PHOTOVOLTANIC SYSTEM *(PV)*

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1. Characteristics

To calculate the power output of a solar panel given its efficiency and dimensions, we use the following approach:

Given:

- **Efficiency**: 21.2% (0.212 as a decimal)
- **Panel dimensions**: 173 cm x 103 cm (convert to meters: 1.73 m x 1.03 m)
- **Standard solar irradiance**: 1000 W/m²
- **Calculate the power per square meter:**

$$\text{Power per square meter} = 0.212 * 1000 = 212\, {}^{W}/_{m^2}$$

- **Calculate the panel area:**

$$\text{Area} = 1.73\text{m} * 1.03\text{m} = 1.782m^2$$

- **Calculate the total power output:**

$$\text{Power} = 212 * 1.782 = 377.8\ \text{W}$$

The calculated value of 377.8 W is very close to the 380 W listed on the website for the panel. This calculation shows how efficiency and panel dimensions directly influence the power output rating of solar panels.

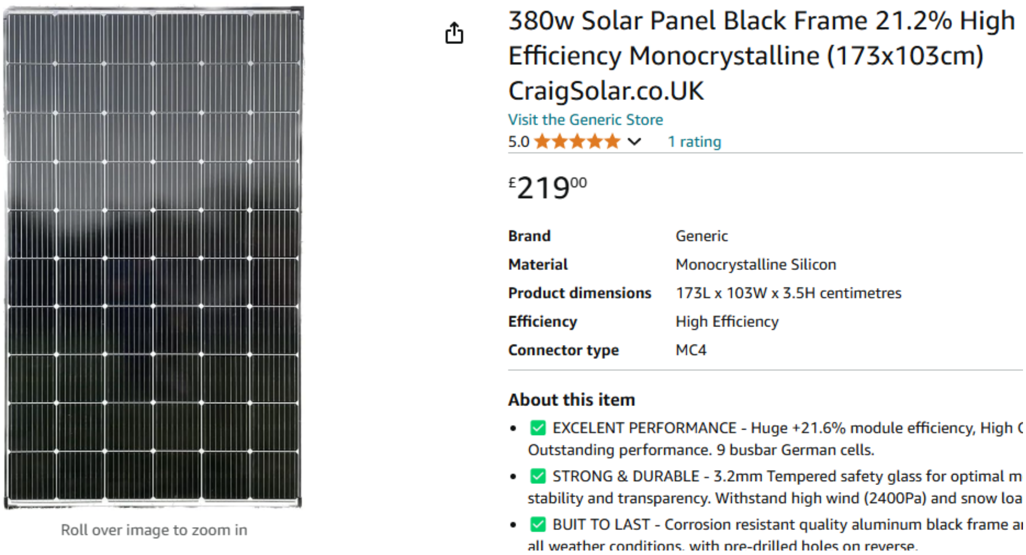

Figure 1: Example of a solar panel

2. Connection

The way solar panels are connected is crucial when predicting the voltage and current they will provide. There are two primary connection methods: **parallel** and **series**.

- **Parallel connection**:
  - In a parallel configuration, the voltage remains constant across all the panels, but the **current is additive**. This means that the total current provided by the system is the sum of the individual panel currents.

- **Key takeaway**: If you need more current while maintaining the same voltage, a parallel connection is ideal.

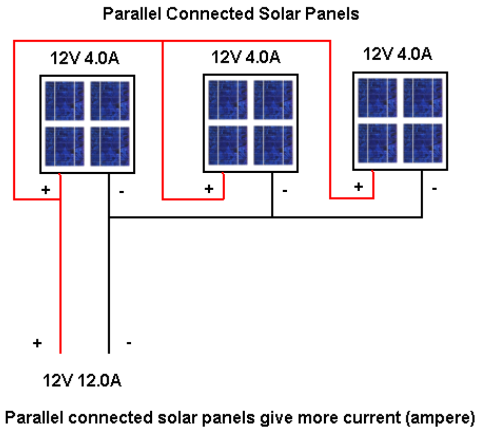

Figure 2: Parallel connection.

- **Series connection**:
  - In a series connection, the **voltage is additive**, meaning the total voltage is the sum of the individual panel voltages, while the current remains the same across all the panels.
  - **Key takeaway**: If you need to increase the voltage but keep the current constant, a series connection is the best option.

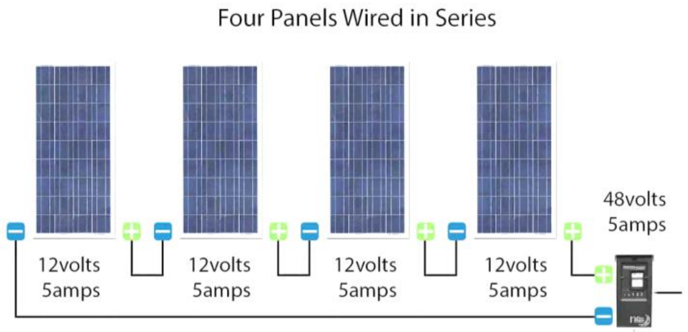

Figure 3: Series Connection

These configurations allow flexibility in designing solar systems to match the required voltage and current for specific applications. Properly choosing the connection type ensures the system operates efficiently and meets energy demands.

3. Shading Effect

The importance of considering the **shading effect** when designing a solar panel circuit is crucial, particularly in countries like the UK where weather conditions can lead to partial shading. When solar panels are shaded, even partially, the entire system can be affected, leading to significant reductions in power output. To mitigate these effects, **bypass diodes** are commonly used.

- **How Bypass Diodes Work:**

Bypass diodes allow the current to "bypass" a shaded panel, ensuring that the rest of the system can continue operating with minimal loss. Without bypass diodes, shading on a single panel can drastically reduce the current and overall system performance.

Example:

Consider a system of four solar panels, each with the following specifications:

- Voltage (V) = 12V
- Current (I) = 6A

❖ Scenario 2: Shaded panel with bypass diodes

The total power (P) produced by the system can be calculated as:

$$P_1 = N * V * I$$

Equation 1: Power formula considering the number the panels.

Where:

- N = number of panels (*3 active panels due to one shaded*)
- V = voltage of each panel
- I = current (6A)

$$P_1 = 3 * 12 * 6 = 216W$$

Equation 2: Power with bypass diode.

❖ Scenario 2: Shaded panel without bypass diodes

If one panel is shaded and there are no bypass diodes, the current of the entire system will drop. Assuming the current drops to 1A:

$$P_2 = 4 * 12 * 1 = 48W$$

Equation 3: Power without bypass diode.

This demonstrates how significant the shading effect can be. Without bypass diodes, even a single shaded panel can drastically reduce the system's output from 216W to just 48W.

Conclusion:

Bypass diodes are essential in reducing the negative impact of shading on solar panel systems. They help maintain a stable output by preventing the entire system from being compromised when one panel is affected.

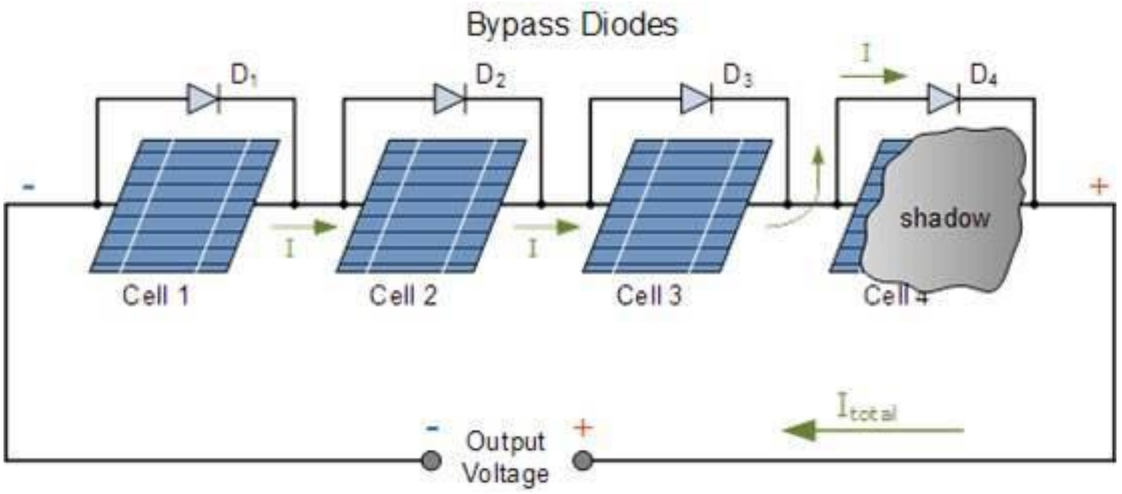

Figure 4: Shading effect.