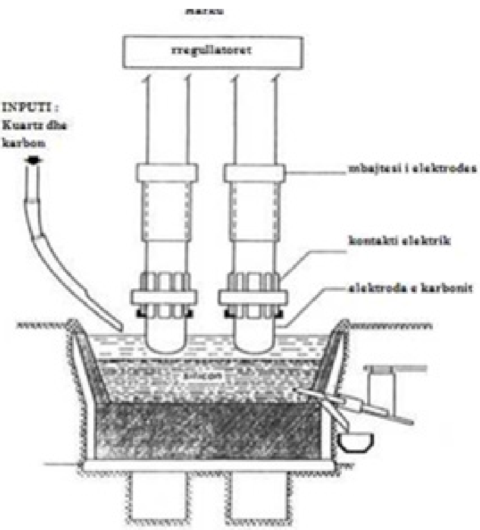
The energy loss experienced by solar cells is due to reflection and shadows. For example, the energy balance of a solar cell is shown below. Most of the energy loss is caused by reflections and shadows. Shortwave radiation causes the production of high-energy photons. Recombination losses are 8%, 20%, and 5%. Also, there are losses in ohmic resistances, which are about 0.5%.

Crystalline silicon

When it comes to solar cells, crystalline silicon is the most important element. It is abundant on Earth and is second only to oxygen in terms of its abundance. Although silicon can be impure, it can be found in mixtures of chemical compounds such as sand or quartz. The first step in separating the unwanted oxygen from the compound known as silicon dioxide is combining quartz with carbon dioxide and coke. This mixture, which is then subjected to an electric arc furnace, produces a type of pure silicon known as metallurgical silicon. In addition to being used in solar cells, raw silicon can also be used in chemical processes to make other electronic components. When mixed with hydrogen chloride, it forms trichlorosilane and hydrogen chloride, which boil at 310 degrees Celsius. In the initial stages, the liquid is distilled to produce a level of impurities required for its manufacture. The process that enables the production of trichlorosilane and hydrogen from water is called the SIEMENS process. It involves throwing both gases into a reactor, where they will be exposed to high temperatures.

FIGURE 6: Schematic representation of the silicon extraction process from quartz and carbon, "Springer Series in Photonics"



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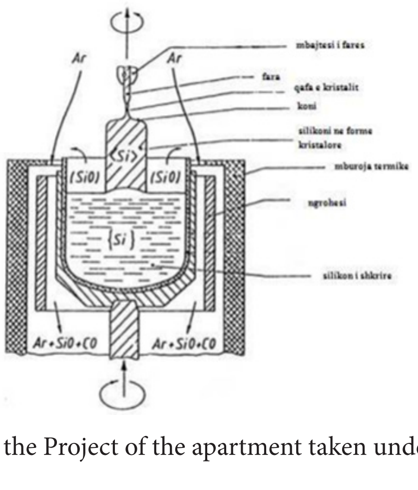
This process produces polycrystalline silicon, which is commonly called polysilicon. The diameter of the rods can be increased from 10 to 15 centimeters. These are then broken into pieces to form mirrors, which are used in solar cells.

Monocrystalline panels - silicon

For a long time, monocrystalline panels have been the standard for electricity generation. These are very efficient and can be distinguished from other types by their color. Each module consists of a single silicon crystal, which makes them easy to identify. The manufacturing process of monocrystalline panels is similar to that of other types of panels. It involves the use of a certain method known as Czochralski, which allows the production of pure silicon crystals. This is useful for semiconductor manufacturing. The origins of the Czochralski method can be traced back to 1915 when a Polish scientist named Jan Czochralski discovered it while studying the crystallization of various metals. In this process, an entire silicon crystal is placed inside a molten silicon reservoir. The initial crystal is then spun and removed, and a small amount of Boron is then introduced into the process. This process then produces a round silicon rod, which is filled with pure silicon. The lines on the rod are then wound and placed in a fire to ignite them after the phosphorus gas is released. The phosphorus atoms then enter the silicon, which is a more porous material due to its proximity to becoming a liquid. The time and temperature are controlled by the outside temperature.

FIGURE 7: Schematic representation of the CZOCHRALSKI process, "Springer Series in Photonics"



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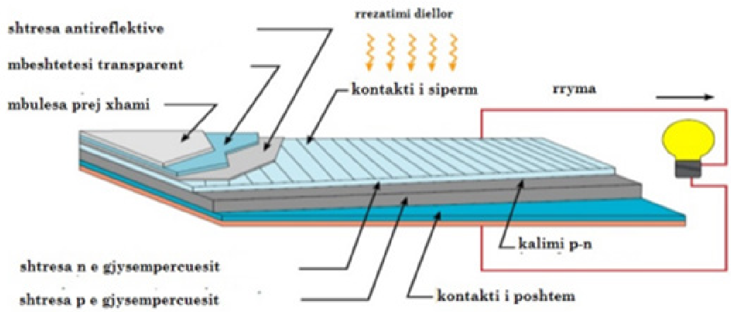
Construction and operation of monocrystalline

We have previously explained how we obtained pure silicon through the Czochracski process. After that, various steps are taken to produce monocrystalline solar cells. These cells are then connected and provide a ready-made photovoltaic panel.

FIGURE 8: Representation of the component layers of a monocrystalline panel



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To move from semiconductors to panels, we need to understand how light falls on the mirror of a panel. When this happens, the electrons in the semiconductor are excited, which makes it possible for Levizin to create an electron-hole pair. The electric field between the two semiconductor layers is shown in Figure 8. This allows electrons to move over the wires that are connected to the two semiconductors. This process then generates an electric current. This is why we switch from solar to electric.

Global formula for calculating the energy generated by a PV system

The global formula for calculating the energy generated by a PV system is:

E – Energy (kWh)
A – total area of the panel (m2)
r – panel production efficiency (%)
H – average annual solar radiation on the panel (not including shadows)
PR – performance ratio, loss ratio (range between 0.5 and 0.9, selected value 0.75)

Let's explain each in turn. R is the output of a solar panel, which is given by the ratio of the electrical energy (in kEp) of a single panel divided by the others. ¨

Example:

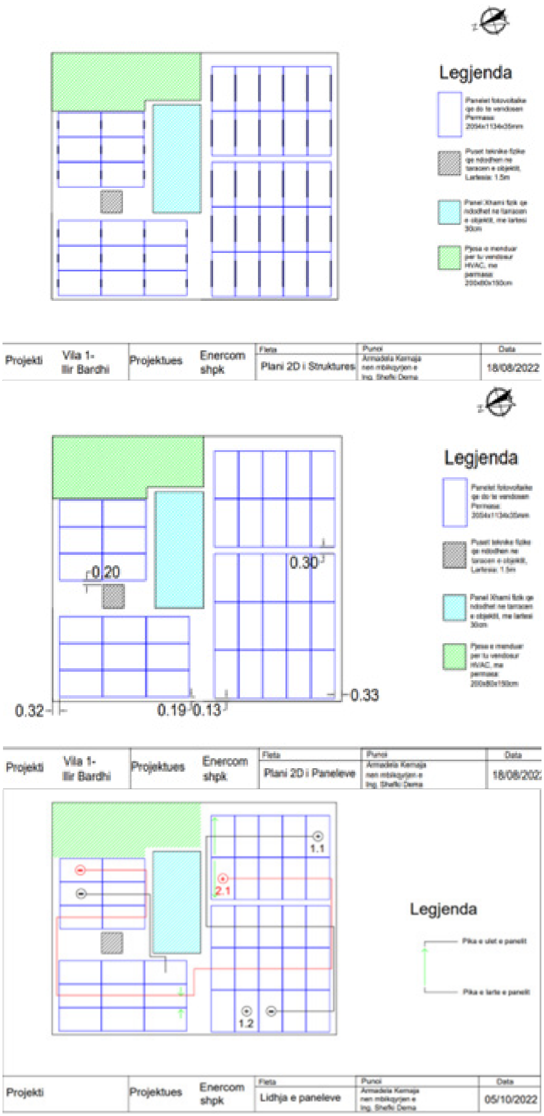
The output of a PV module, with 250 Wp, with an area of 1.6m2, is 15.6% (this ratio is provided by STC). Radiation = 100¨e/m2; Cell temperature = 250C; Wind speed = 1m/s; AM=1.5; . The combination of the nominal power of this panel under these conditions is called WATT PEAK Wp or kWp=1000Wp or MEp = 1000000Wp; As we said above, H is the average annual solar radiation on the panels. It has a value between 200 kWh/m2 in Norway and 2600 kW in Saudi

Arabia. The performance ratio is a very important value to evaluate the quality of a PV installation because it performs an installation independent of orientation. Includes all losses.

Electricity calculation

We have considered a terrace area of a villa as in the figure below.

FIGURE 9: Schematic representation of a villa



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We have taken into account the various household appliances located in the apartment above. The labels on these devices show the power value P (Watt). We then determine the usage time of these devices by measuring how long they have been plugged in. We are interested in learning how much energy they consume per day or month. A relationship can be established by considering the usage time and power of different household appliances. Then we calculate the energy consumed by these devices.

E = P xt(kW h)(10)

Table 1 shows how much energy a household appliance with power P(W) consumes for a time of use (hours). In the table below, we have presented the daily, monthly, and annual consumption of household appliances, and at the end, we have calculated the total for each. For the following calculations, we used the following formulas: (daily consumption) E = P tx(3.2) (monthly consumption) E(month) = Ex30 = (P tx)x30(3.3) (annual consumption) E(year) = E (month)x12.

TABLE 1 : how much energy a household appliance with power P(W) consumes for a time of use

Appliance	Power Rating	Hours per Day	Common Power Use in a Day	Percentage of Power for the Day
Split System Air Con	1200W	6	6 kWh	18.0%
Pool Pump	1100W	8	8.8 kWh	26.5%
Electric Hot Water	3600W	1.5	5.4 kWh	16.2%
Electric Cooktop	2400W/element	1	4.8 kWh	14.4%
Fridge	150W	12	1.8 kWh	5.4%
Toaster	900W	0.2	0.18 kWh	0.5%
Microwave	1200W	0.2	0.24 kWh	0.7%
Kettle	2400W	0.2	0.48 kWh	1.4%
TV	200W	5	1.0 kWh	3.0%
Sound System	60W	4	0.24 kWh	0.7%
Phone Chargers	15W x 2	5	0.15 kWh	0.5%
Laptop	100W	2	0.2 kWh	0.6%
Combined Lighting	130W (LED)	5	0.65 kWh	2.0%
Bathroom Fan	60W	0.5	0.03 kWh	0.1%
Washing Machine	2400W	4 hrs / week	1.37 kWh	4.1%
Standby Appliances	120W	16	1.92 kWh	5.8%
TOTAL			**33.3 kWh per Day**	

Mounting a PV system on a terrace surface

In total, this apartment for a year consumes 979.41 kW of electricity per month, at a cost of approximately 9800 ALL (per month/year). The process of setting up a utility-scale solar system begins with designing the site where the plant will be located. After that, the terrain where the plant will be erected was analyzed. The calculation of the efficiency of the plant is carried out after the consumption of the customer has been determined.

FIGURE 10: Schematic representation of the method of placing panels, inverters, controllers, and electrical boxes in a house, "SolarON"

To produce a plant with a total area of 75.95 square meters, a total of 28 solar panels and an inverter with a capacity of 7.0 kWp are needed. These products will be used in a project that is online. Other components that will be needed include a metal structure with a multi-angle 30 regulator and an MC4 connector. The excess energy produced by the consumer is fed into the system and used at night and during days when the weather conditions are unfavorable. Data collected by the Data Logger will be used to monitor energy production. If the customer has a Fronius inverter, then the Data Logger will also be able to control the energy production. The control method for this system is similar to a regular monitoring page. The area required for this project is 60.4 square meters. Due to the structure used, the plant will take up more space. The cost of this system is 8600 euros. The products used for this project have different performance guarantees. For example, the panels come with a 15-year warranty and a 25-year warranty. The metal structure has a 5-year warranty and a 12-year warranty. In case we have an off-grid system, the plant will have to have a capacity of 7.55 kW. The 28 solar panels that are being used for this project are from the German company Luxor. Other products being used include a metal structure 30 with many angles, a battery, and a regulator. The battery calculation shows that they are only half used, which voids their warranty. For example, the panels and battery have a 15-year and 25-year warranty, respectively. On the other hand, the inverter battery has a 5-year warranty. High battery costs are the main reasons why off-grid systems are not ideal for large plants. This type of system can be very expensive to install, especially when the facilities are not connected to the grid and there is no other means of power supply.

Why should we make such an investment?

The monthly electricity consumption is equal to a cost of 1000 ALL. We will then compare this to the energy generated by the panels over the year.

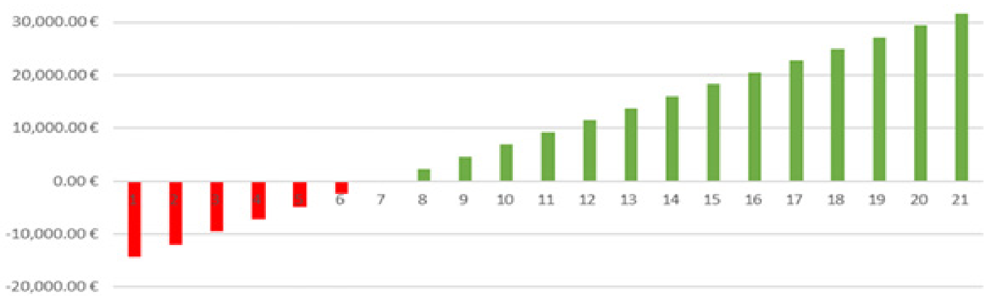
Ee = AHrP H = 13833kW

The cost of the panels that are part of the ONGRID system is around 8,600 euros. This amount includes the cost of the panels and the 15-year warranty. For the monthly payment, we received 47.7 euros. Based on this, we can estimate that the panels will consume approximately 1,811,200 ALL of electricity in 15 years. To achieve a total saving of 800,000 ALL in 15 years, we must first compare the costs of the panels with those of a PV system. Let's analyze the energy consumption of the panels during the year and their production. In addition, taking into account the shortened working hours, we can get an estimate of the energy efficiency of the panels. For a year, the panels consume 8656.92 kilowatt hours of electricity. On the other hand, the PV system produces 13833 kilowatt hours of electricity. This means we have about 5,000-kilowatt hours of extra energy to use for a year.

For how many years do these panels cover the investment?

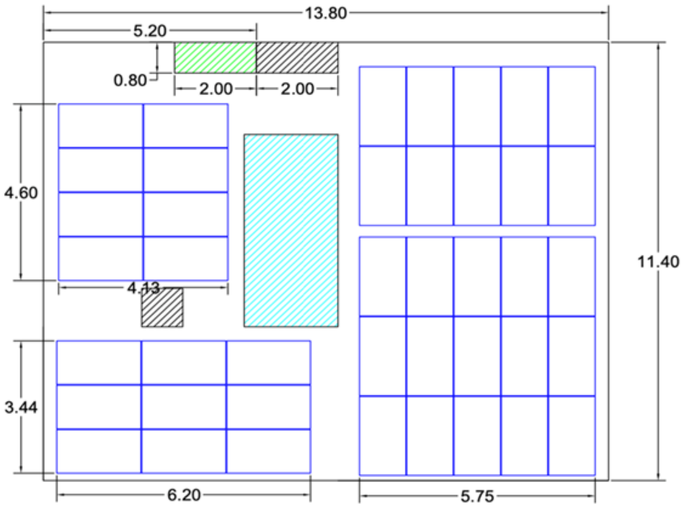
The energy consumption of the panels is the first step in calculating the cost of the system. For one year we will have to pay about 120 thousand ALL. For the next eight years, we will spend about 10 million ALL for the panels. After that, we will have free electricity for seven years. Using the language of energy, we can deduce that the panels have generated 831 kW of free power. The following tables will explain it more clearly.

FIGURE 11: Return on investment after using the panels



Source: Study of the Project of the apartment taken under review

20.58kWp	**6.9 years**	**2420.86 €**	**14,000 €**
Size Photovoltaic Plant	*Return on Investment*	*Annual savings on electricity bills*	*The cost of the Photovoltaic Plant*



According to calculations made by experts, a photovoltaic plant capable of producing 20.58 kWp can be placed on the roof of a building. There are 42 panels on the surface of the building. These panels are designed to produce a maximum power of 490 Wp. They will be connected to an efficient 20 kVA electric vehicle. The 490 Wp photovoltaic panel measures 2054x1134 mm and weighs 27.4. When considering the different distances between which the panels will be mounted, the total area that will be used for their installation is approximately 125 m2. The energy production of the photovoltaic plant is expected to reach 24627.34-kilowatt hours per year. The excess power that the system generates is then sent to OSHEE's grid.

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