3.8. How to determine solar panel efficiency and demand?

3.8.1. Solar panel size and specifications

Most common sizes of solar panels are 1,70m x 1,0m dimensions with an output ranging between 250 – 440 watts. These panels are made up of 60 cells. Also we can find 2,0 x 1,0m dimension solar panels with an output ranging between 350-400 watts. And made up of 72 cells.

You might also hear of 120 half-cell panels (equivalent size to 60 cell) or 144 half-cell panels (equivalent size to 72 cell). These half-cell panels, as you might suspect, have their solar cells cut in half. This leaves the output of the panel the same but reduces the electrical resistance in each of the cells leading to an efficiency gain for the solar cell. This is now a common technology deployed in most newer solar panel models (WEB-1: *Solar Panel Sizes and Dimensions*).

Manufacturer specification sheets for photovoltaic (PV) solar panels typically include a set of common terms that are measured under standard test conditions (STC). These STC include an irradiance of 1000 watts per square meter (1 kW/m^2), an air temperature of 25°C, and an air mass of 1,5.

Among the key terms found on a PV solar panel specification sheet are:

1. **THE MAXIMUM POWER RATING (P_{max})** – the power of the solar panel which is calculation of the voltage and maximum power, multiplied by the current at maximum power.
2. **THE VOLTAGE AT MAXIMUM POWER (V_{mp})** – the voltage being put out by the solar panel.
3. **THE CURRENT AT MAXIMUM POWER (I_{mp})** – the current that's being put out under maximum power.
4. **SOLAR PANEL SIZE** – the width and length of the solar panel.

In addition to these parameters, specification sheets also often include information on the module's weight, temperature coefficient of power and other guidelines.

The number of solar panels you need for your building depends on your daily energy consumption and the output size of solar panels.

SOLAR SYSTEM SIZE =NUMBER OF SOLAR PANELS × MAXIMUM POWER RATING(W)

6kW system = 20 x 300W solar panels (Fig. 3.8.1). **6kW system = 15 x 400W solar panels** (Fig. 3.8.1).

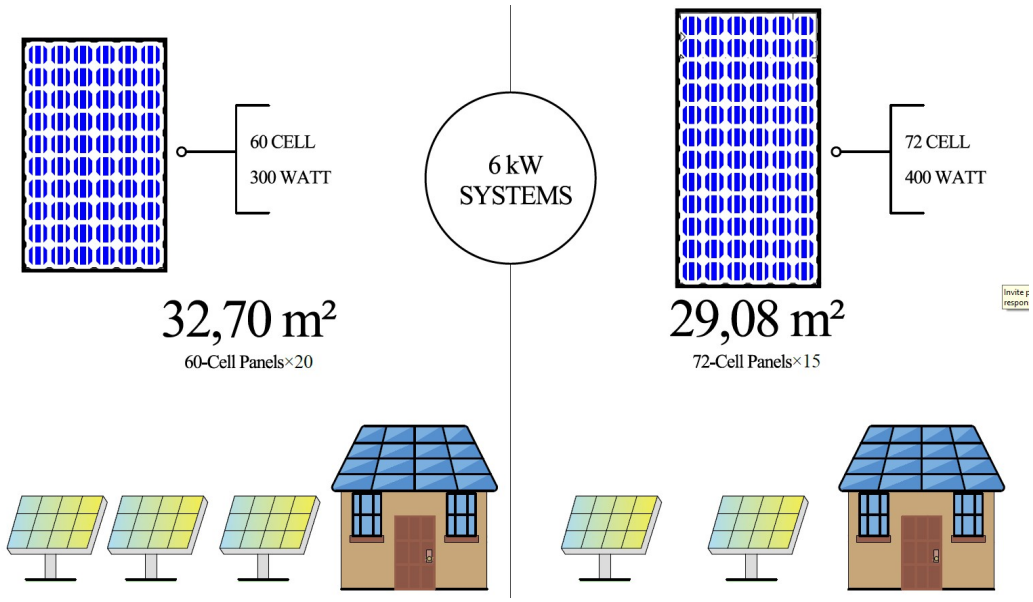

Fig.3.8.1. 6 kW solar power system. (Source: own elaboration based on https://www.solarchoice.net.au/products/panels/size/).

Solar panels generate power in units of watts (W). However, since watts are a small unit of power, it is more common to use kilowatts (kW) when discussing the amount of power needed to run a building. The amount of produced energy is measured in kilowatt-hours (kWh).

A solar panel's output refers to the amount of power it produces. To determine this, you would take the panel's power rating and multiply it by the number of hours of sunlight in your area. However, it is important to note that the output can be affected by shading or if the panel is not facing the right direction. To ensure maximum output, the panel should be installed in an area that receives direct sunlight and is not shaded, and should be angled towards the north.

SOLAR PANEL POWER RATING× SUNLIGHT HOURS IN AREA = SOLAR PANEL OUTPUT (kWh)

If a 300W solar panel receives an average of 4 sunlight hours, its output for the day will be 1200W.

The calculation is **300W x 4h = 1200W = 1,2kWh**. Annually such system will produce 432kWh.

3.8.2. Solar panel efficiency

Some solar panels are more efficient than others. The efficiency of commercially available solar cells is typically in the range of 15 to 20%. This percentage measure of efficiency shows how much of the sun's energy a particular solar cell can convert into electricity (WEB-2: *Solar Panel Size Guide: Which Size Of Solar Panel Is Best?)*.

These efficiencies are measured under laboratory conditions, so it's unlikely that your building solar system will manage to achieve those figures. Nevertheless, the efficiency rating is a good way to compare different solar panels (WEB-2: *Solar Panel Size Guide: Which Size Of Solar Panel Is Best?)*.

Definition of solar panel efficiency:

$$\mathbf{EFFICIENCY(solar\ panel)} = \frac{\mathbf{POWER\ \ OUT}}{\mathbf{POWER\ \ IN}}$$

The EXAMPLE of solar panel efficiency calculation:

Solar panel specifications:

1. **SOLAR PANEL SIZE**: 1,7m x 1m.
2. **SOLAR PANEL POWER RATING**: 300W.

Calculations:

1. Solar panel area: $1{,}7 \times 1 = 1{,}7\ \mathrm{m}^2$.
2. $POWER(m^2) = \frac{PANEL\ \ POWER\ \ RATING}{PANEL\ \ AREA} = \frac{300\ \ W}{1{,}7\ \ m^2} = 176{,}47\,W/m^2$.
3. Sunlight input at STC = 1000 W/m².
4. $EFFICIENCY = \frac{POWER\ \ OUT}{POWER\ \ IN} = \frac{176{,}47\,W/m^2}{1000\,W/m^2} = 0{,}1765 \times 100\% = 17{,}65\%$.
5. **Conclusion:** Efficiency of solar panel is 17,65% .

3.8.3. Recommendations

When considering a solar energy system, it is important to first evaluate your energy needs and determine how much power you will need to generate. Additionally, you should assess the amount of roof space available for the installation of the solar panels. With this information, you can estimate the potential output of the system based on the amount of sunlight your area receives.

Once you have a good understanding of your energy needs and the potential output of the system, you can decide whether to invest in high-efficiency, but more expensive panels, or opt for less efficient, but more affordable options.

References

1. WEB-1: *Solar Panel Sizes and Dimensions*. [Online] Available from: https://www.solarchoice.net.au/products/panels/size/ [Accessed 24.01.2023].

2. WEB-2: *Solar Panel Size Guide: Which Size Of Solar Panel Is Best?* (2021). [Online] Available from: https://www.solarchoice.net.au/products/panels/size/ [Accessed 24.01.2023].