UNIVERSITEIT STELLENBOSCH UNIVERSITY

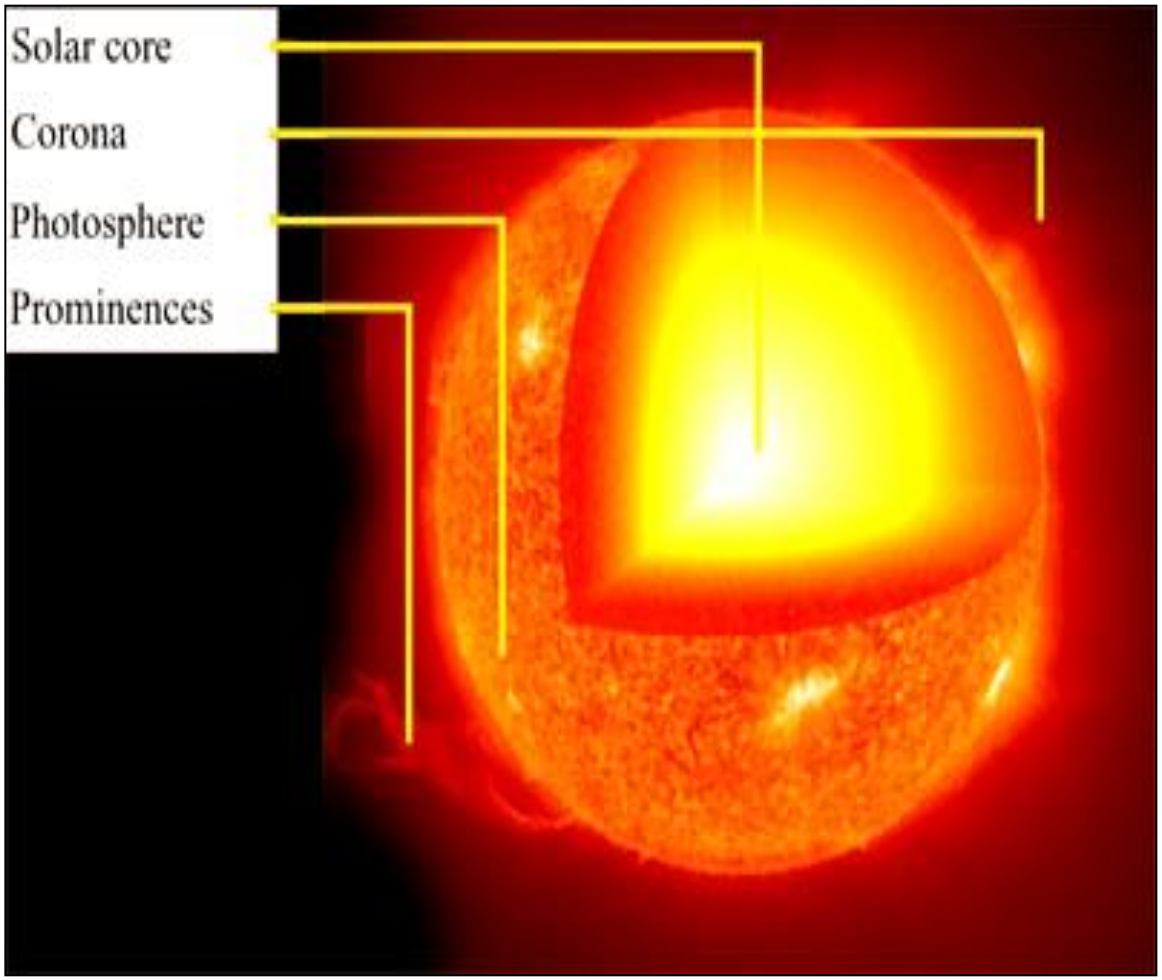
science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

Solar Energy

RENEWABLE & SUSTAINABLE ENERGY STUDIES

The Sun

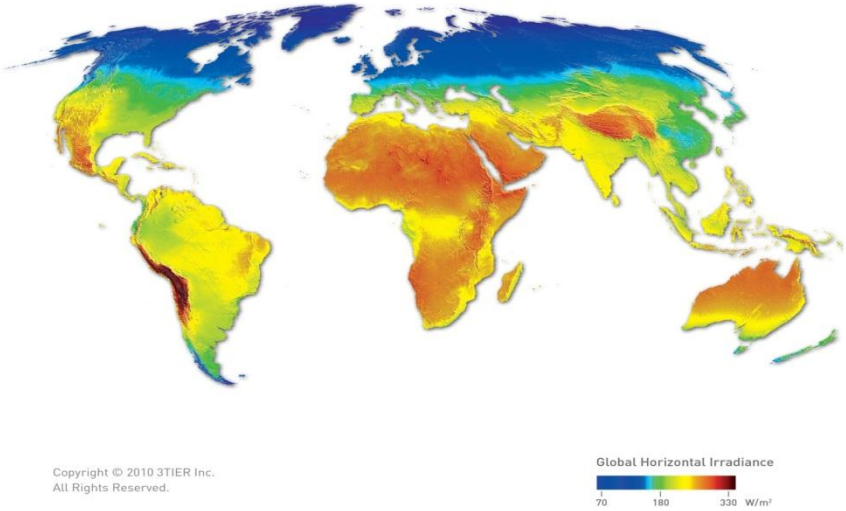
- The **sun** is a **star**
- **Source of energy** in the sun is at its **core**
- This energy is **released** into space primarily as **electromagnetic radiation**
- We experience this **radiation** as **heat** and **light**

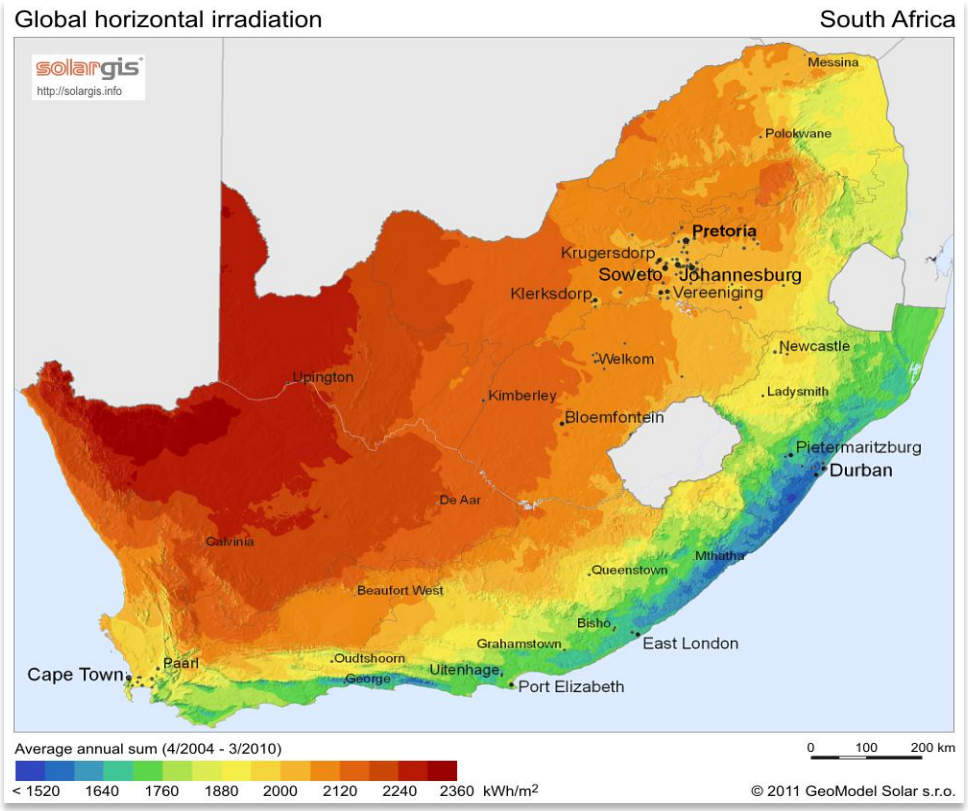


Solar Energy

How Powerful is Solar Energy?

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





- **South Africa** represents the spot of **highest solar insulation** in the world.
- **South Africa** has the **perfect climate** for **solar energy**

Solar Energy

Uses for Solar Energy

Three main uses:

- **Heating** of **water**
- **Solar thermal power stations**
- **Photovoltaic panels**

Solar Water Heating

- **Indirect system: heat transfer fluid** moves heat from solar collector to tank
- **Direct solar system: heats water directly**

Water in **direct system** circulated in two ways:

- **Active system: pumps** heated water from collector to solar storage tank
- **Passive system: no pump - thermosiphon**

- Two types of **solar collectors:**
  - **Flat panel**
  - **Evacuated Tube system**

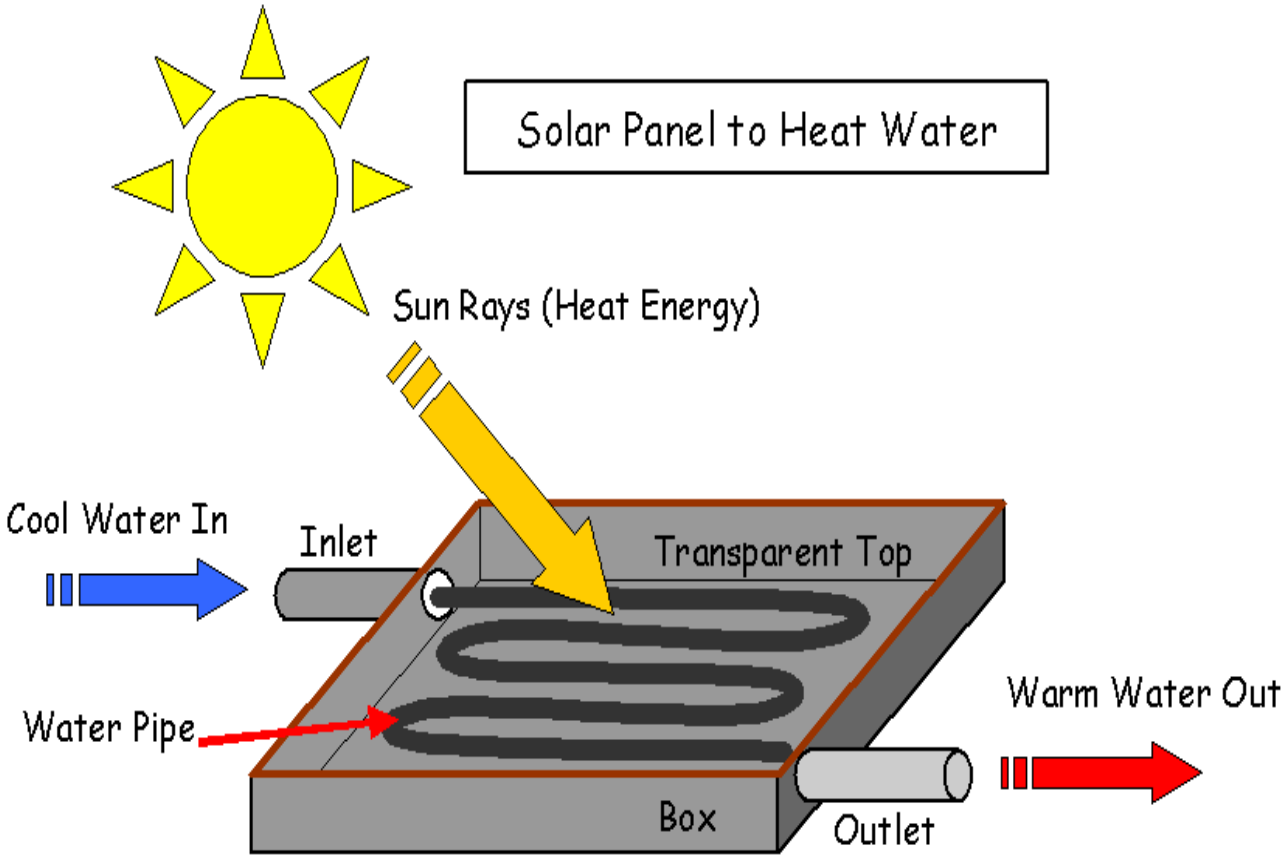
Solar Flat Panel

- **Glass-covered framework**

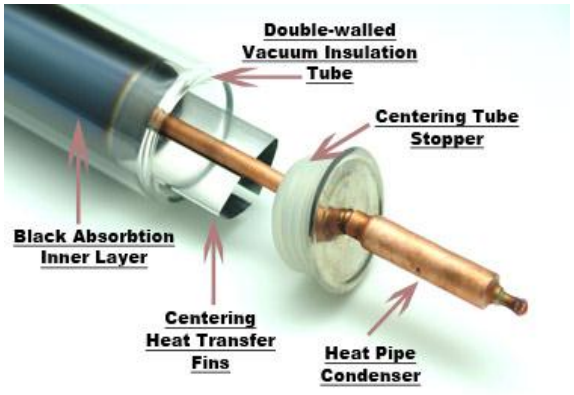
- Inside a series of **copper tubes** with **copper fins** attached

- Entire structure coated in **black substance** designed to **capture** the **sun's rays**

- Rays **heat water**, which **circulates** from the collector to an **isolated tank**



Evacuated Tube System

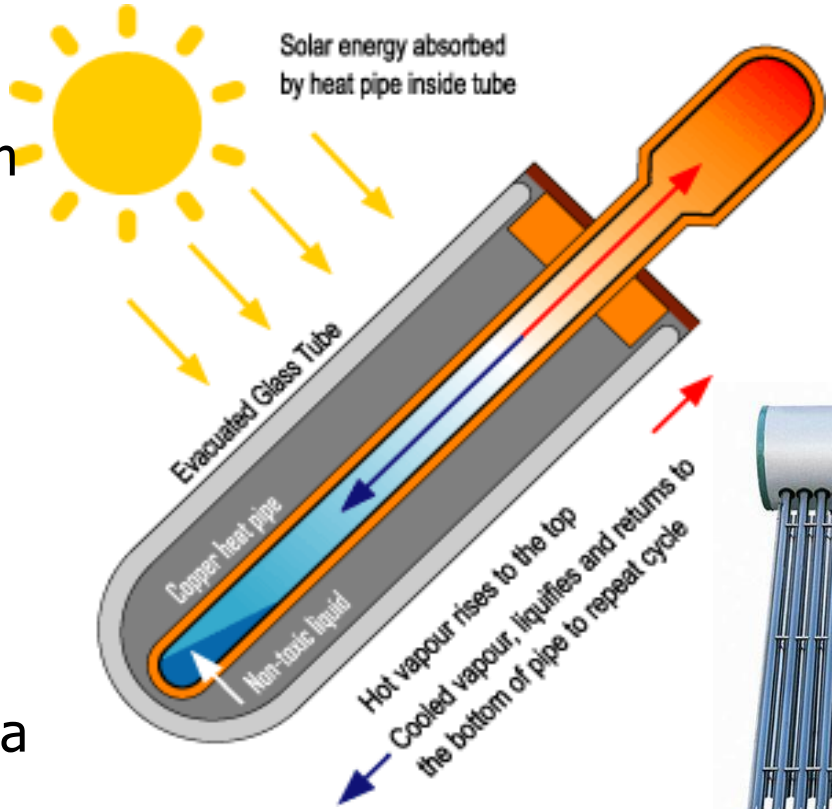


- Multiple **evacuated glass tubes** with **solar absorbers** collect heat energy from **sun**

- **Absorber** inside vacuum tube **absorbs radiation** from **sun** and heats up fluid inside the copper pipe

- Additional **radiation** is picked up from **reflector** behind tube

- Effective **whatever the angle of the sun** – even on a **cloudy day**



Solar Water Heating

Concentrated Solar Energy

- Used in **Concentrated Solar Thermal Power Plants (CSP)**

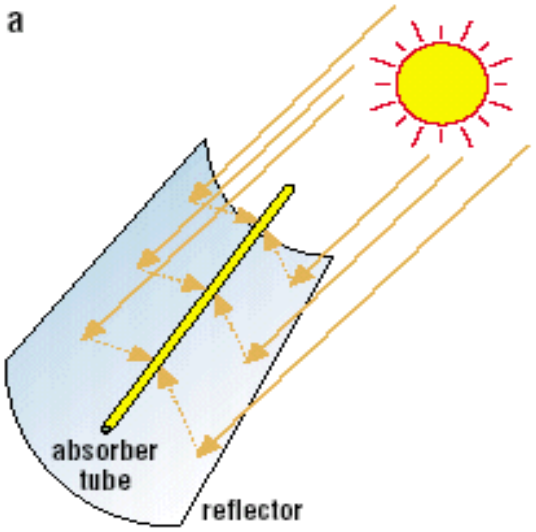
- **Solar energy** is **concentrated** to a **central receiver:**

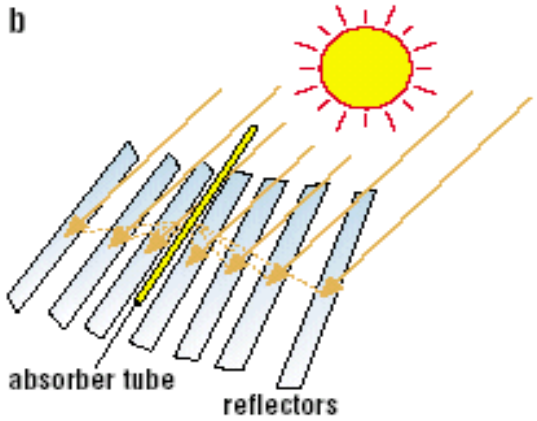
a. Parabolic Trough

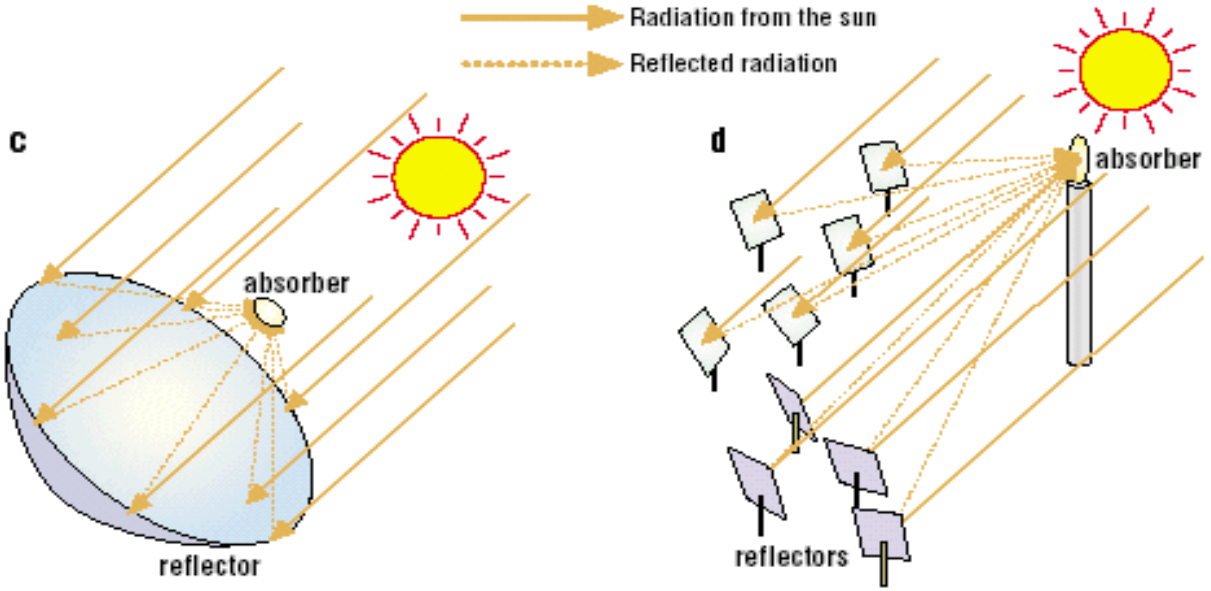
b. Fresnel

c. Parabolic Dish

d. Central Receiver







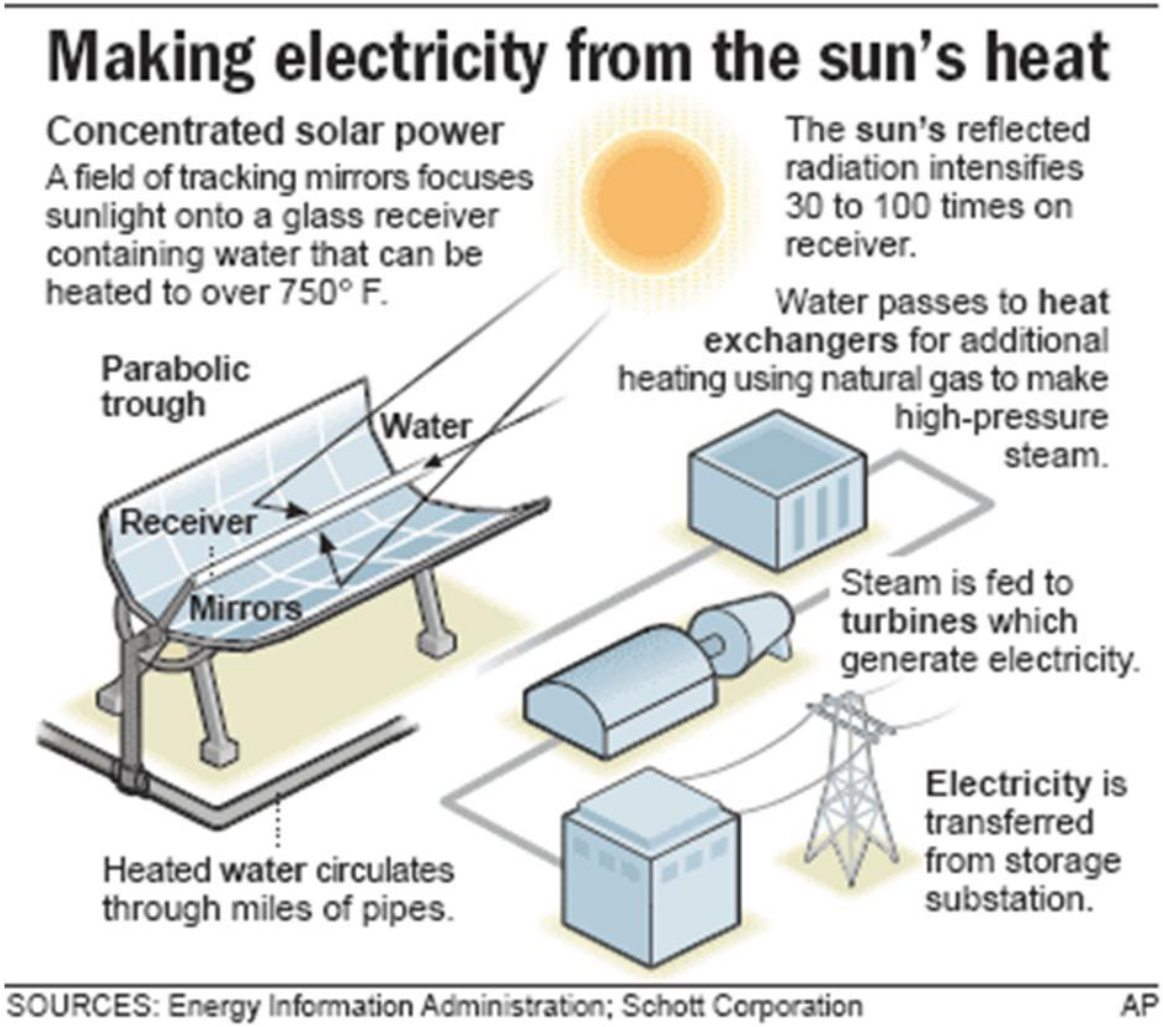
Concentrated Solar Thermal Power Plants

Converting Solar Energy (Heat) into Electricity

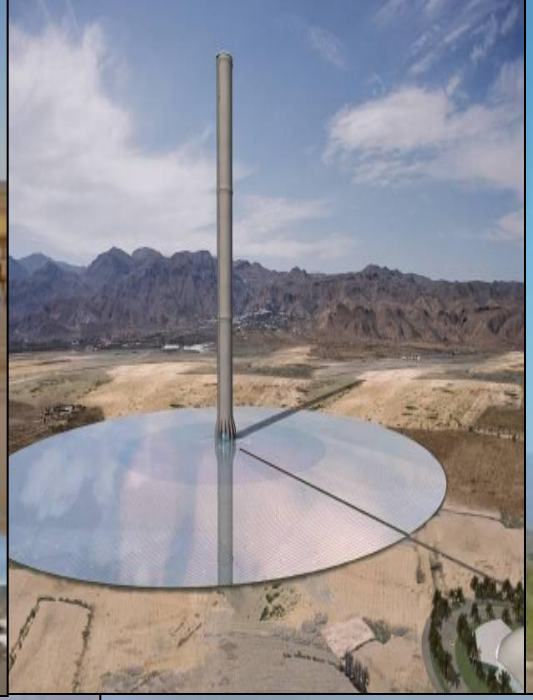
- A **solar thermal power plant** converts **solar energy** into electricity

- The **temperature** in a concentrated solar power station is high enough to produce **steam**

- The **steam** is fed into a turbine which **generates electricity**



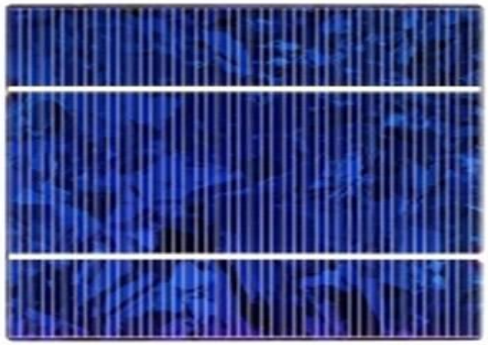
Concentrated Solar Thermal Power Plants

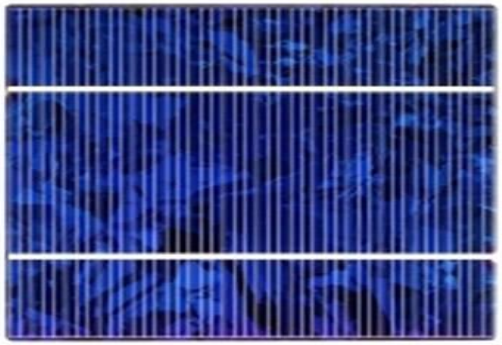





Concentrated Solar Thermal Power Plants

Photovoltaic Effect





- **Converting solar energy** to **electrical energy** by means of solar cells = **photovoltaic effect**

- **Photovoltaic panel** consists of a **group** of **solar cells**

- **Solar cells** are predominantly made from **silicon**, a **semiconductor**

Photovoltaic Panels

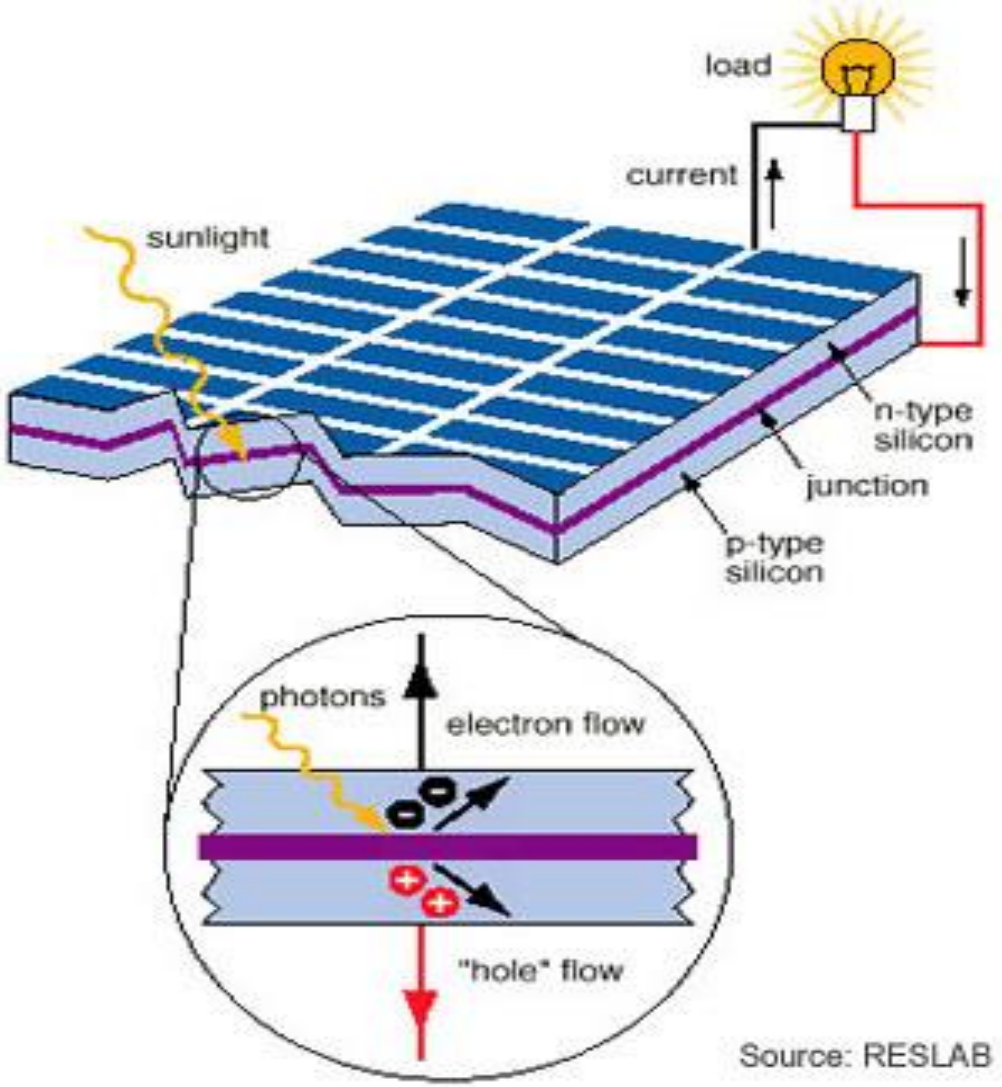
Converting Solar Energy (Light) into Electricity

- PV panels consist of **semiconductors**

- PV cells have two types of **semiconductors:** one **positively charged** and one **negatively charged**

- When **light** shines on the semiconductor, the **electric field** **across the junction** between these two layers causes an **electric current**

- The **greater** the **intensity** of **light**, the greater the flow of **electricity.**



Photovoltaic Panels

Photovoltaic Power Plants