

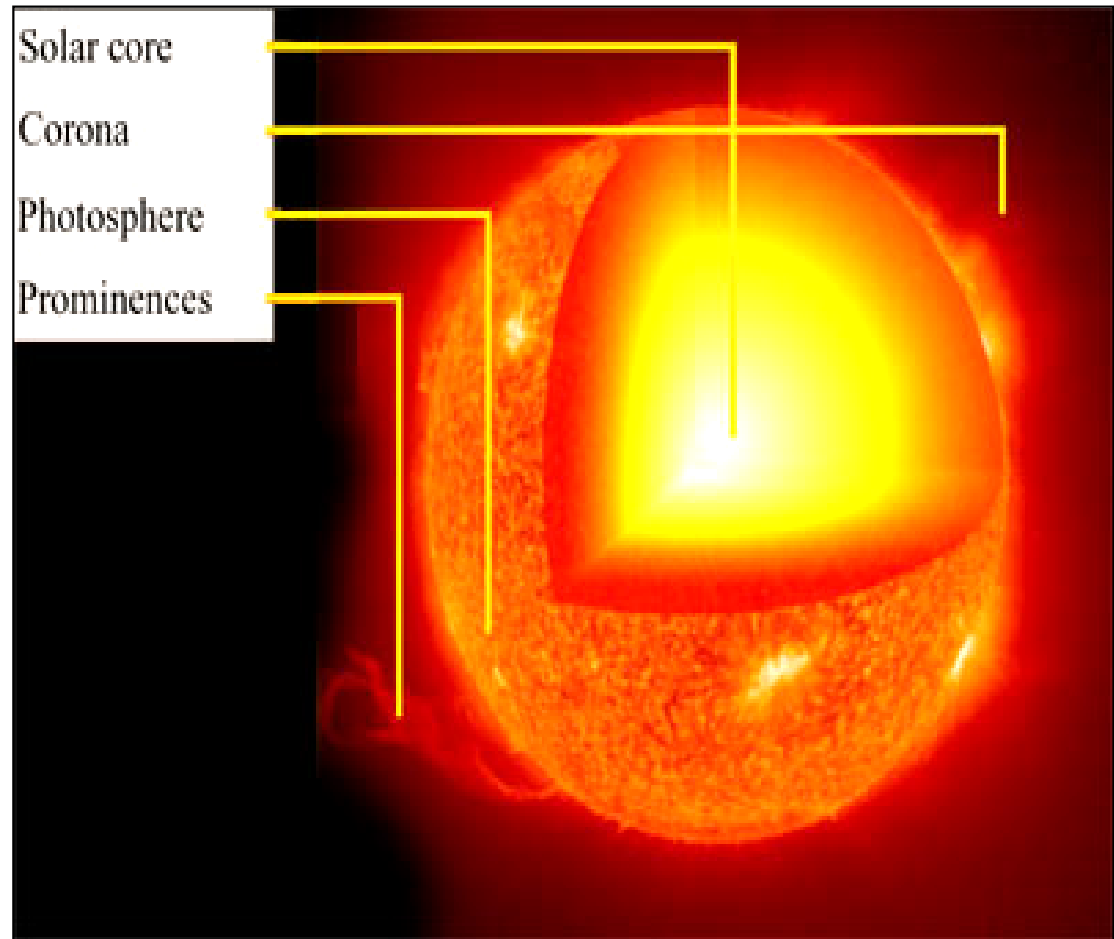
Solar Energy



RENEWABLE & SUSTAINABLE
ENERGY STUDIES

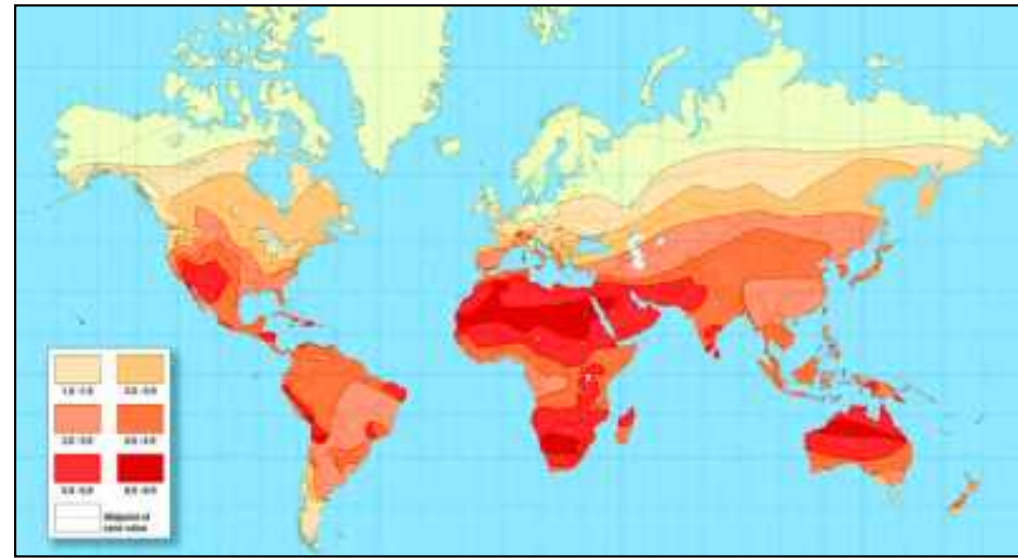
Solar Energy

- **Sun** is a **star**
- **Source of energy** in the sun is at its **core**
- This energy is **released** into space primarily as **electromagnetic radiation**
- We experience this **radiation** as **heat** and **light**

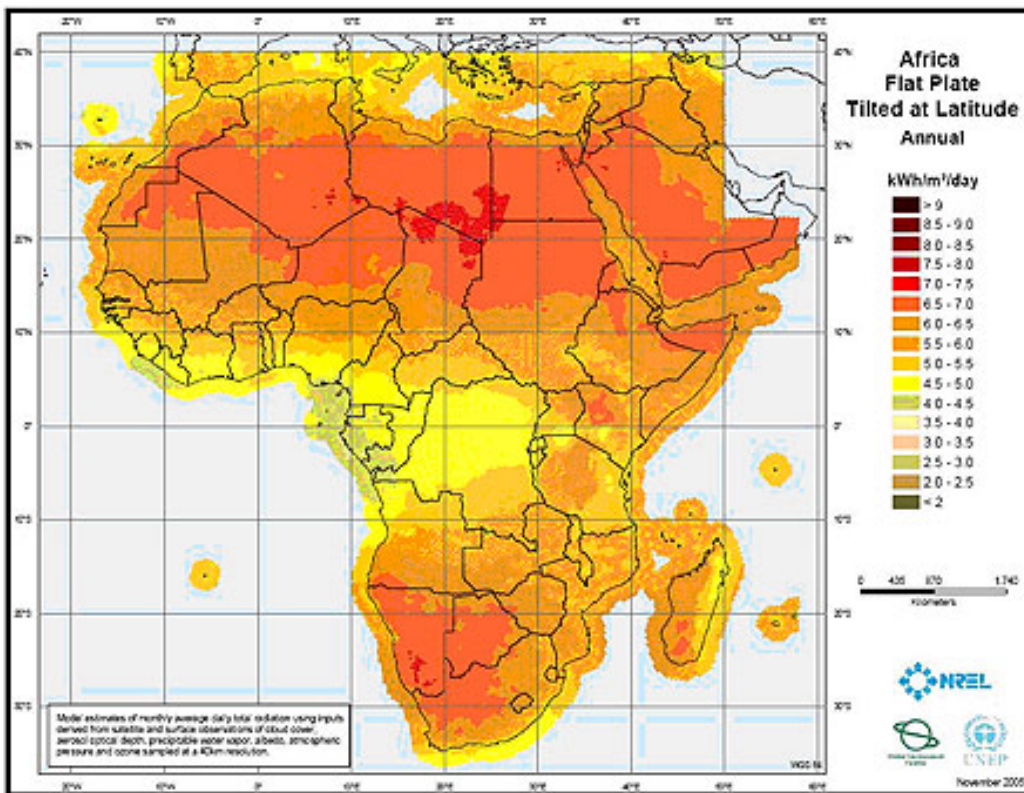


The Sun

**Every hour,
enough sunlight energy
reaches the Earth
to meet the world's energy
demand
for a whole year**



The **dark red spot**, roughly over the highlands of **South Africa** indicates the spot of **highest solar insolation** in the world. **South Africa** has the perfect climate for solar energy



How Powerful is it?

Solar Energy

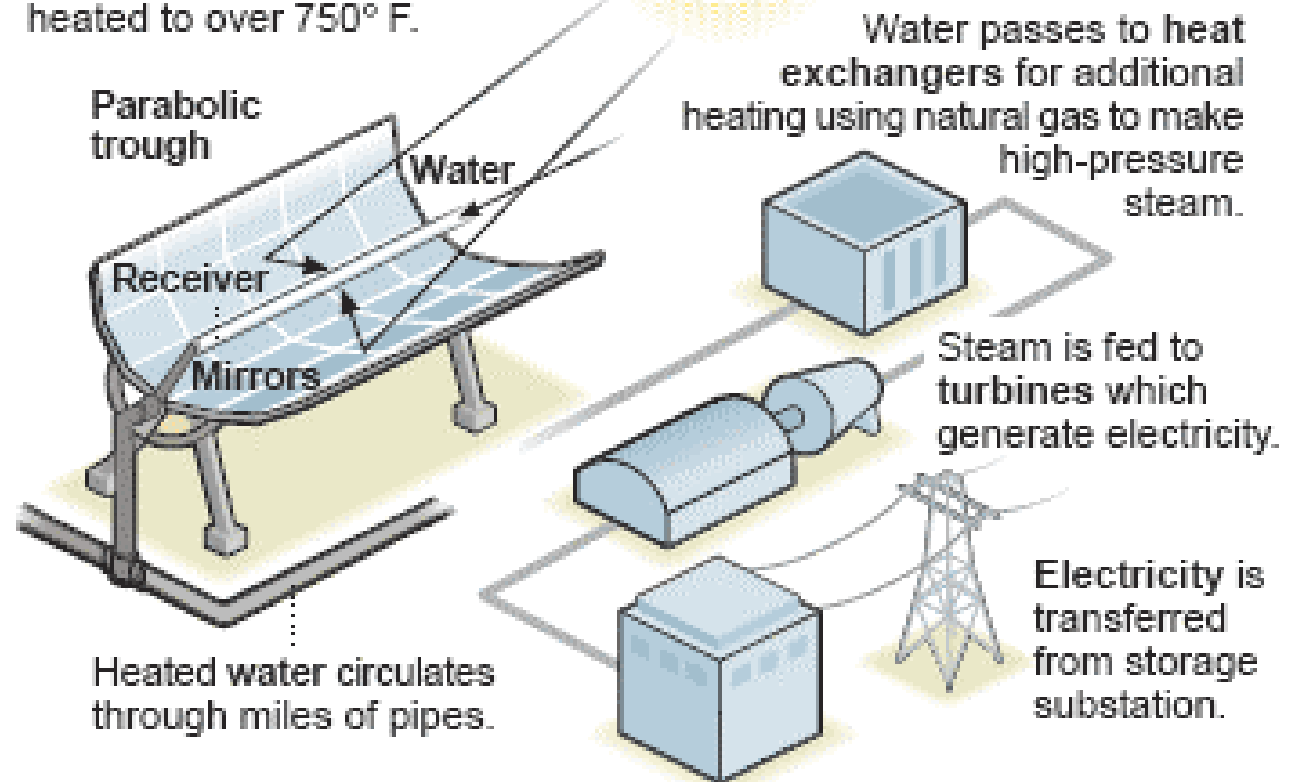
Three main uses of solar energy:

- Heating of water
- Solar thermal power station
- Photovoltaic panels

Making electricity from the sun's heat

Concentrated solar power
A field of tracking mirrors focuses sunlight onto a glass receiver containing water that can be heated to over 750° F.

The sun's reflected radiation intensifies 30 to 100 times on receiver.



SOURCES: Energy Information Administration; Schott Corporation

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Solar Energy

Concentrated Solar Thermal Power Plants

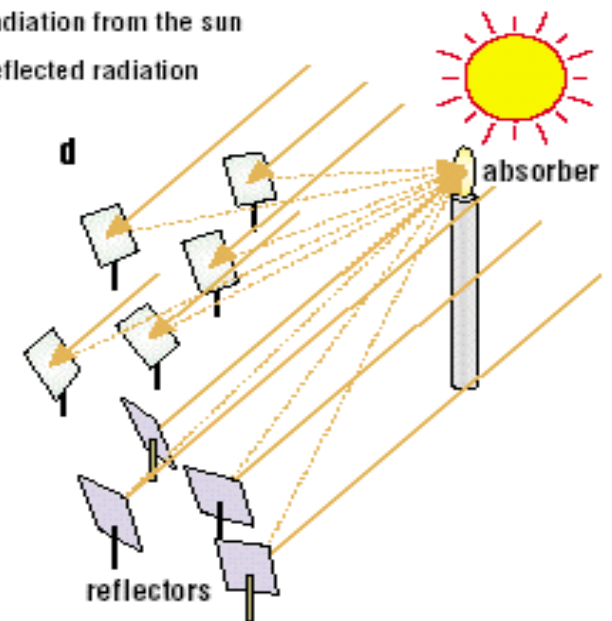
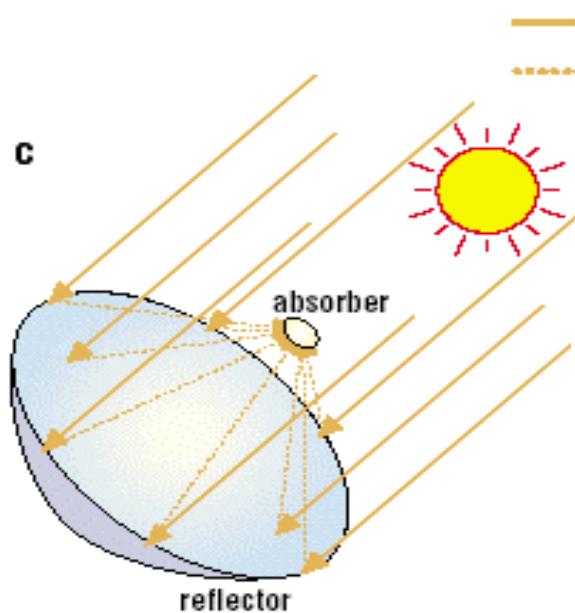
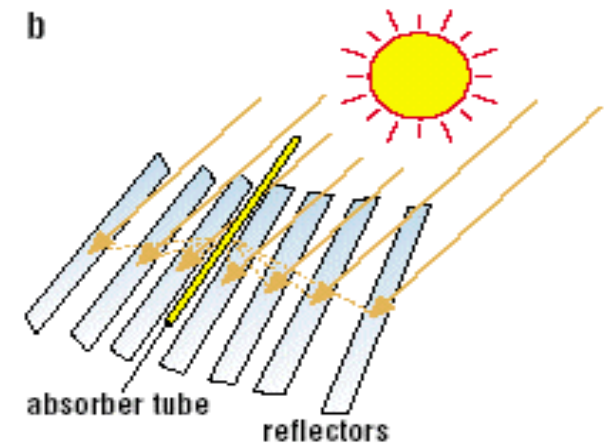
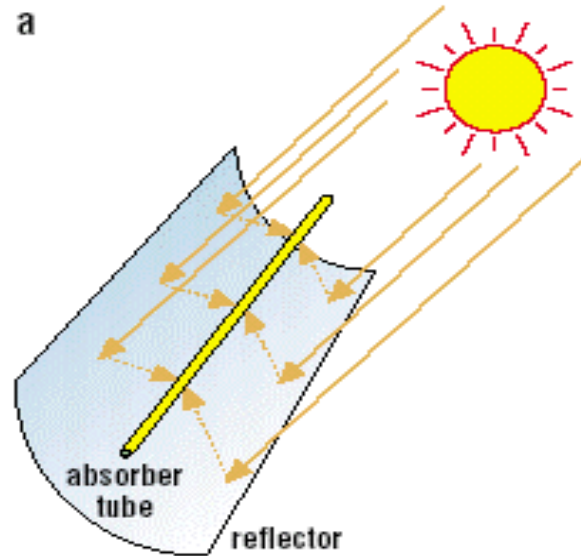
Solar energy
is concentrated to
a central receiver

a. Parabolic Through

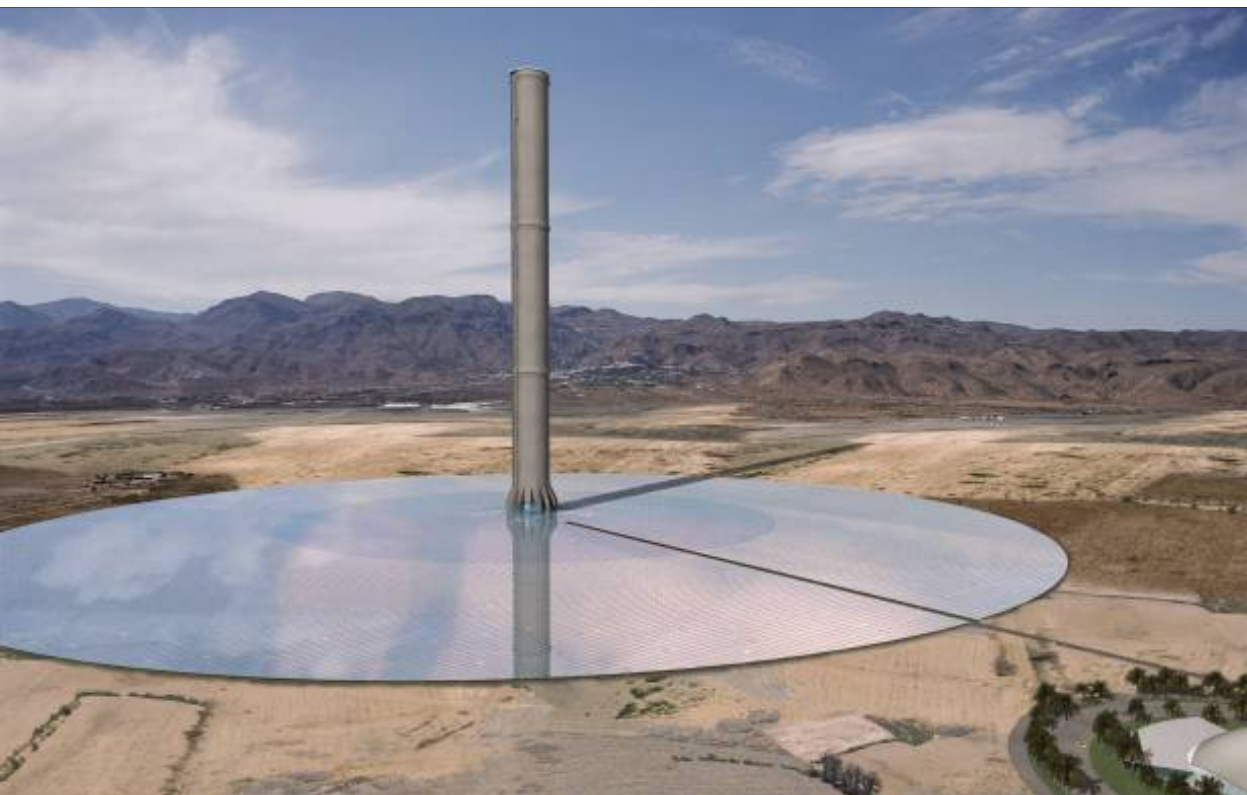
b. Fresnel

c. Parabolic Dish

d. Central Receiver



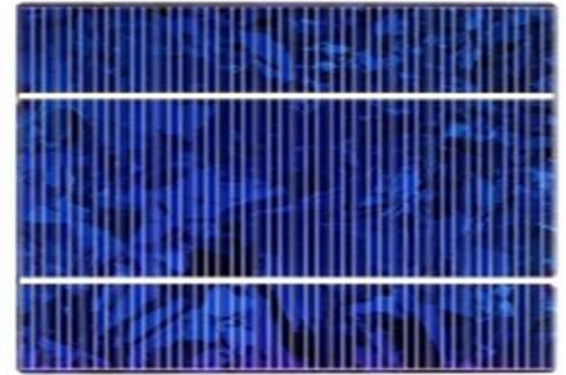
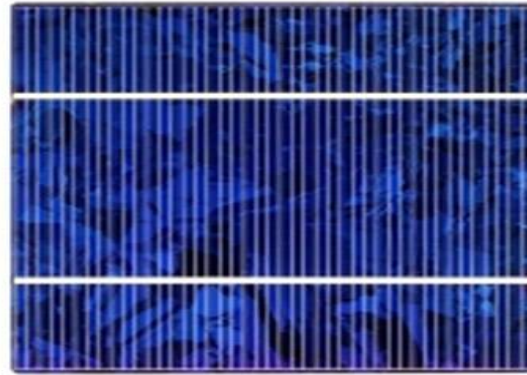
Concentrated Solar Energy



Solar Thermal Power Plants

Photovoltaic Effect

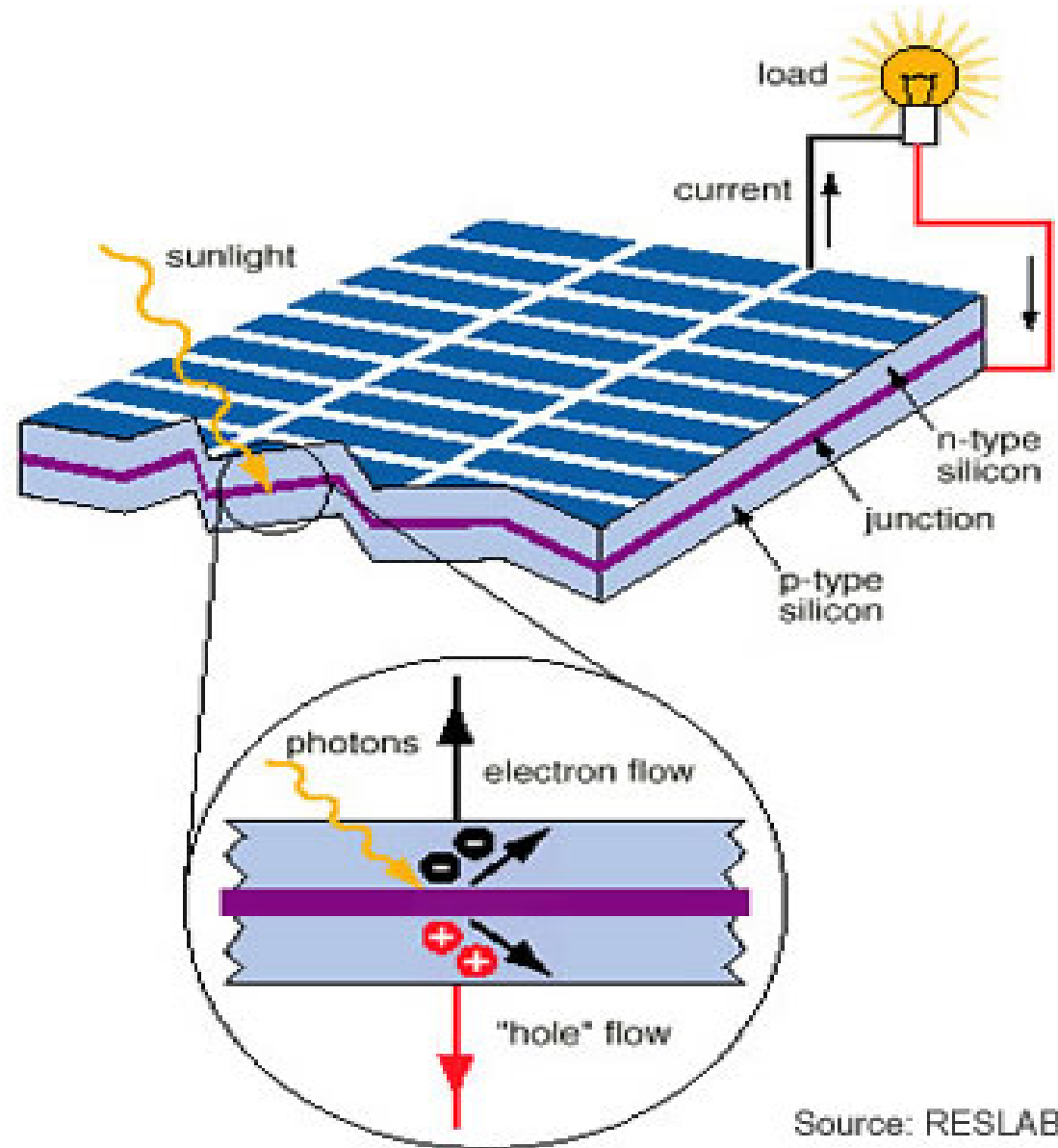
- **Converting solar energy** to **electrical energy** by means of solar cells = **photovoltaic effect**
- **Photovoltaic panel** is a **group** of **solar cells**
- **Solar cells** are predominantly made from **silicon**



Photovoltaic Effect

Photovoltaic Panels

- PV panels consist of **semiconductors**
- PV cells have two layers of semiconductors, one **positively charged** and one **negatively charged**
- When **light shines** on semiconductor, the **electric field across the junction** between these two layers causes **electricity** to flow
- The greater the intensity of light, the greater the flow of electricity



Photovoltaic Panels



Photovoltaic Power Plants

Solar Water Heating

- Indirect system uses **heat transfer fluid** to move heat from solar collector to tank
- Direct solar systems **heat the water**

Water in direct system circulated in two ways:

- **Active system** **circulation pump transfer** heat from collector to solar storage tank
- **Passive system** **no pump or control system** to transfer heat to storage tank

- **Two types** of solar collectors:

Flat panel

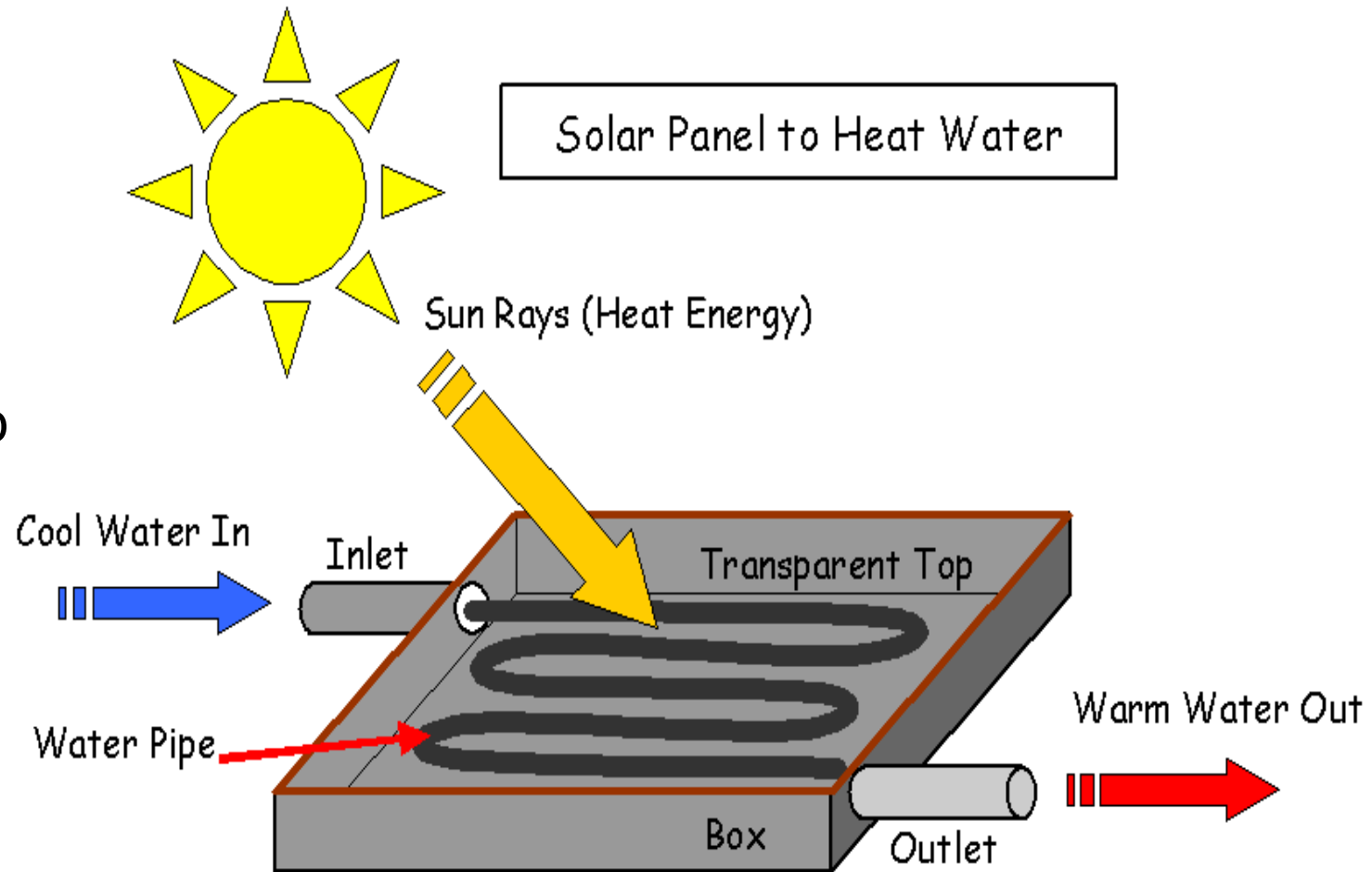
Evacuated Tube system



Solar Water Heating

Solar Flat Panel

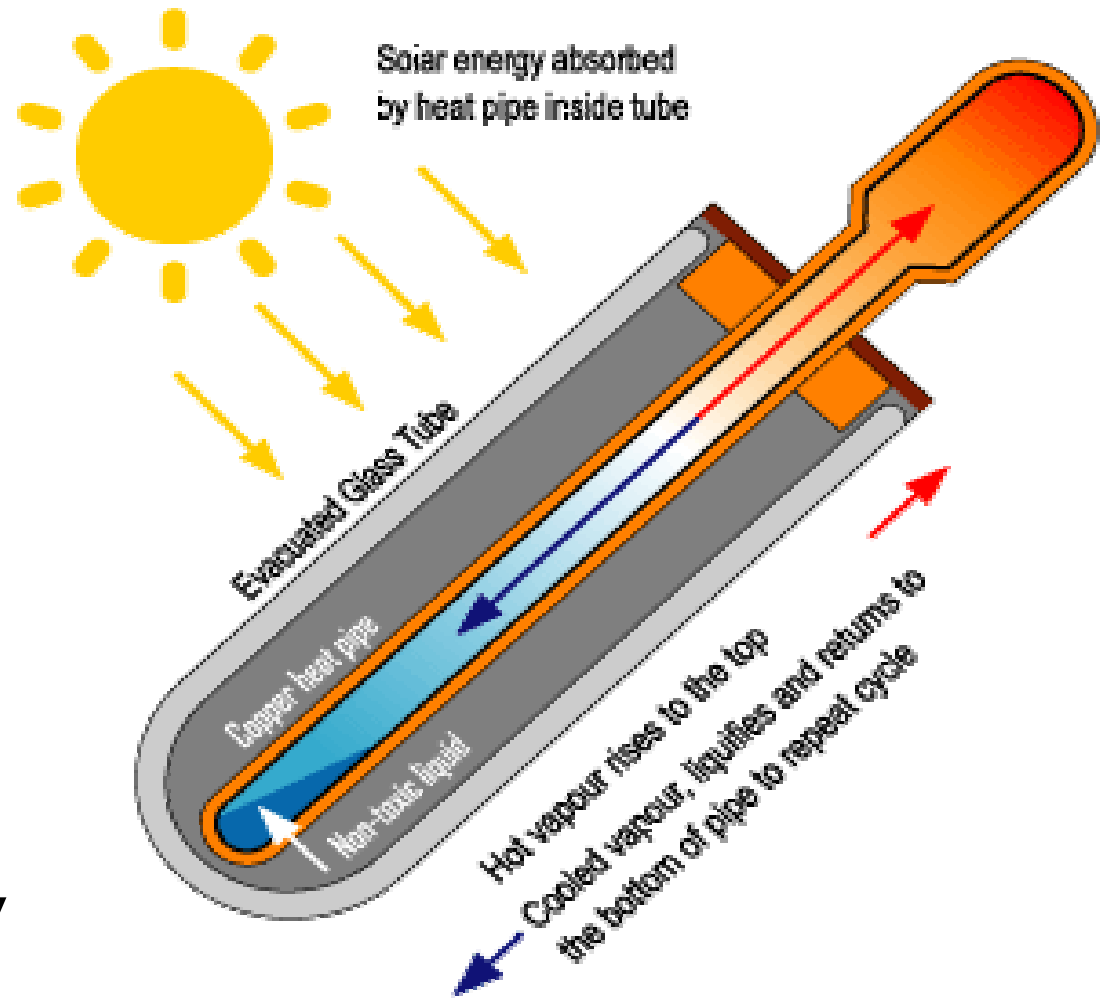
- Sun heats up water contained in dark vessel
- Can be used from domestic **hot water** and **space heating** to **swimming pool** heating, **solar-assisted** cooling, **industrial process** and **desalination** of drinking water



Solar Flat Panel

Evacuated Tube System

- **Absorber** inside vacuum tube **absorbs radiation** from **sun** and heats up fluid inside
- Additional radiation is picked up from **reflector** behind tubes
- **Whatever the angle** of sun the **round shape** of vacuum tube allows it to reach absorber
- On **cloudy day**, when light is coming from many angles, vacuum tube collector can still be effective



Evacuated Tube System