

PHOTOVOLTANIC SYSTEM (PV)

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1. Solar Panels

- **Function:** Solar panels convert solar energy into electrical energy.
- **Solar Charge Controller:** Regulates the charging voltage of the battery.
- **Batteries:** Store the electricity generated by the solar panels (DC).
- **Inverters:** Convert DC voltage into AC voltage, which is necessary for household operations.

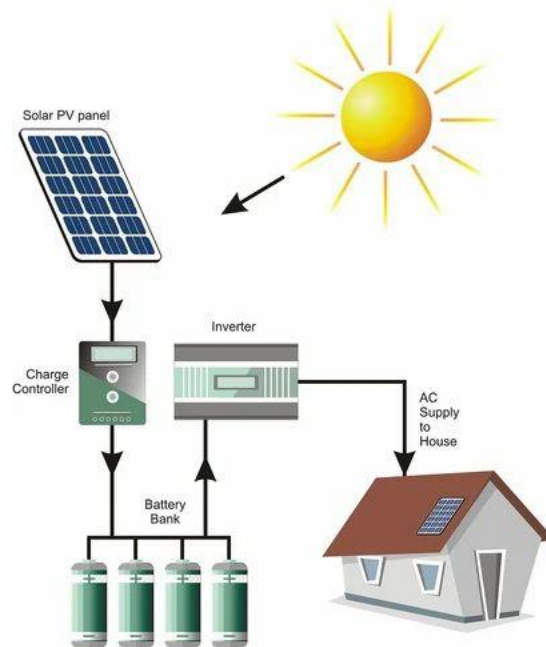


Figure 1: Solar Photovoltaic system.

A photovoltaic (PV) panel is composed of multiple layers, each contributing to the panel's efficiency. These layers reduce the reflection of sunlight and include conductors to facilitate the flow of electrons. Each solar panel consists of a combination of cells, which together form a module or panel. Multiple modules can be combined to create arrays. These cells are typically made of silicon. The use of semiconductors allows for the production of electrical energy through PN junctions.

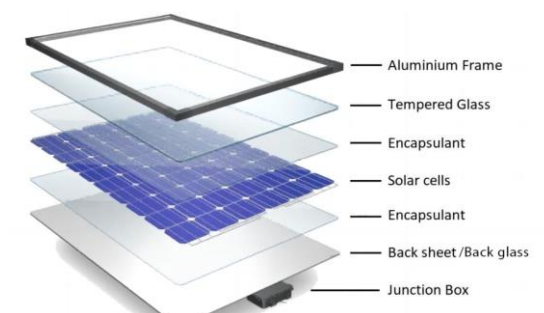


Figure 2: Solar panel layers.

1.1. Advantages

- Provides green, renewable energy.
 - Sunlight is free and readily available.
 - It can be used locally, minimizing energy losses.
 - Low operational and maintenance costs.
- PV systems are silent and produce no noise.
 - No mechanical parts, reducing the risk of wear and tear.
 - Easy to install.
 - Used in spacecraft applications.

1.2. Disadvantages

- No power generation at night or during cloudy/rainy weather.
- Batteries can be expensive.
- Low efficiency (around 20%).
- It requires continuous cleaning to maintain efficiency.
- High-power PV systems need large areas, which is challenging in urban settings.

1.3. Busbars and Fingers of a solar panels

The purpose of busbars in solar cells is to conduct the DC power generated when photons strike the cell. Busbars are the wires that connect each cell to the others, allowing the current to flow efficiently.

Essentially, the fingers on the cell collect the generated DC current and deliver it to the busbars. The cells are typically connected in series to increase the total voltage, with each cell generating approximately 0.5 to 0.9 volts.

There are various configurations for busbars in a PV solar panel, determined by the number of busbars used. Increasing the number of busbars in a solar panel can significantly enhance its efficiency by reducing the distance between them.

For instance, consider two solar panels of the same size: Panel A with three busbars (3BB) and Panel B with five busbars (5BB). Panel B, with more busbars, will have less internal resistance, which directly impacts the panel's performance.

According to Ohm's Law, reducing resistance in a circuit leads to an increase in current, provided the voltage remains constant. In the context of solar panels, a higher current at the same voltage results in greater power output. Therefore, by increasing the number of busbars, you not only minimize internal resistance losses but also maximize the overall power generated by the panel.

This improvement in power output makes solar panels with more busbars more efficient and effective, particularly in high-performance applications where maximizing energy yield is critical.

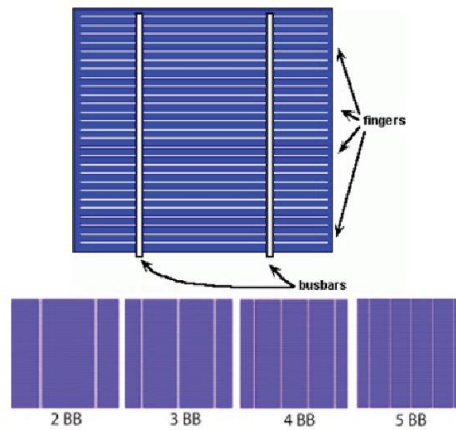


Figure 3: Solar panel and Busbar code.

1.4. Types of Solar Panels

Monocrystalline Silicon Solar Panel:

- **Efficiency:** 15% to 24%
- **Space Requirements:** Requires less space compared to other types of solar panels because it produces more energy per square meter.
- **Cost:** The higher efficiency leads to increased costs.
- **Sensitivity:** Can be damaged or have its performance affected by dirt and debris.

Polycrystalline Solar Panels

- **Efficiency:** 13% to 16%
- **Cost:** More economical, making it a cost-effective option for homeowners.
- **Space Requirements:** Requires more space compared to monocrystalline solar panels due to its lower efficiency.

Thin Film Solar Panels

- **Efficiency:** 7% to 13%
- **Cost:** The most economical option on the market.
- **Space Requirements:** Requires a large space due to its lower efficiency.
- **Sensitivity:** Degrades more quickly compared to other types of solar panels.



Figure 4: Types of solar panels.