HOW SOLAR PANEL WORKS

"Towards a better future"

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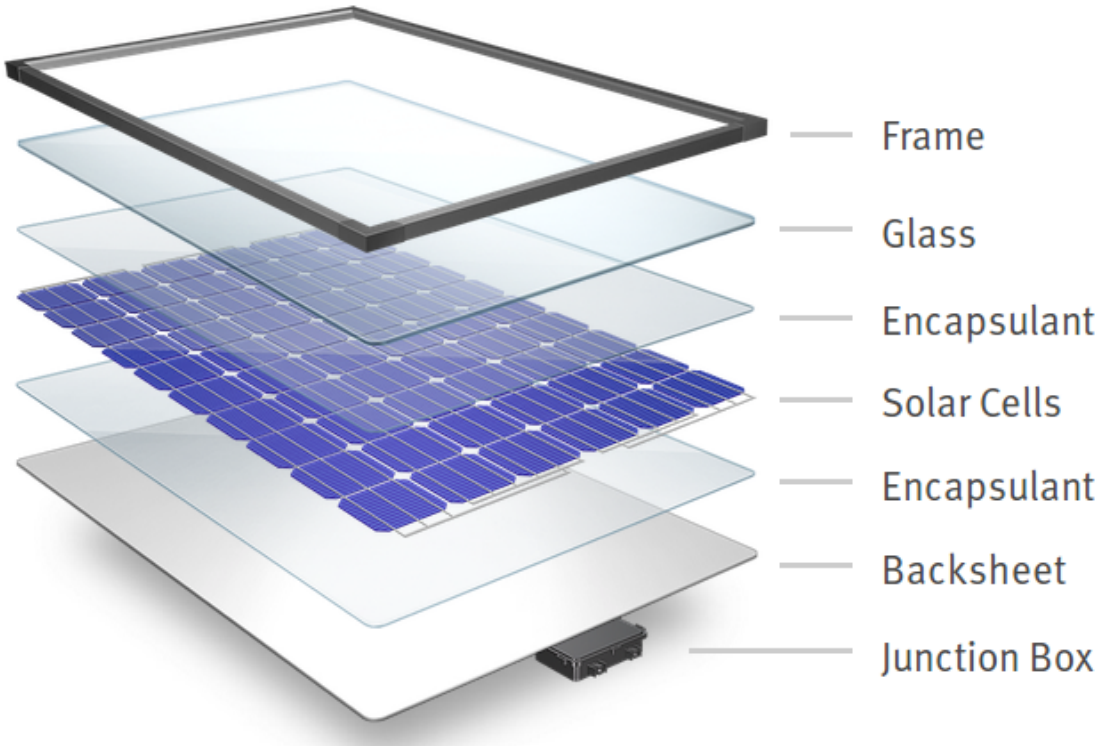
INTRODUCTION

The earth receives 25 times more energy from the sun than we use in the world every day. Solar panels can be used to harness that energy. A Solar panel is a panel designed to absorb sunlight. The sunlight absorbed is the source of energy to generate electricity. Typically, a solar panel has capacities ranging from 230-300 W. But, the smallest capacity of a solar panel is 2W. The area that a solar panel occupy depends on its capacity. The thickness of fully assembled solar panels ranges from 2.5-4cm. A high-quality solar panel can withstand the rain for 25 years or longer because of the components used to protect the solar cells.

This document is intended to provide information about the components in a solar panel to anyone who is interested in making their own panels. It can also help its users to make a decision in choosing the right type of solar cells they want to install in their place.

COMPONENTS OF A SOLAR PANEL AND THEIR FUNCTIONS



Source : http://www.wealthdaily.com/report/solar-technology/1409

Frame

The first layer of the solar panel is the frame. The frame is usually made up of aluminum. It is used to fix and encapsulate solar modules, increase its intensity and prolong its operating life. The frame is usually easy to install and transport. Solar panel frame surface treatment mainly involves sandblasting oxidation and electrophoretic coating.

Glass

The next layer underneath the frame is a glass. The glass is placed on top to protect the solar cells from environmental elements. There can be two types of panel glass- tempered glass and flat plate glass. The tempered glass strength is 6 times greater than the normal plate glass.

Encapsulant

Below the glass is the encapsulant. An encapsulant is a thin plastic sheet that provides protection to the solar cells. Solar cells are sensitive to oxygen, moisture and weather. If the solar cells are not protected, they will degrade over time and become unable to produce energy. An encapsulant is usually placed on the top surface and the rear surface of the cells. The material is chosen based on its stability at elevated temperature and high UV exposure. It must also be optically transparent. The most commonly used encapsulant material is a thin transparent film called EVA (ethyl vinyl acetate).

Solar cells

The solar cells are placed underneath the encapsulant. The function of these cells is to convert the sun's energy into electricity. The greater the amount of sunlight that hits the cells, the greater the electricity produced. In a module, typically, there are 36-40 cells. Solar cells are usually connected in series to achieve desired output voltage, but they can also be connected in parallel to provide a desired current capability. Commonly, they are made out of **silicon** and come in two common varieties; crystalline (**wafer**-based) and thin-film cells.

Crystalline (wafer based)

For crystalline silicon, it is divided into two types; monocrystalline and polycrystalline.

First is the monocrystalline silicon solar cells (mono-Si). They are easy to recognize because of their even coloring and uniform look. These features indicate high-purity silicon. Mono-Si cells are cylindrical in shape because they are made out of silicon **ingots**. Four sides are cut out of the cylindrical ingots to lower the cost of a single monocrystalline solar cell and to optimize its performance. One of the ways to differentiate mono and polycrystalline is their shape. Polycrystalline solar cells are rectangular while monocrystalline solar cells have rounded edges.

Advantages

- Monocrystalline solar panels have the highest efficiency because they are made out of the highest-grade silicon.
  Efficiency rate ≈ 15-20%
- They have the longest rate of lives. (25-year warranty)
- These solar panels are space efficient. They required the smallest amount of space compared to other types because they produce the highest power output.

Disadvantages

- Monocrystalline panels are the most expensive.
- The entire circuit can break down if the solar panel is covered with snow, dirt or shade.
- Lots of original silicon ends up as waste because of the sides that are being cut.
- They perform best in warm weather, but their performance tends to decrease with increasing temperature.

The second type is the polycrystalline silicon solar cells. Raw silicon is melted and poured into a square mold. It is then cooled, and cut into a square wafer.

Advantages

- Polycrystalline solar panels do not cost a lot.
- The amount of waste silicon is less than monocrystalline panels.

Disadvantages

- The efficiency of the solar panels is approximately 13-16%.
- These solar panels have relatively low space efficiency.
- They do not have a uniform look compared to monocrystalline and thin-film solar panels.

Thin-Film Solar Cells (TFSC)

Thin-film cells also have several types depending on the **substrate** that the photovoltaic mineral deposited on. The substrates are:

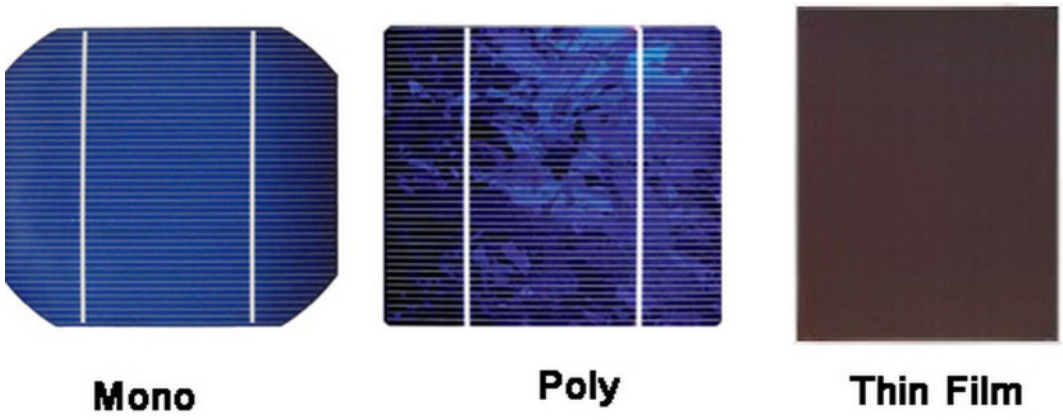
- Amorphous silicon (a-Si)
- Cadmium telluride (CdTe)
- Copper indium gallium selenide (CIS/CIGS)
- Organic photovoltaic cells (OPC)

Advantages

- They can be made flexible.
- These solar panels are thin and uniform making them look more attractive.
- They are easy to mass produce.
- They are cheap.
- High temperature and shading don't hinder their performance.

Disadvantages

- Thin-film cells efficiency is 7-13%, with an average operating efficiency of 9%.
- They have low space efficiency.
- They are not suitable for most residential area.
- They have shorter warranties compared to crystalline silicon panels because they degrade faster.



Source:http://www.solarcloset.com/understanding-solar-equipment/difference-between-monocrystalline-polycrystalline-and-amorphous-thin-film-solar-cell/

Back sheet

Below the second encapsulant is the back sheet. The function of this back sheet is to protect the solar cells and electrical components from water and hot temperature. They also act as an electrical insulator. Typically, a polymer sheet is used as the back sheet which can lower the flammability.

Junction box

The junction box is an enclosure on the panel where the photovoltaic strings are electrically connected. It protects the electrical connections of the solar panel from any environmental conditions. It is usually attached to the back of the solar panel.

CONCLUSION

Solar energy is the most abundant renewable energy source available. Using solar panels is not only nonpolluting, but they can decrease the user's carbon footprint and save money on electric bills. They do not require much maintenance and run for a long time. Last but not least, solar panels are easy to install.

GIOSSARY

1. Ingots : a block of steel, gold, silver, or other metal, typically oblong in shape
2. Silicon : a nonmetal with semiconducting properties, used in making electronic circuits
3. Substrate : a substance or layer that underlies something, or on which some process occurs, in particular.
4. Wafer : thin slice of semiconductor material, such as a crystalline silicon, used in electronics for the fabrication of integrated circuits and in photovoltaics for conventional, wafer-based solar cells.

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