



SNS COLLEGE OF TECHNOLOGY



# *Powerplant Engineering*

## *Unit IV*

### *Solar Power Plants*





# Solar Power Plants



- The solar power plant is also known as the **Photovoltaic (PV) power plant**.
- It is a large-scale PV plant designed to produce bulk electrical power from solar radiation.
- The solar power plant **uses solar energy to produce electrical power**.
- Therefore, it is a conventional power plant.
- Solar energy can be used directly to produce electrical energy using solar PV panels.
- Or there is another way to produce electrical energy that is concentrated solar energy.

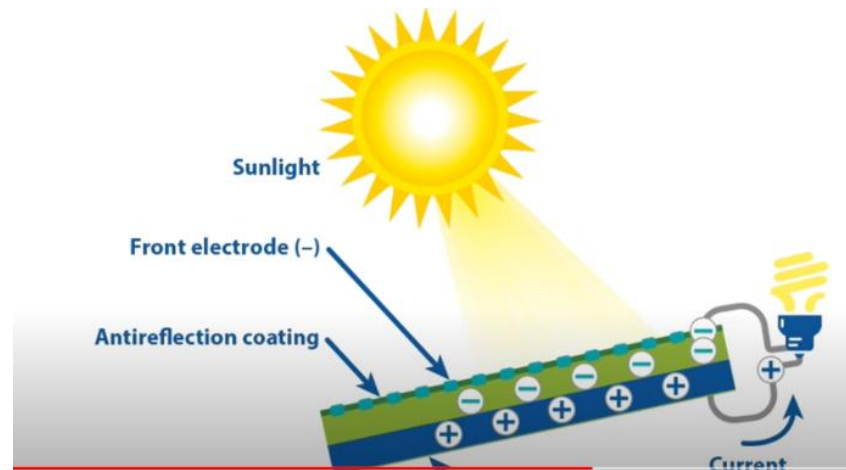




# Solar Power Plants



- In this type of plant, the radiation energy of solar first converted into heat (thermal energy) and this heat is used to drive a conventional generator.
- This method is difficult and not efficient to produce electrical power on a large scale.
- Hence, to produce electrical power on a large scale, solar PV panels are used. In this article, we will explain details about solar PV plants and PV panels.

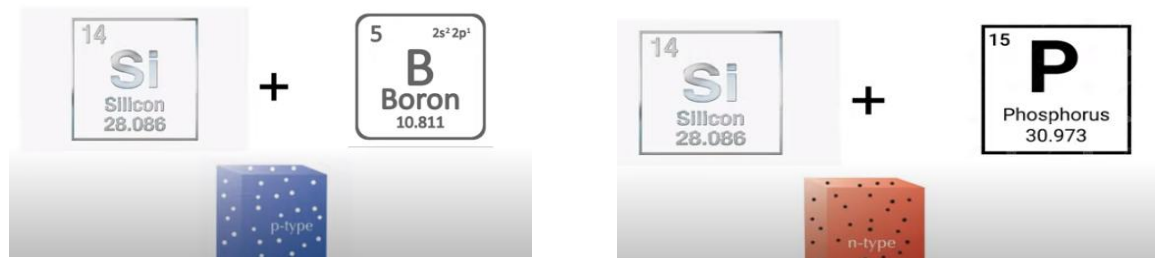




# Solar Power Plants



- **Photo Voltaic (PV) Principle**
- **Silicon** is the most commonly used material in solar cells.
- Silicon is a semiconductor material. Several materials show photoelectric properties like; **cadmium, gallium arsenide**, etc
- **Electron-holes pairs** are created in solar cells.
- The PV materials have the **property to absorb photons of sunlight**. The valance band electrons of semiconductor material are at lower energy and the electrons of conduction band are at a higher energy level. The *difference between* this energy level is known as bandgap energy

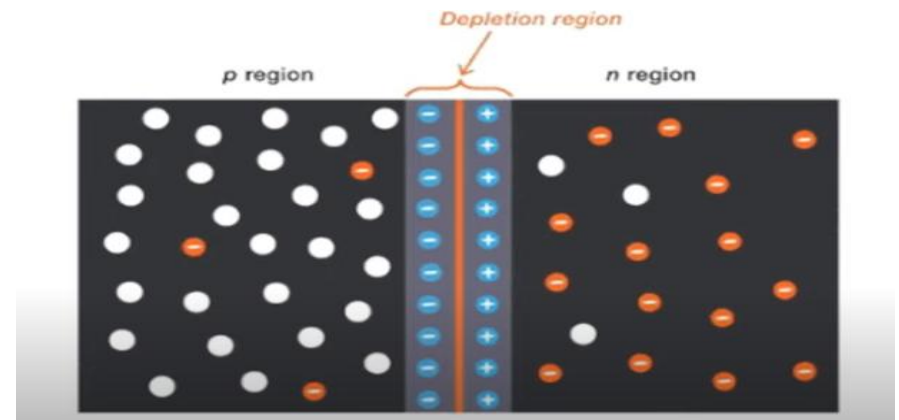
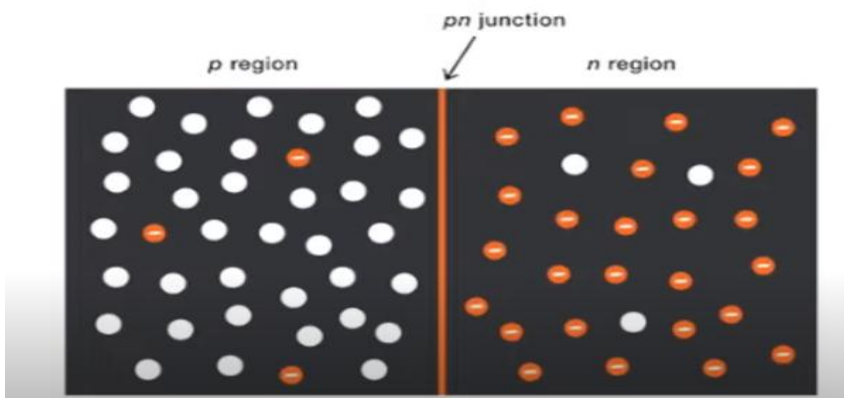




# Solar Power Plants



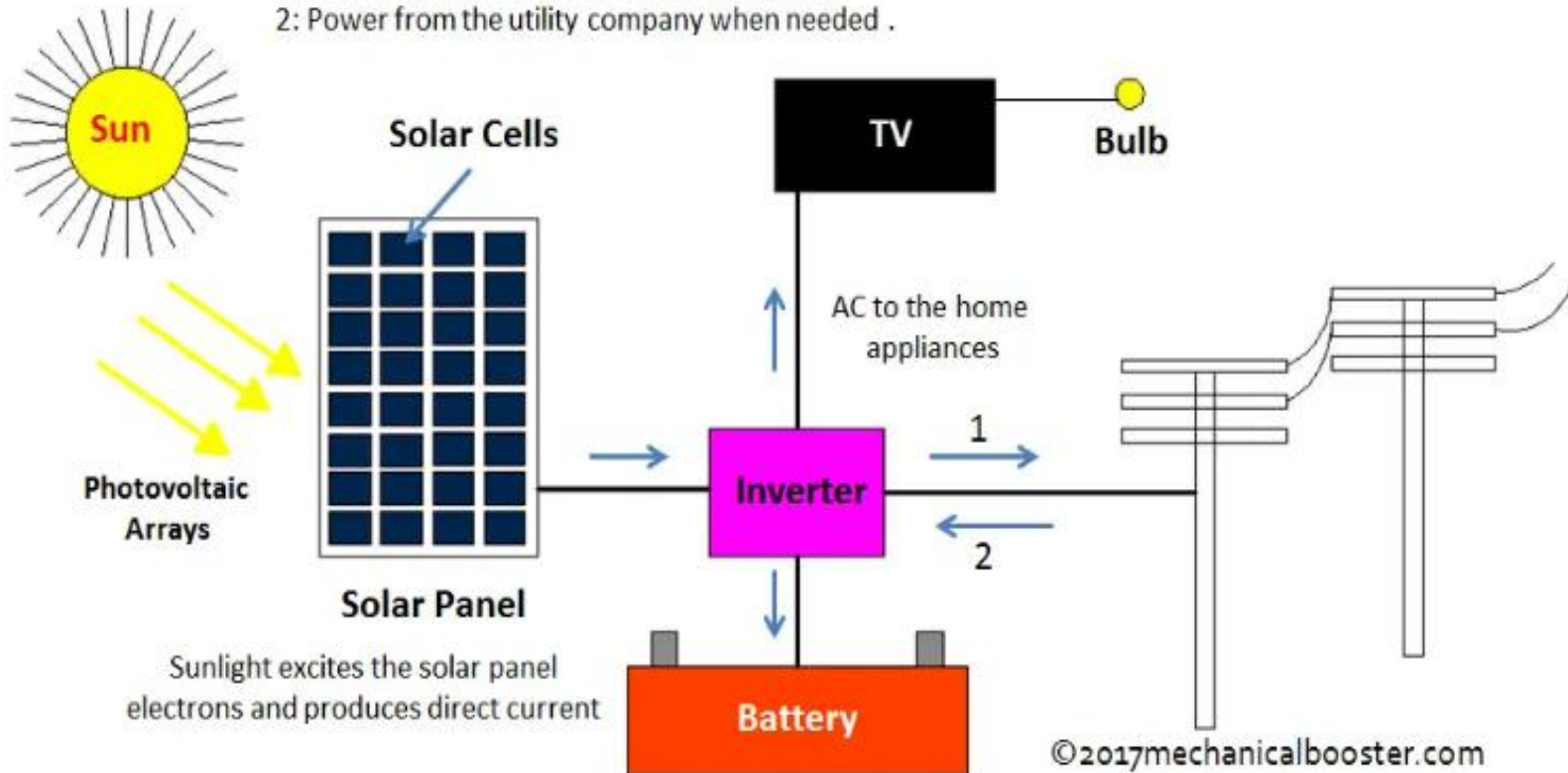
- When sunlight falls on solar cells, the difference between photon energy  $E$  and bandgap energy  $E_g$  is absorbed by the cell. And it excites some electrons to jump across the bandgap. These electrons move from the valance band to the conduction band and create holes in the valance band.
- Therefore, if the potential difference exists within the cell, the electrons of the conduction band and holes of the valance band made the flow of current in the circuit.





# Solar Power Plants

- 1: Extra power is sent to the utility company.
- 2: Power from the utility company when needed .



**Working of Solar Power Plant**





# *Solar Power Plants*



- **Components of Solar Power Plant**
- The major components of the solar photovoltaic system are listed below.
  - Photovoltaic (PV) panel
  - Inverter
  - Energy storage devices
  - Charge controller
  - System balancing component



# Solar Power Plants



- **Photovoltaic (PV) Panel**
- PV panels or Photovoltaic panel is a most important component of a solar power plant. It is made up of small solar cells. This is a device that is used to **convert solar photon energy into electrical energy**.
- Generally, silicon is used as a semiconductor material in solar cells. The typical rating of silicon solar cells is 0.5 V and 6 Amp. And it is equivalent to 3 W power. The number of cells is connected in series or parallel and makes a **module**.
- The number of modules forms a solar panel.
- According to the capacity of power plants, a number of plates are mounted and a group of panels is also known as Photovoltaic (PV) array.





# Solar Power Plants



- **Inverter**
- The output of the solar panel is in the **form of DC**. The most of load connected to the power system network is in the form of AC. Therefore, we need to convert **DC output power into AC power**. For that, an inverter is used in solar power plants.
- For a large-scaled grid-tied power plant, the inverter is connected with special protective devices. And a **transformer** is also connected with the inverter to assures the output voltage and frequency as per the standard supply.



# Solar Power Plants



- **Energy storage devices**
- The batteries are used to **store electrical energy** generated by the solar power plants.
- The storage components are the most important component in a power plant to meet the demand and variation of the load.
- This component is used especially when the sunshine is not available for few days.
- The capacity of a battery is that how much amount of electrical power it can store.
- The capacity of batteries is measured in **Ampere-hours (AH) rating.**



# *Solar Power Plants*



- There are two types of batteries used in the solar power plant;
- Lead-Acid battery
- Nickel-Cadmium battery



# Solar Power Plants

- **Charge Controller**
- A charge controller is used to **control the charging and discharging of the battery.**
- The charge controller is used to avoid the overcharging of the battery.
- The overcharging of a battery may lead to **corrosion and reduce plate growth.** And in the worst condition, it may damage the electrolyte of the battery.



# Solar Power Plants



- **System balancing component**
- It is a set of components used to **control, protect and distribute power in the system.**
- These devices ensure that the system **working in proper condition** and utilize energy in the proper direction. And it ensures maximum output and security of other components of a solar power plant.



# Solar Power Plants



- **Blocking diode**

- The solar PV panels are connected with a battery.
- And these panels are used to charge the battery during sunlight is available.
- During charging of the battery, the current flows from panel to battery.
- But when the sunlight is not available, the current **can be flow in a reverse direction and it may harm the solar panel.**
- So, the blocking diode is a diode that is connected between the battery and panel to avoid reversal current from battery to panel.





# Solar Power Plants



- **Voltage regulator**
- The output of solar panels depends on sunlight.
- And the sunlight is not constantly available.
- It is continuously varying. Similarly, the output of the solar panel is also varying with respect to sunlight. This results in fluctuation in load current. The voltage regulators are **used to maintain fluctuation within an acceptable range.**



# Solar Power Plants



- **Advantages**
- Solar energy is a **clean and renewable source of energy** which is an unexhausted source of energy.
- After installation, the solar power plant produces electrical energy at **almost zero cost**.
- The **life of a solar plant is very high**. The solar panels can work up to 25 years.
- This plant is **not causing pollution**.
- There are **no moving parts in solar cells**. So, maintenance is not needed to keep a solar plant running.
- It **does not produce any noise**.
- For a bulk generation, this plant can be installed in any land. So, there are **no specific site selection criteria** like thermal and hydropower plants.
- The solar plant can be **installed on the house or flat**. So, it reduces the transmission cost as it generates energy near the load center.



# Solar Power Plants



- **Disadvantages**
- The **initial cost of a solar panel is very high.**
- It requires large land to produce electrical power in bulk amounts.
- The solar plant is only installed in countries where **sunline is available efficiently.**
- During a cloudy atmosphere, the solar plant cannot operate efficiently.
- The **efficiency of a solar panel is very less.**



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