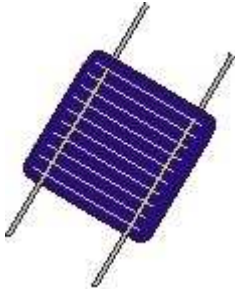


SOLAR ENERGY

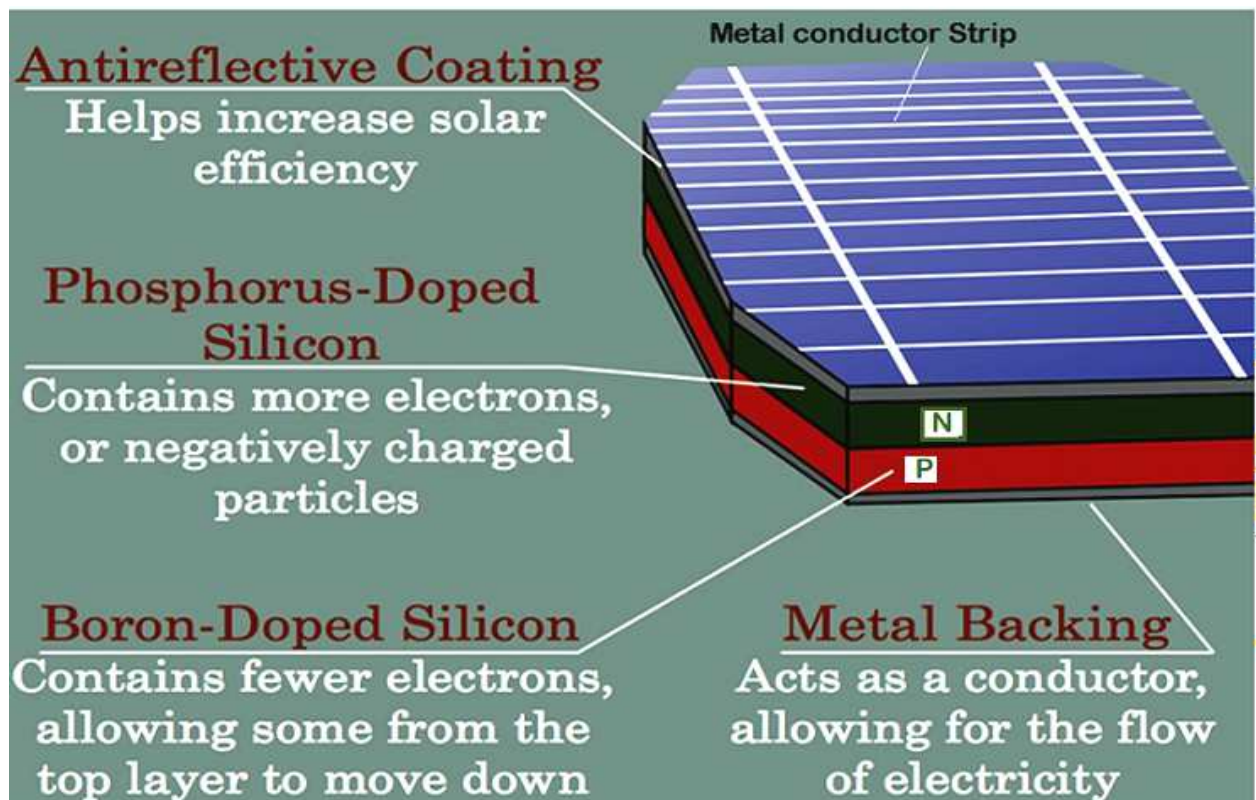
ABOUT SOLAR CELL:

Solar power or electricity from the solar system is obtained from solar photovoltaic (PV) cells. The PV cell looks like as;

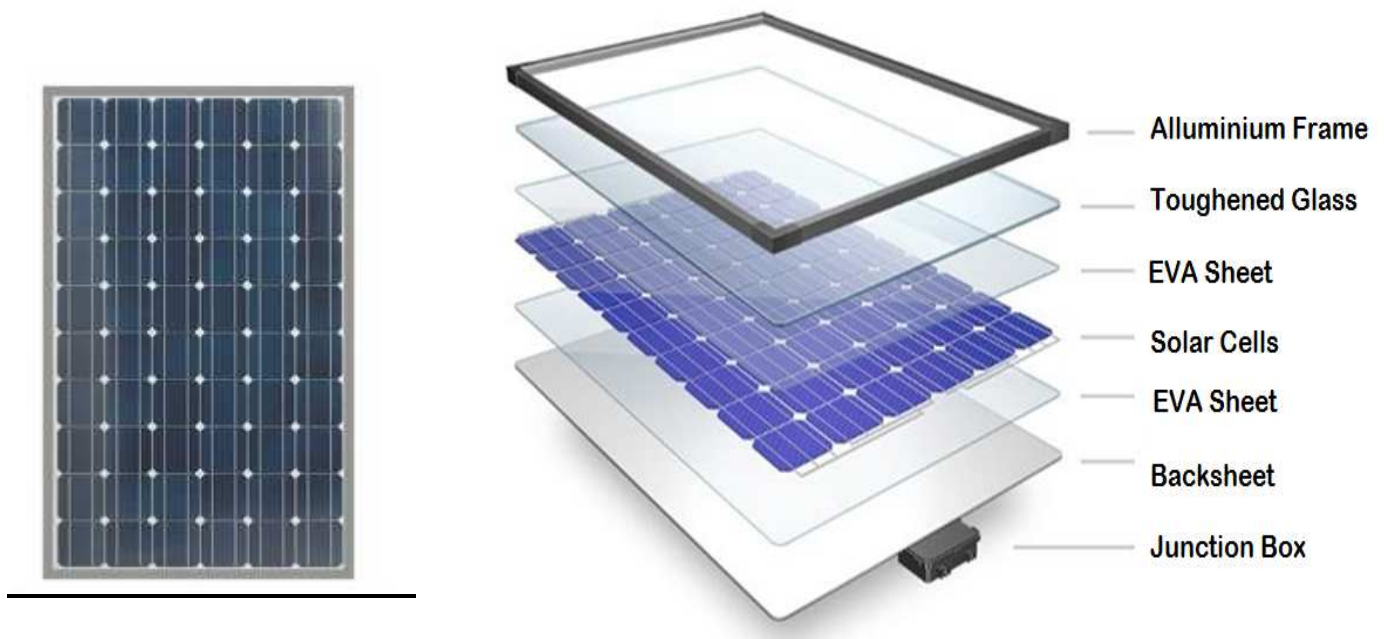


- The PV cell made from the silicon material, which is semiconducting material.
- It is called the photovoltaic (PV) cells because in Greek language phos means light, and volt, a measurement unit named for Alessandro Volta (1745-1827), a pioneer in the study of electricity. Therefore, it's called photovoltaic.
- Solar cells are small devices, which can convert sunlight into electricity.
- One cell has 0.5 to 0.6 volt. So to get higher voltage, no. of cells connected in series to get higher voltage.

The main layers of a solar cell are;



SOLAR MODULE:



A PV module consists of a number of series connected solar cells (typically 36 connected in series) encapsulated into a single, long-lasting, stable unit.

It's rating in watt peak (Wp).

It has a 6 stage;

Aluminum Frame: Use to support the solar panel.

Toughened Glass: Use to protect the solar cells from environmental elements. Having up to six times the strength of normal plate glass.

EVA Sheet: Ethyl vinyl acetate sheet is a thin plastic sheet, called an encapsulant – Solar cells are sensitive to moisture, oxygen and weather.

Solar Cell: For electricity.

Backsheet: A backsheet is needed to protect the solar cells and electrical components from water and hot temperatures. A polymer sheet, is used.

Junction Box: For Connections.

Solar module;

- Available in 10 W to 300 Wp
- No. of cell may be 36, 48, 54, 60, 72
- One cell has 0.5 to 0.6 V
- Module voltage may be 12, 24, 36 V
- The area of 250 W, 60 Cell panel is 6 x 3 foot

SOLAR PANEL:



Solar panel is the no. of solar module connected in series to get higher voltage.

SOLAR ARRAY OR STRING:



Solar array is the no. of solar panels connected in parallel to get higher power.

WORKING OF SOLAR CELL

When sunlight hits the top silicon layer, it 'excites' the electrons and gives them enough energy to move. The electrons begin to flow from the top layer to the bottom. And as we know, when a bunch of electrons starts to move along in the same direction, we have electricity. Put two metal contacts on either side of the silicon sandwich and we have electricity moving through a circuit.

The electricity generated by PV solar cells is DC (direct current). The electricity used in your house is AC (alternating current). So the current from the solar panel system has to go through an *inverter*, to convert it from DC to AC before it can be supplied into our house.

TYPES OF SOLAR MODULE

1. Monocrystalline solar panels :

The most efficient and expensive solar panels are made with Monocrystalline cells. These solar cells use very pure silicon and involve a complicated crystal growth process. Long silicon rods are produced which are cut into slices of 4 mm thick discs or wafers which are then processed into individual cells that are wired together in the solar panel.

2. Polycrystalline solar panels :

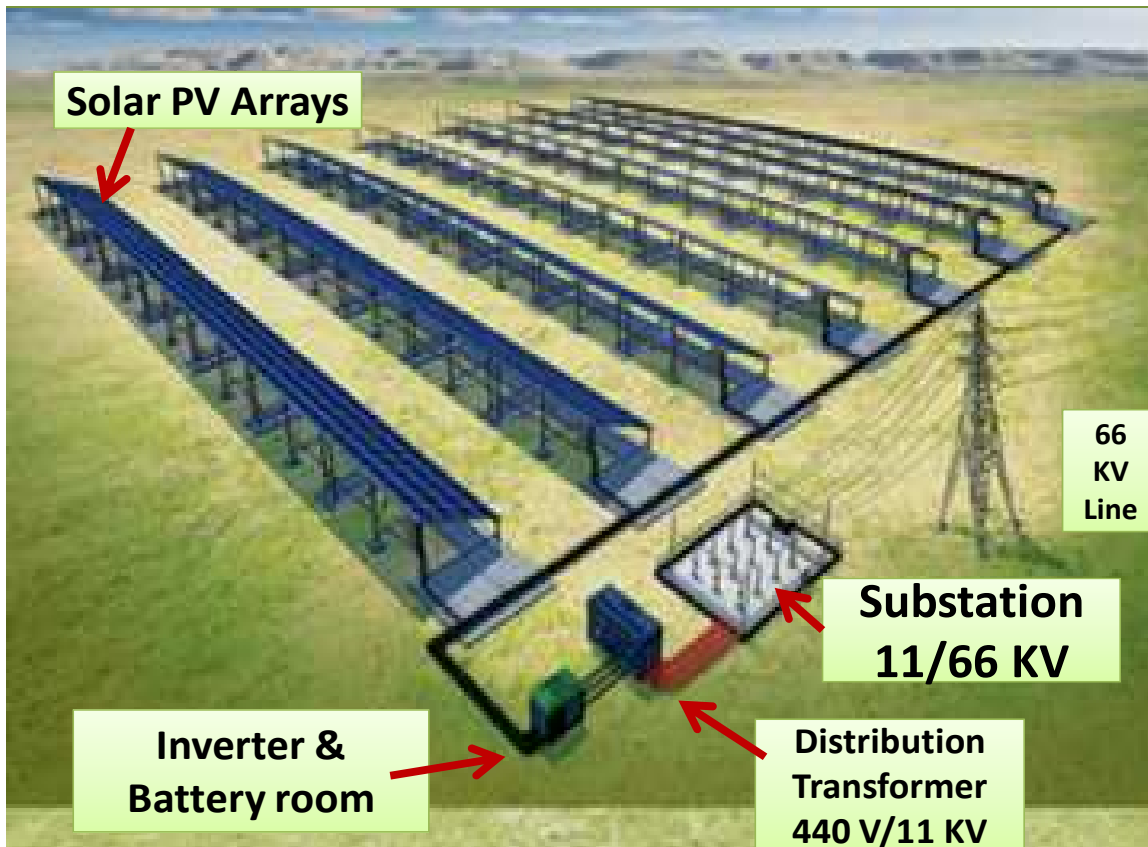
Often called Multi-crystalline, solar panels made with Polycrystalline cells are a little less expensive & slightly less efficient than Monocrystalline cells because the cells are not grown in single crystals but in a large block of many crystals. This is what gives them that striking shattered glass appearance. Like Monocrystalline cells, they are also then sliced into wafers to produce the individual cells that make up the solar panel.

3. Amorphous solar panels :

These are not really crystals, but a thin layer of silicon deposited on a base material such as metal or glass to create the solar panel. These Amorphous solar panels are much cheaper, but their energy efficiency is also much less so more square footage is required to produce the same amount of power as the Monocrystalline or Polycrystalline type of solar panel. Amorphous solar panels can even be made into long sheets of roofing material to cover large areas of a south facing roof surface.

Monocrystalline	Polycrystalline	Thin Film
Single Crystal of silicon	Multiple Crystal of silicon	Amorphous silicon
Efficiency-15-20%	Efficiency-14-16%	Efficiency-6-12%
High Cost	Medium cost This type of panel Mostly used in India	Low Cost

COMPONENTS OF SOLAR POWER PLANT



Solar PV Array

Solar PV arrays are the group solar panels connected in parallel to supply large amount of power.

Inverter & Battery Room

The supply available from solar array is DC, Inverter use to convert DC into AC. Battery use for backup supply.

Distribution Transformer

It converts low voltage (380-400V) AC from inverter to 11 KV High voltages AC (11000 V). In India 11 KV use for the electricity distribution.

Substation

Substation comprises with the switching and protective equipments. The control of solar power can be done by substation.

Power Transformer

It converts 11 KV to 66 KV. The higher voltage required to deliver power at long distance load centre.

Transmission line

The transmission line uses to transmit power at long distance.

LOSSES IN SOLAR PLANT

- ➔ Temperature Loss-11 %
- ➔ Dust & Moisture Loss- 7%
- ➔ Module Mismatch Loss- 2%
- ➔ Cable Loss-3%
- ➔ Inverter Loss-5%
- ➔ Transformer Losses-2%

ADVANTAGES OF SOLAR POWER

- (1) Clean and Non-Polluting
- (2) Renewable energy
- (3) Solar cells do not produce noise means totally silent plant.
- (4) Require very low maintenance
- (5) Provide Electricity to Remote area
- (6) Leads Role to reduce Global Warming
- (7) There are no fuel costs or fuel supply problems

DISADVANTAGES

- (1) Soar power cannot be obtained in night time
- (2) Solar cells (or) solar panels are very expensive
- (3) Air pollution and whether can affect the production of electricity
- (4) Solar Plant required large area of land to produce sufficient power.
- (5) Reliability depends on location

SOLAR PLANT SITE SELECTION CRITERIA

- ✓ High Radiation availability
- ✓ West Land
- ✓ Road Transportation Facility
- ✓ Near Water Source
- ✓ Near Load Centre
- ✓ Availability of labour near site

TYPE OF SOLAR PLANT

Solar Rooftop System



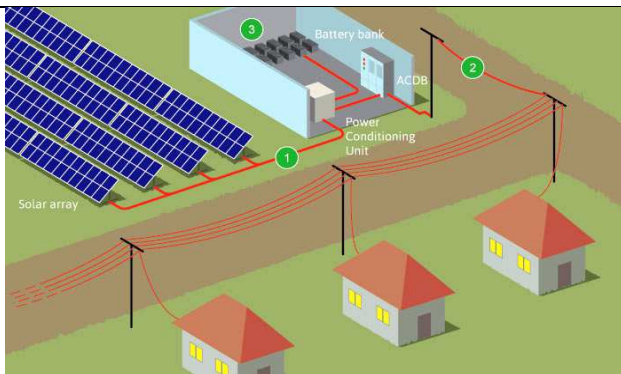
Solar rooftop plant is mainly installed on roof of our home, building, shop etc. this plant generally in KW capacity.

ON Grid Plant



The ON Grid Solar plant is mainly installed for large scale power generation. In Gujarat Charanka Solar Park is ON Grid solar Plant, which is connected with power transmission line(grid) and deliver electricity to long distance. These plant are in MW rating.

Off grid plant (stand alone)



Off grid plant use for provide electricity for those area where conventional power grid is not possible. Specifically for isolated area village. This plant also in KW capacities.

Hybrid Solar Plant



The hybrid mens combimation of solar and wind or solar –Hydro, solar-thermal with battery, the plant depends on available source. It may be on grid or off grid.

FACTORS AFFECTING ON SOLAR POWER OUTPUT

- Radiation intensity
- Area of solar panel
- Efficiency of PV cell
- Whether condition
- Geographical condition of area
- Technology used to improve efficiency

DESIGN AND COSTING OF SOLAR ROOFTOP PLANT FOR A HOME

Consider five points for design;

1. Load calculation and plant capacity
2. Calculation of numbers of solar modules and rating
3. Rooftop Area
4. Inverter Size and
5. Total cost estimation of the system.

1. Load calculation and plant capacity

The sanction load is mention in your home light bill, suppose it is 3 KW then as per Gujarat Govt. Solar Power policy, you can set up 1.5 KW (50% of the sanction load) capacity plant at your home.

In light bill, suppose 2 month Usage reading is 211 KWh

Then, $211 \times 1000 = 211000$ Wh (2 Month=60 days)

$211000/60 = 3517$ Wh/day

= 3.5 Unit per day

2. Calculation of numbers of solar modules required

Total PV panels energy required :

$3517 \times 1.3 = 4572$ Wh/day

Where 1.3 factor is the energy lost in the system.

Total Wp rating of panels : $4572/4.32 = 1058.33$ Wp = 1 KWp

Where 4.32 is the "panel generation factor" For Gujarat.

State	CUF (%)	1 kWp panel (kWh/day)
Gujarat	18	4.32
Karnataka	19	4.56
Madhya Pradesh	19	4.56
Maharashtra	19	4.56
Punjab	19	4.56
Rajasthan	20	4.80
Seemandhra/Telangana	20	4.80
Tamil Nadu	19	4.56
Uttarakhand	19	4.56

➡ Total No. of PV panels:

Modules are available in 100 W, 200 W, 250 W etc. If we choose 250 W solar module then $1058.33/250 = 4.23 = 5$

So this system should be powered by at least 5 modules of 250 Wp rating.

Hence, numbers of solar modules required=5

3. Rooftop Area

→ Normally, one panel of 250 W required 1.62 m^2 Area.

→ As per calculation, 5 panels of 250 W needed.

→ Then $1.62 \times 5 = 8 \text{ m}^2$ Area + as per thumb rule 30% extra area required,
So, $8+2.4= 10.2 \text{ m}^2$

→ In round Figure 10 m^2 shaded free area required

4. Inverter Size

The total wattage of the Home appliances is 1013 Watts,

So, 1 KW Capacity inverter required.

5. Total cost estimation of the system

The below rate is as per current market:

Required Equipment	Rate per Watt	Total Cost
Solar Panel (250 W x 5)	30	37,500
Inverter (1 KW)	18	18,000
Structure	6	6000
Cable	6	6000
GEDA File Charge	1.5	1500
Labour	3	3000
Total Plant Cost		72,000/-

Summary of 1 KW Solar rooftop plant

- Area Required: 100 *Square Feet.* (10 m²)
- No. of Panels Required: 5 of 250 Wp
- No. of Units Generated per day : 4
- Inverter Size: 1 KW
- Total Cost of Plant: Rs.72000/-
- Cost of Plant at customer level: Rs.40,000/-

Dear Students, in the two day workshop on solar energy you will learn following contents.

- ✓ Solar Power Installed capacity Scenario-Global, National and State level
- ✓ Benefits of Solar Power.
- ✓ Solar plant Site selection Criteria
- ✓ Solar Radiation and it's Measurement Techniques
- ✓ Solar power plant view, Panel Installation and equipment description
- ✓ Technical details of solar cell
- ✓ Data of current Research work on solar cell efficiencies
- ✓ Solar Cell Manufacturing Process- **Video**

- ✓ Technical details of solar panel/module
- ✓ Solar Module manufacturing Process-**Video**
- ✓ Design and costing of a rooftop solar plant
- ✓ Gujarat Govt. Normas and Policy to set up Rooftop (KW Capacity) and Large scale (MW Capacity) Solar Plant
- ✓ State and Central Govt. Subsidy Scheme for setup solar plant
- ✓ List of Solar Power System Supplier (**Registered by GEDA**)
- ✓ Overview of solar cell/panel manufacturing **industries** in India
- ✓ Overview of Solar Power Plants in Gujarat & Solar Park Charanka-**Video**
- ✓ Overview of Training Institutes related Solar Power
- ✓ Overview of Bachelor, Master & PH.D level Courses institutes in Gujarat
- ✓ Student level Solar projects for practical/course work
- ✓ Solar power related Interview Questions -Answer
- ✓ Important **Mobile Apps** on Solar Power
- ✓ Solar PV- Design Softwares
- ✓ Solar power **Magazines**
- ✓ Career in solar Power Sector