Energy and Environmental Engineering
CEME 102

Dr. Kamlesh S.

Assistant Professor, MED

SVNIT Surat

GLOBAL AND NATIONAL ENERGY SCENARIO. **(1 hours)**

INTRODUCTION TO ENERGY SOURCES **(2 hours)**

Classification of Energy Sources in terms of Primary and Secondary Sources, Commercial and Non Commercial Sources of Energy; Renewable and Fossil based Sources of Energy;

INTRODUCTION TO FUELS AND ITS PROPERTIES **(1 hours)**

INTRODUCTION TO VARIOUS ENERGY CONVERSION SYSTEMS **(6 hours)**

like Power Plant, Pump, Refrigerator, Air Conditioner, Internal Combustion Engine, Solar PV Cell, Solar Water Heating System, Biogas Plant, Wind Turbine System general functioning including their normal rating specifications.

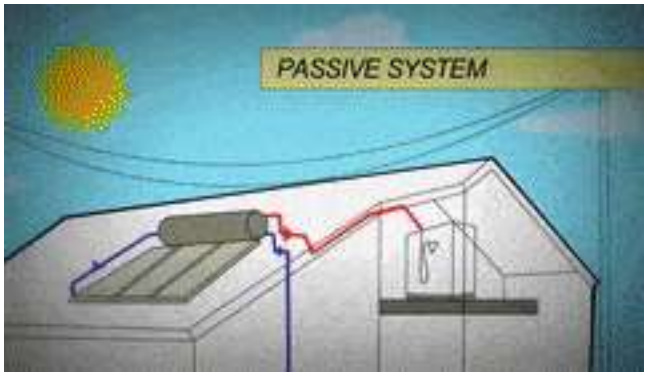
ASPECTS OF ENERGY CONSERVATION AND MANAGEMENT **(4 hours)**

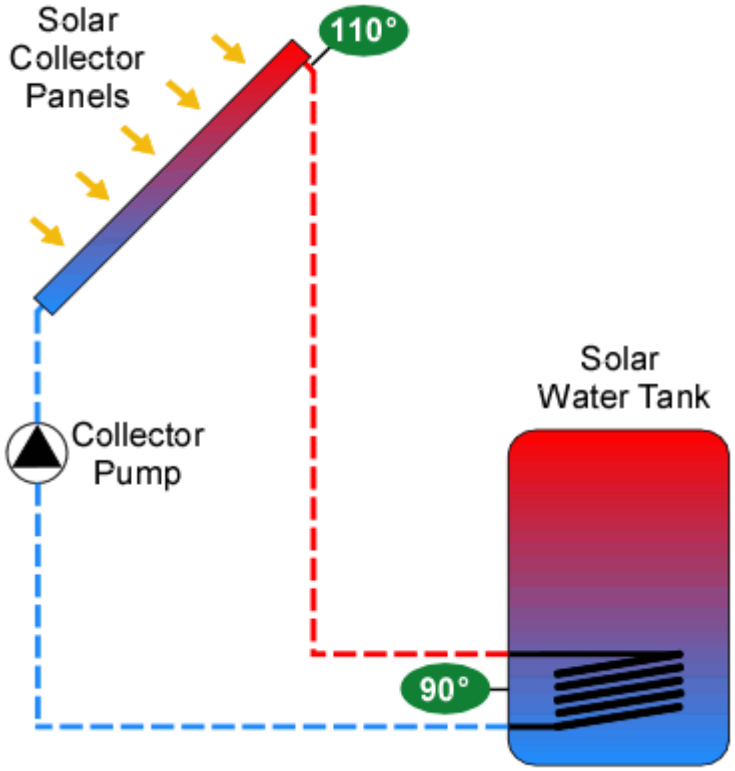
Energy Conservation Act, Energy Policy of Company; Need for Energy Standards and Labelling; Energy Building Codes.

ENERGY STORAGE IN BATTERIES **(2 hours)**

Type of batteries; Electric Vehicles

Solar Water Heating System (SWHS)





Active System

solar radiation has an intensity of approximately 1380 watts per square meter (W/m2).

Content

- Solar water heating System (SWHS)
- Components
- Working
- Application/Uses
- Types
- Working Video

Solar water heating System

- Solar water heating system is a device that uses solar energy to heat water for domestic, commercial, and industrial needs.
- Heating of water is the most common application of solar energy in the world.
- A typical solar water heating system can save up to 1500 units of electricity every year, for every 100 litres per day of solar water heating capacity.

Components of SWHS

- A solar water heating system consists of a **flat plate solar collector**, a **storage tank** kept at a height behind the collector, and **connecting pipes.**
- The collector usually comprises copper tubes welded to copper sheets (both coated with a highly absorbing black coating) with a toughened glass sheet on top and insulating material at the back. The entire assembly is placed in a flat box.
- In certain models, evacuated glass tubes are used instead of copper; a separate cover sheet and insulating box are not required in this case

Working of a solar water heater

- The system is generally installed on the roof or open ground, with the collector facing the sun and connected to a continuous water supply.
- Water flows through the tubes, absorbs solar heat and becomes hot.
- The heated water is stored in a tank for further use.
- The water stored in the tank remains hot overnight as the storage tank is insulated and heat losses are small.

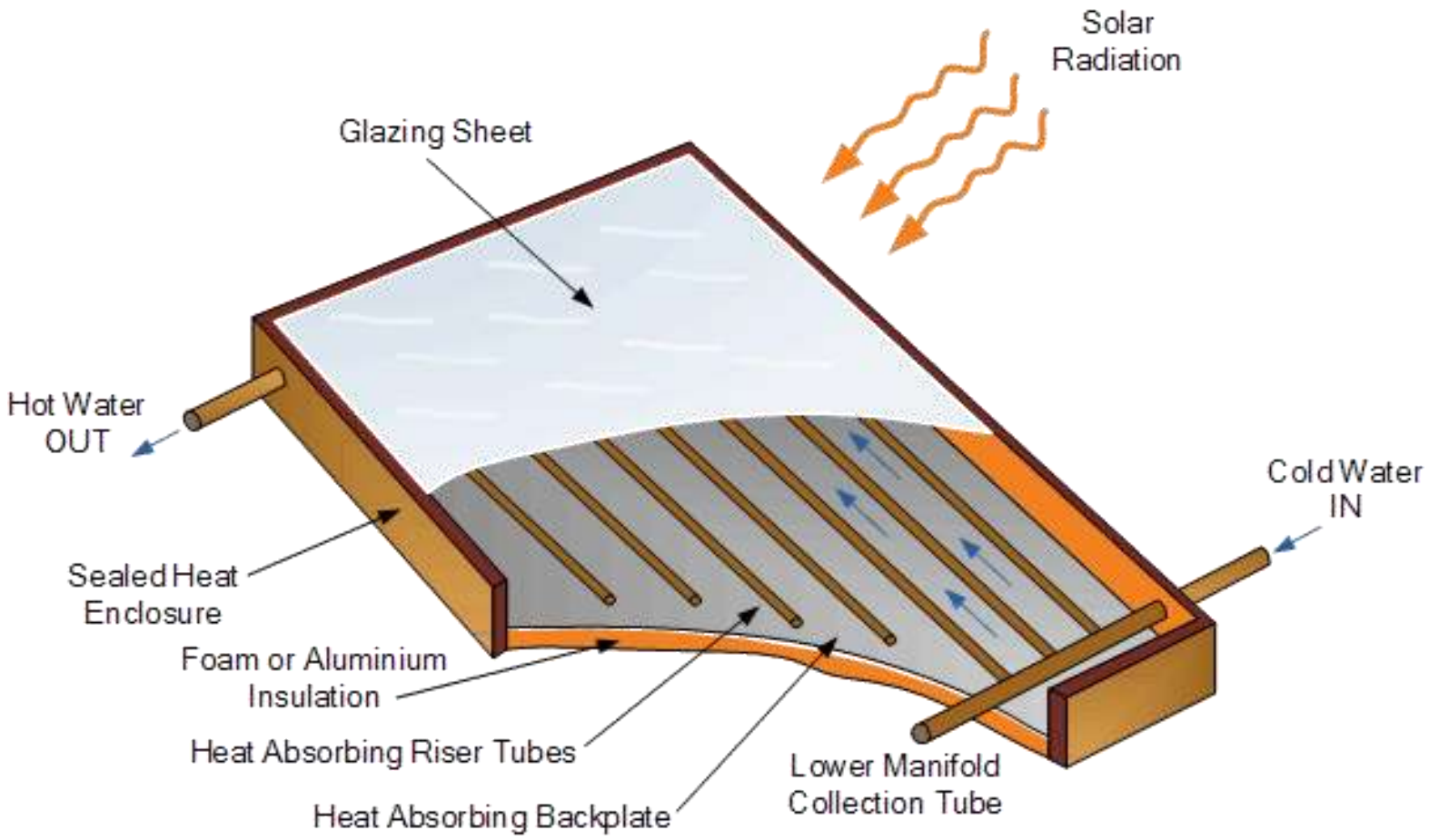
Uses of solar water heater

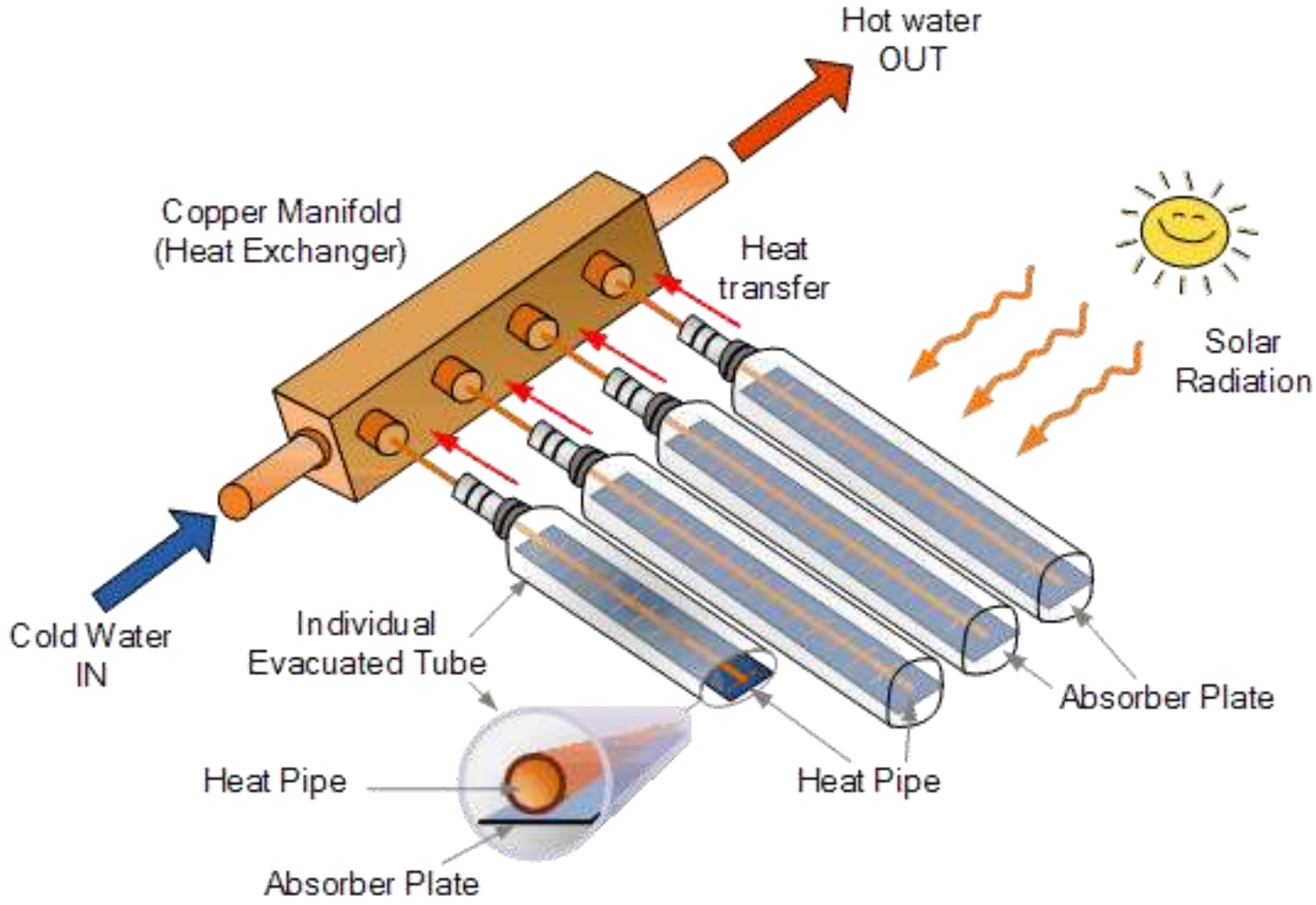
- SWHs can be used at homes for producing hot water that can be used for bathing, cleaning, and washing.
- Solar water heaters (SWHs) of 100-300 litres capacity are suited for domestic application.
- Larger systems can also be used for a variety of industrial applications. Hot water at 60-80^{o}C could be obtained through use of solar water heaters.
- Fuel Savings: A 100 litres capacity SWH can replace an electric geyser for residential use and saves 1500 units of electricity annually.
- Saves cost on power generation - The use of 1000 SWHs of 100 litres capacity each can contribute to a peak load saving of 1 MW.
- Environmental benefits - A SWH of 100 litres capacity can prevent emission of 1.5 tonnes of carbon-dioxide per year.
- Pay back period - SWHs have a life span of 15-20 years. The pay back period is about 3-4 years when electricity is replaced, 4-5 years when furnace oil is replaced and 6-7 years when coal is replaced

Types of SWHS

- **Flat plate collectors** – used in domestic solar water heating systems in India as they are relatively cheaper when compared to others.
- **Evacuated tube collectors-** also been proposed for domestic solar water heating systems, but are not commonly available.
- **Concentrating collectors -**are likely to be more useful for higher temperature applications such as power generation and industrial use.

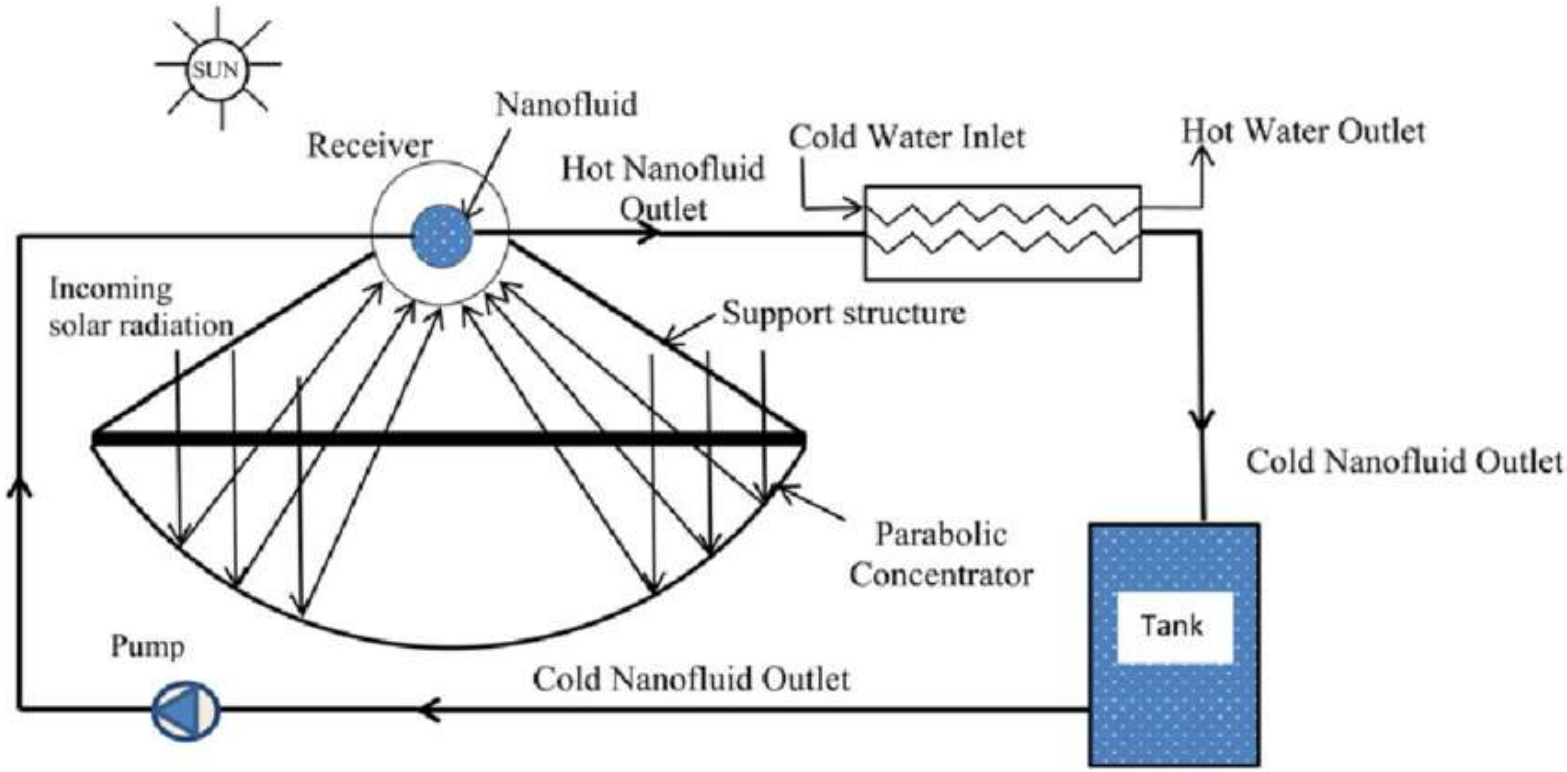
Flat plate collectors



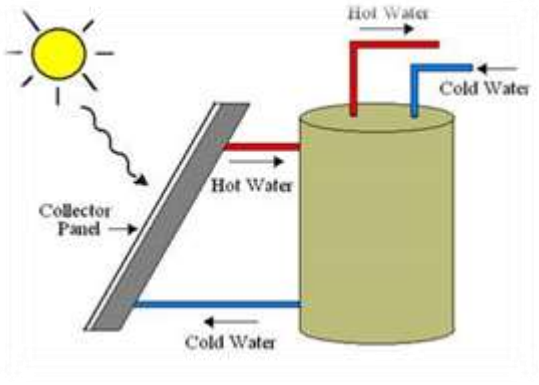


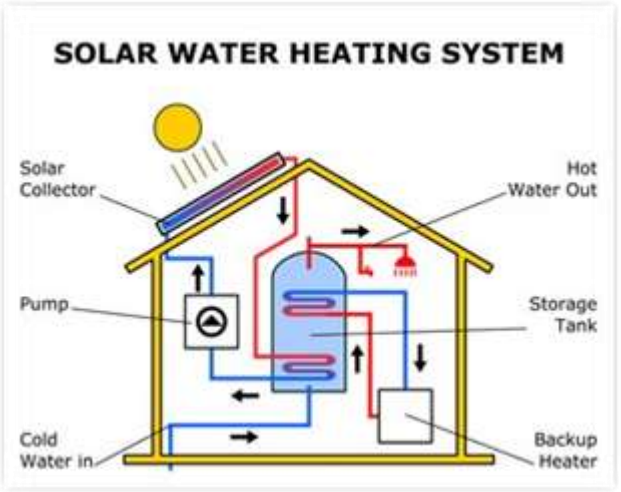
Evacuated tube collectors-

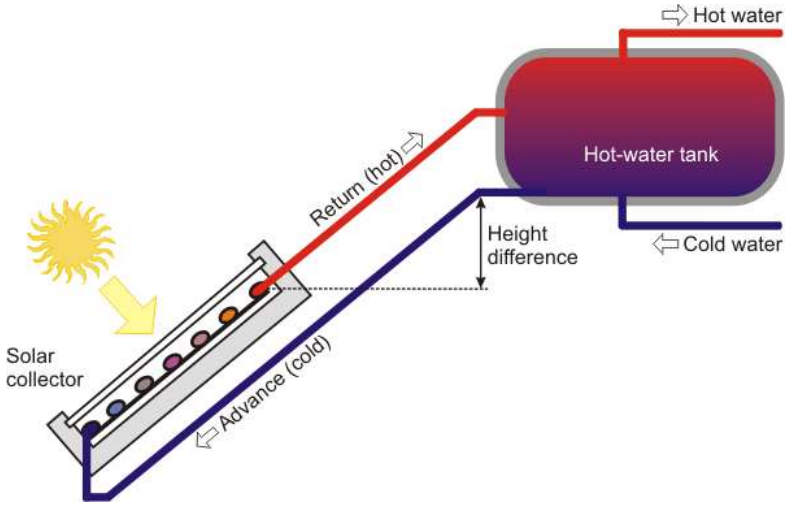
Concentrating collector



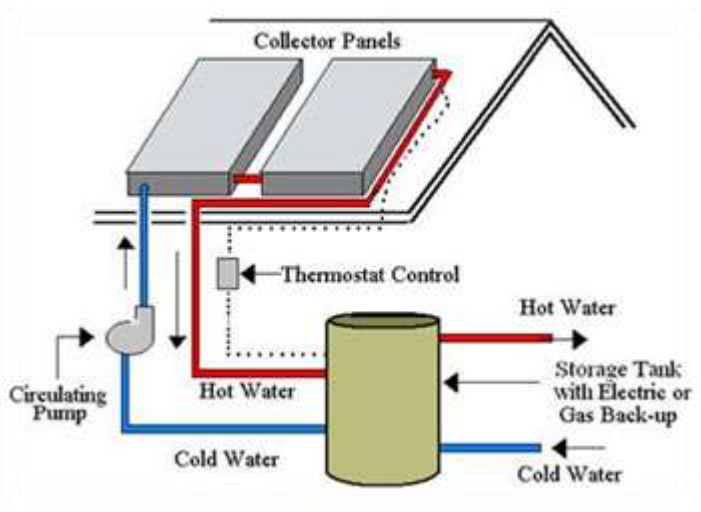
CS Water Heating System







Passive SWHS

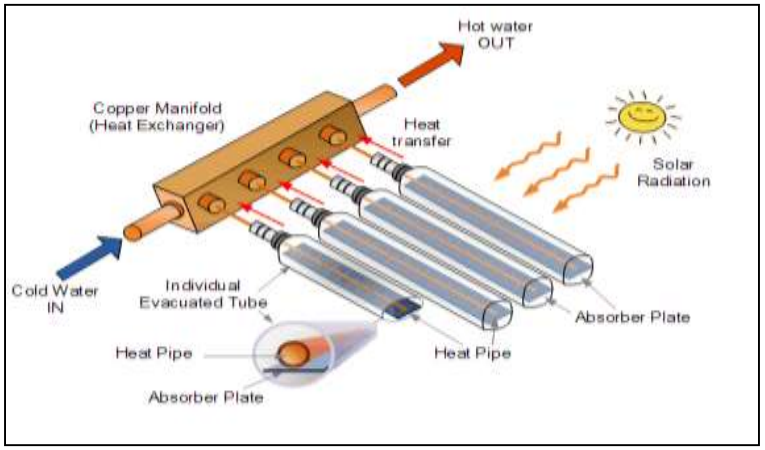


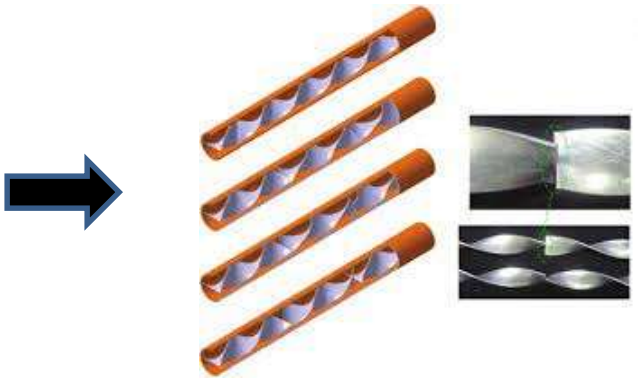
Active SWHS

Working video

- How SWH System works:
  - https://www.youtube.com/watch?v=YmP04fg7yOA
- How evacuated tube works
  - https://www.youtube.com/watch?v=BGsmlIoiJN8

Extra Stuff


Hot water
OUT
Copper Manifold
(Heat Exchanger)
Heat
transfer
Solar
Radiation
Cold Water
IN
Individual
Evacuated Tube
Absorber Plate
Heat Pipe
Heat Pipe
Absorber Plate




VS.
flat panel
evacuated tube

Solar Water Heaters Types and Benefits

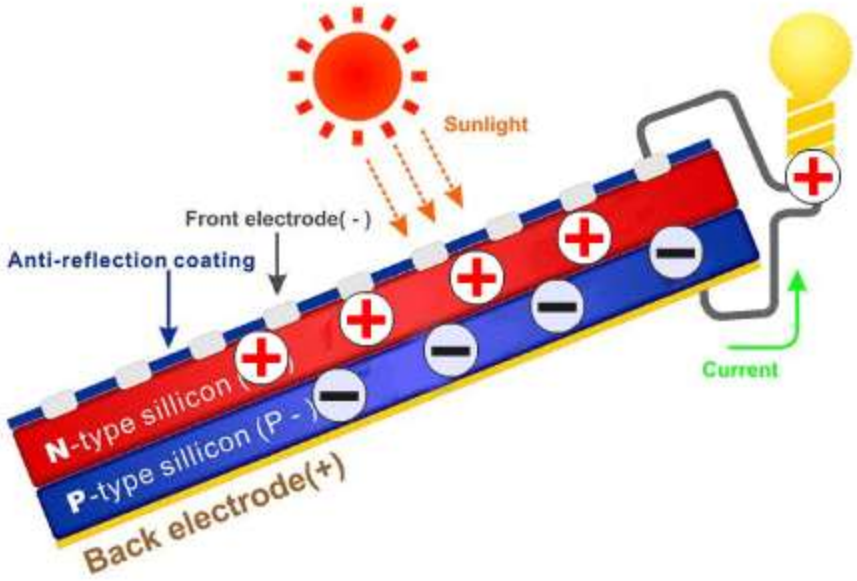
Flat Plate Collectors (FPC) System	Evacuated Tube Collectors (ETC) System
Long lasting as they are metallic. But are expensive	Fragile but cheaper.
Can work in colder regions with sub zero temperature but will need an anti freeze solution.	Very good for colder regions where the temperature is sub zero.
In places with salty water a heat exchanger is required with FPC system.	Require regular cleaning where the water is salty.

Benefits of a 100 lts Solar Water Heater in India.

	Northern Region	Eastern Region	Southern Region	Western Region
Expected no. of days of use of hot water per year	200 days	200 days	300 days	250 days
Expected yearly electricity saving on full use of solar hot water (units of electricity)	1000	1000	1500	1250

Bijli Bachao!
because saving electricity saves money

Solar PV System



Introduction to **PV**

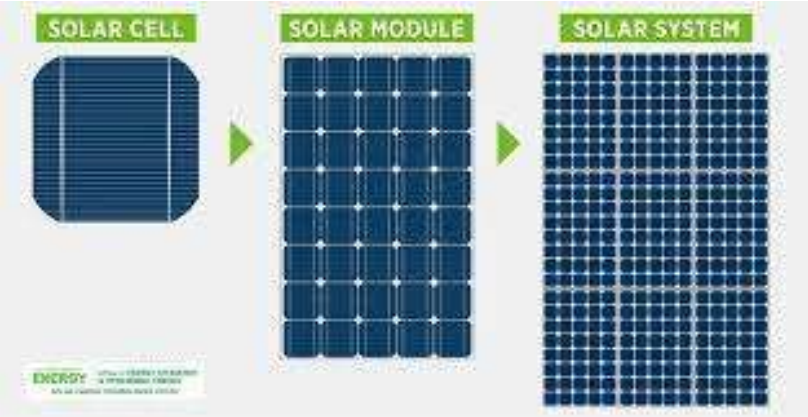
- A **solar cell**, or **photovoltaic cell**, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.
- PV materials and devices convert sunlight into electrical energy.
- A single PV device is known as a cell.
- An individual PV cell is usually small, typically producing about 1 or 2 watts of power. These cells are made of different semiconductor materials and are often less than the thickness of four human hairs.
- In order to withstand the outdoors for many years, cells are sandwiched between protective materials in a combination of glass and/or plastics.

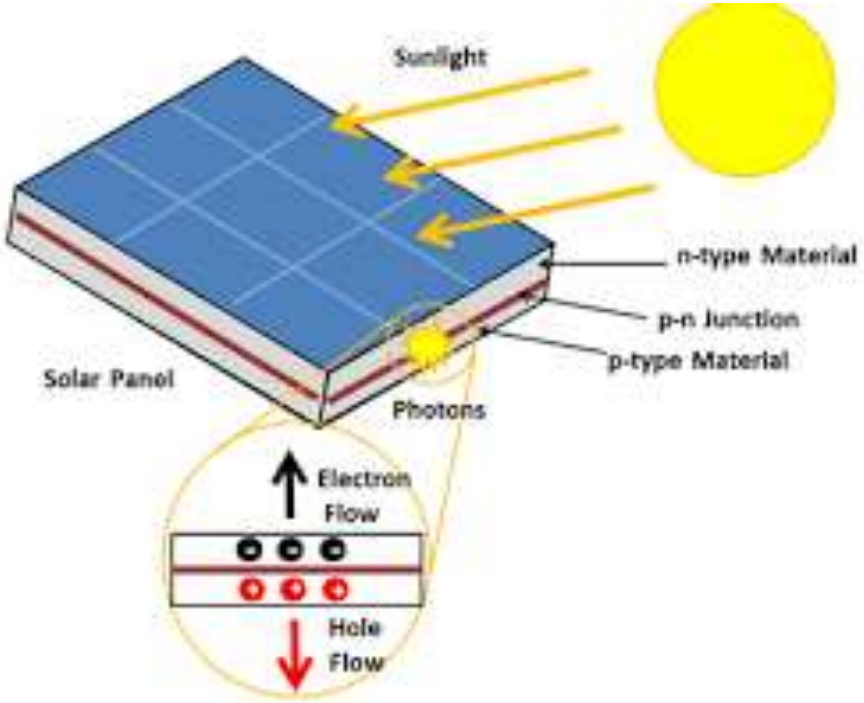
Working

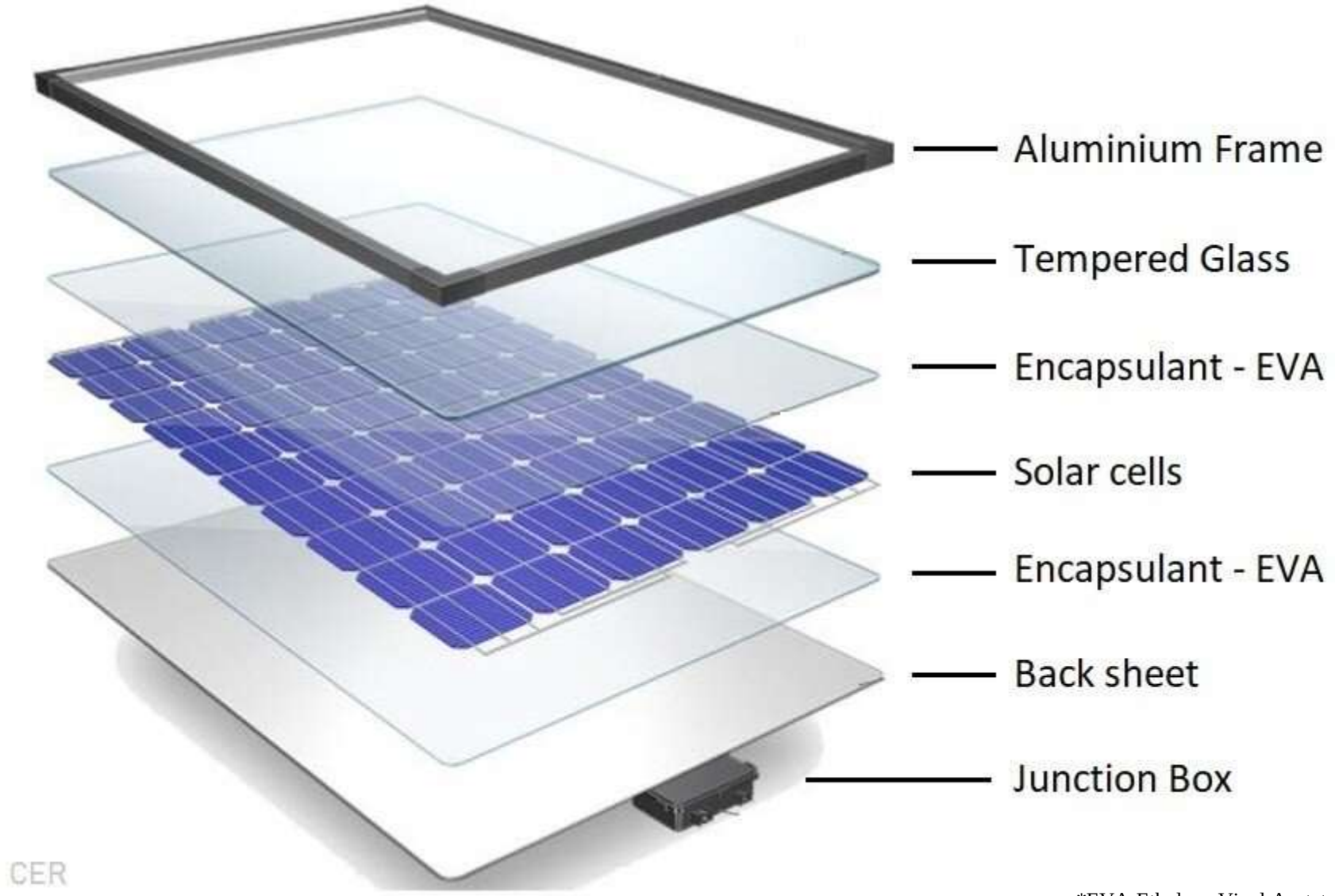
- The operation of a photovoltaic (PV) cell requires three basic attributes:
  - The absorption of light, generating either electron-hole pairs or excitons.
  - The separation of charge carriers of opposite types.
  - The separate extraction of those carriers to an external circuit.

Working video

- Working Principle of Solar PV cell:
  - https://www.youtube.com/watch?v=X0OZ6tpZ3Mc


SOLAR CELL
SOLAR MODULE
SOLAR SYSTEM

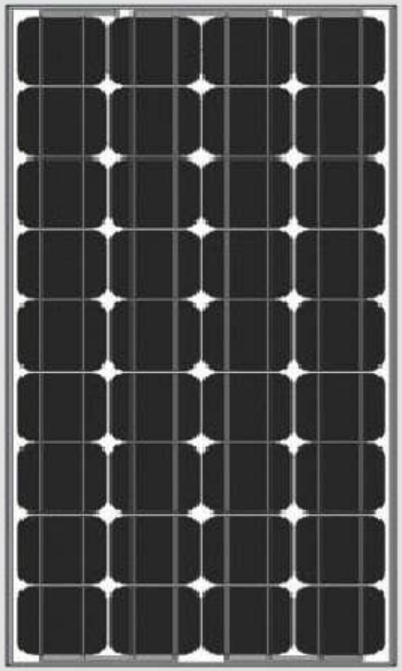

Sunlight
n-type Material
p-n Junction
p-type Material
Solar Panel
Photons
Electron Flow
Hole Flow



*EVA-Ethylene Vinyl Acetate

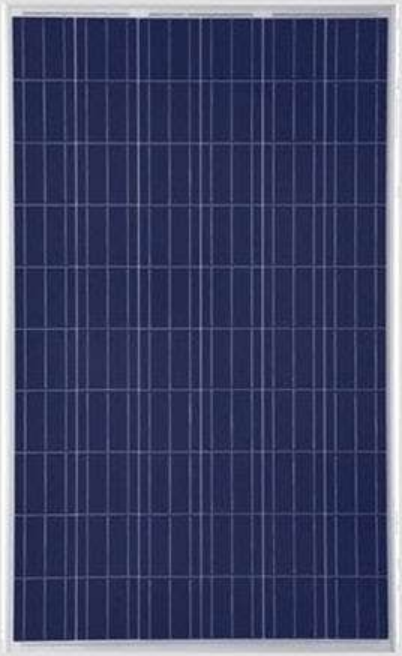
solar panel components

Mono Crystalline



VS

Poly Crystalline



Comparison chart: Monocrystalline vs. Polycrystalline solar panels

Parameters	Polycrystalline	Monocrystalline
Cost	Less expensive	More Expensive
Lifespan	+25 years	+25 years
Efficiency	Less Efficient	Highly Efficient
Appearance	Solar cells have a blue hue	Solar cells have a black hue
Manufacturing	The process is simpler	Waste of silicon during manufacturing

Applications

Kochi airport (about 65 Cr)

15MW Solar Plant in Gujarat

Indian railway solar panel system

Solar Trees

Solar energy with Farming