

A collage of energy-related images. In the foreground, there are solar panels. In the background, there are wind turbines, a hydroelectric dam, and a waterfall. The text "ENERGY RESOURCES" is overlaid in the center.

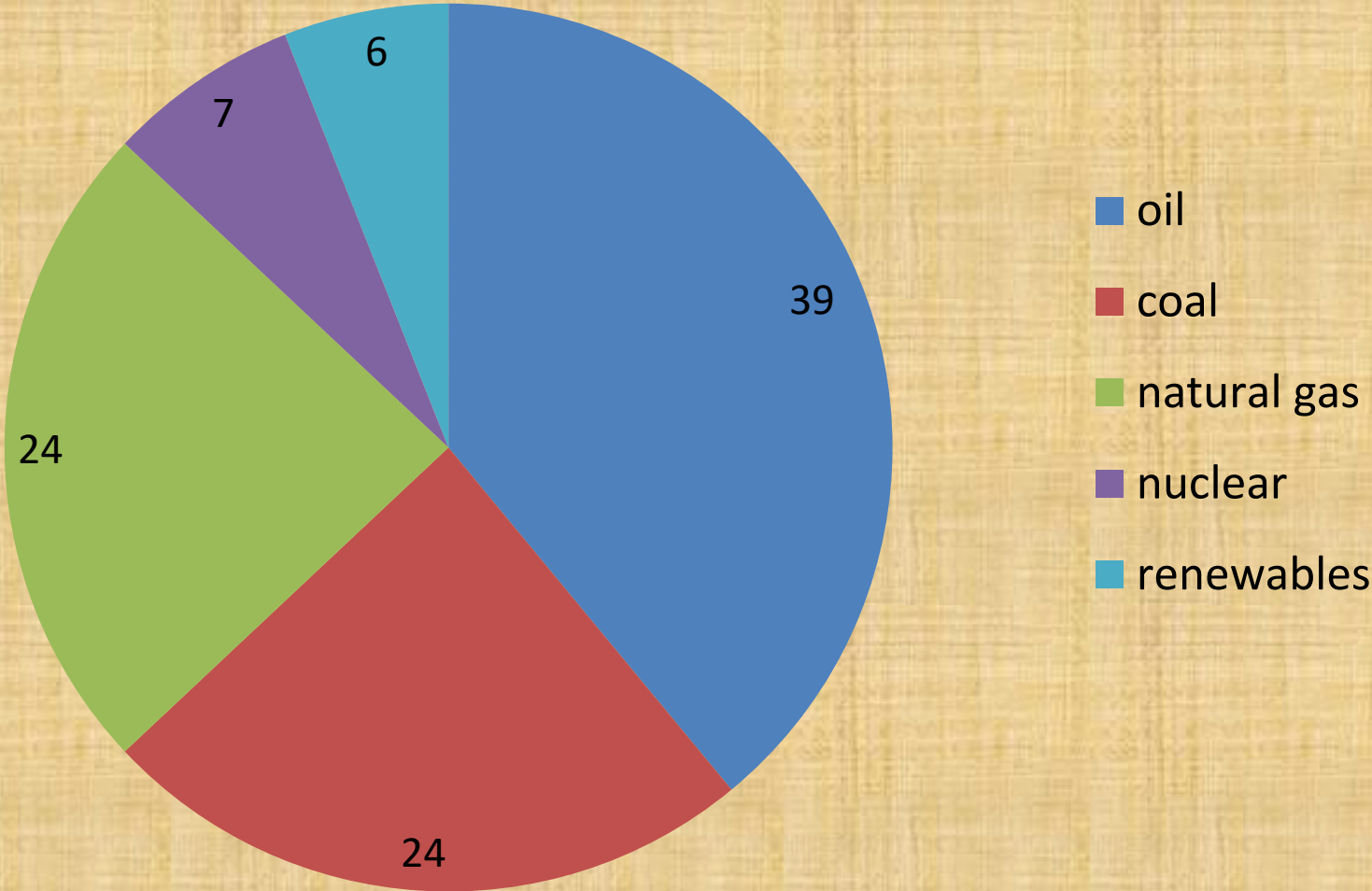
ENERGY RESOURCES

Energy Resources – Introduction/Importance

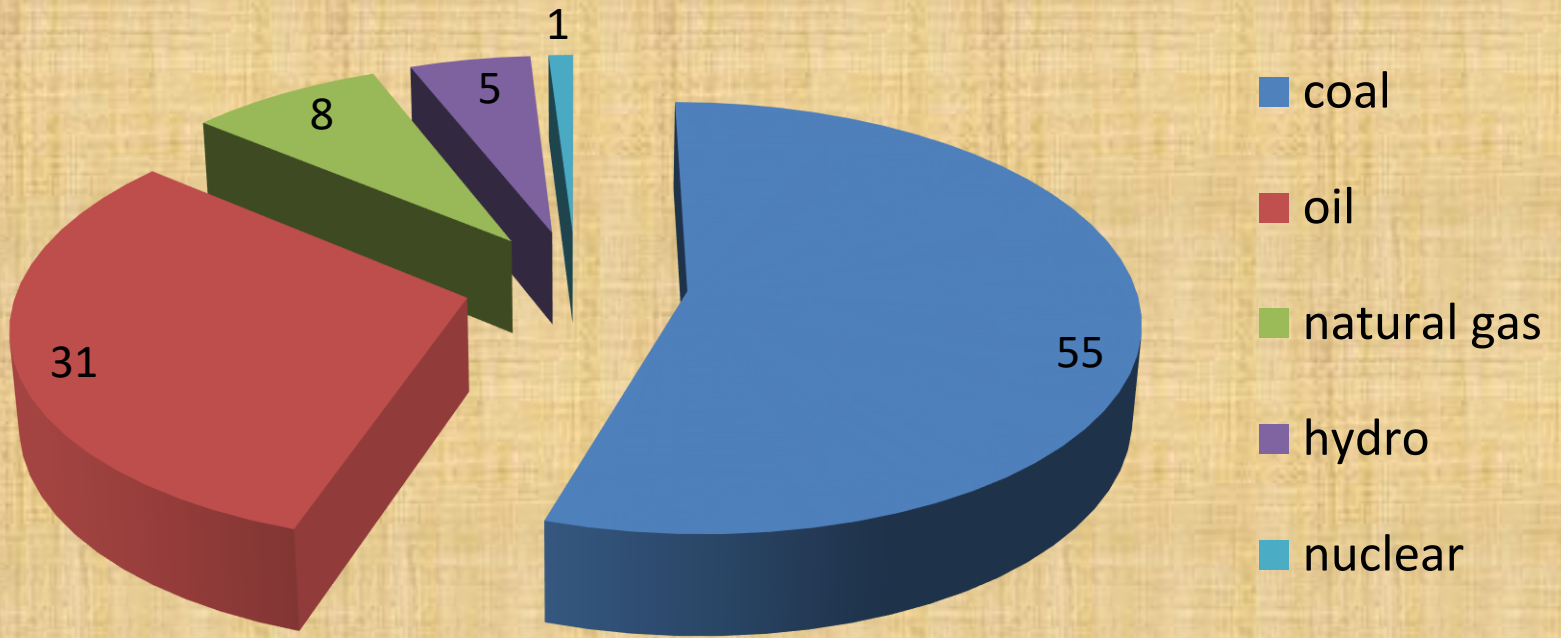
- Energy – capacity to do work.
- **Sun** (solar energy) – primary energy source
- Electrical energy - various sources like hydel power, thermal power stations powered by fossil fuels.
- Nuclear energy - held in the nucleus of an atom.
- Energy released into the atmosphere - global warming.
- Energy resources are very vital for Human Development and Sustenance

- Wastage of electricity during transmission as well as at the user level.
- No access to electricity - more than 2 billion people worldwide.
- Average American uses 24 times the energy used by an Indian (World Resources Institute, 1998).
- The world's demand for electricity has doubled over the last 22 years!
- By 2005, the Asia-Pacific region was expected to surpass North America in energy consumption.
- THREATS

World's Energy Consumption In 20th Century



Commercial energy sources (India)



Usage of fuel for electricity generation in India

- **Biomass** (mainly wood and dung) accounts for almost 40% of primary energy supply.
- **Coal** continues to remain the dominant fuel for electricity generation.
- **Nuclear** power has been increasingly used since the 1970s and 1980s.
- Use of **natural gas** has increased rapidly in the 80s and 90s.

Energy Sources

A source of energy is one that can provide adequate (sufficient) amount of energy in a usable form over a long period of time.

These sources are of two types:

➤ **Renewable Resources** – which can be generated continuously in nature and are inexhaustible (also called as non-conventional energy sources)

e.g., wood, solar energy, wind energy, tidal energy, hydro power, biomass energy, bio-fuels, geo-thermal energy and hydrogen

➤ **Non-renewable Resources** – which have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted.

e.g., coal, petroleum, natural gas and nuclear fuels like uranium thorium...

Use of alternate energy sources

ENERGY FOR TOMORROW: RENEWABLE ENERGY

Solar Energy

Photo Voltaic

Wind Energy

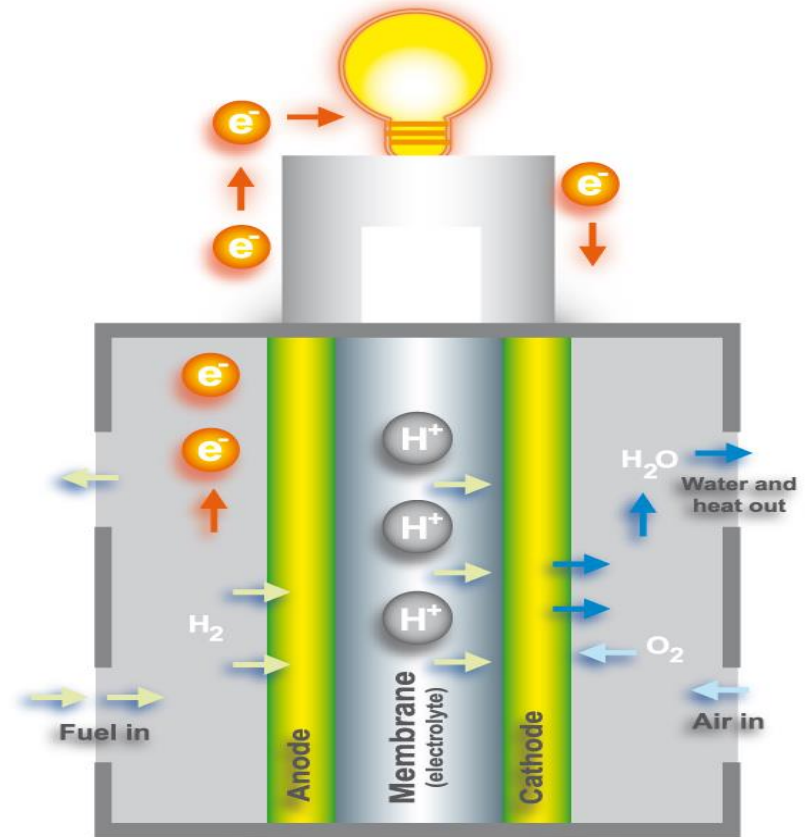
Hydro Energy

Tidal Energy

Geothermal Energy

Bio-Energy

Hydrogen Fuel Cell



Solar Energy

- Sun is the ultimate source of energy.
- Fusion reaction taking place inside the sun release enormous quantities of energy in the form of heat and light.
- The solar energy received by the earth space is approx. $1.4 \text{ kJ/m}^2\text{-s}$ (solar constant)
- Traditional uses – drying clothes and food grains, preservation of eatables, for obtaining salt from sea-water etc.
- Techniques for harnessing Solar energy
 - Solar Heat Collectors
 - Solar Cookers
 - Solar Furnaces
 - Solar Cells
 - Solar Water Heaters
 - Solar Power Plants

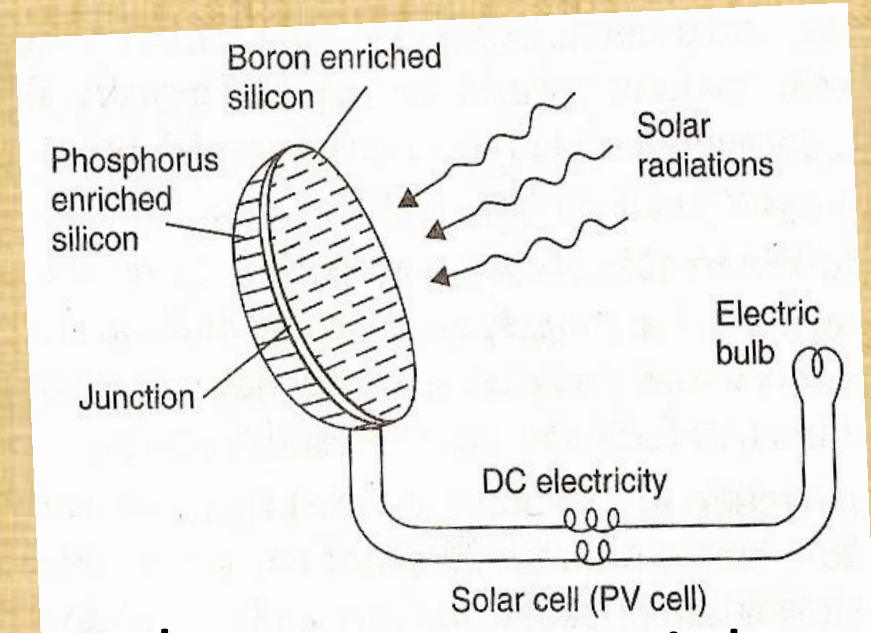
Solar Heat Collectors

- These can be passive or active in nature.
- Passive heat collectors are natural materials like stones, bricks...which absorb heat during day time and release it slowly at night
- Active solar collectors pump a heat absorbing medium (air or water) through a small collector which is normally placed at top of the building.

Solar Cell

➤ Known as photovoltaic cells

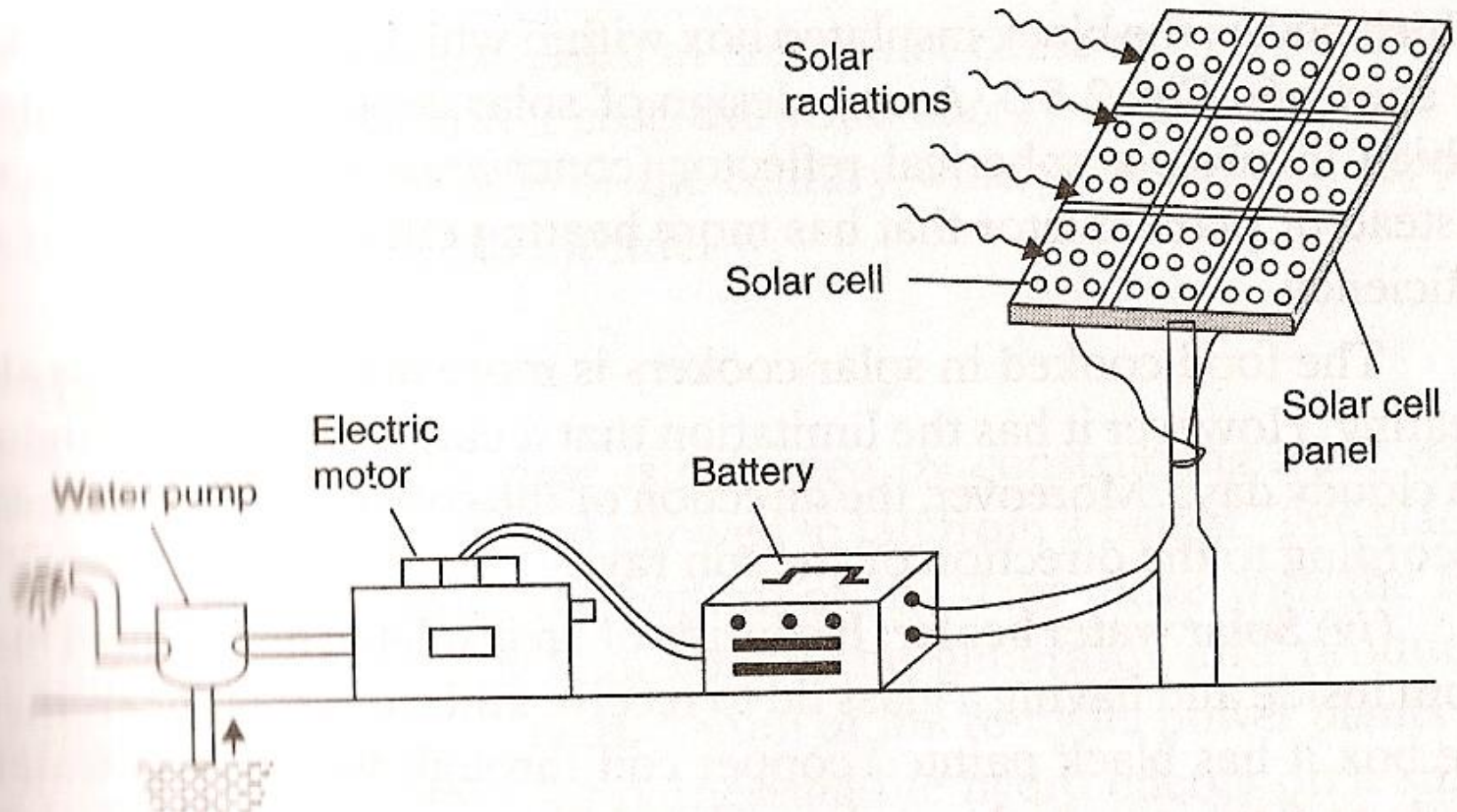
➤ Made of thin wafers of semi-conducting materials like silicon or gallium.



➤ When solar radiations fall on them, a potential difference is produced which causes the flow of electrons and produces electricity.

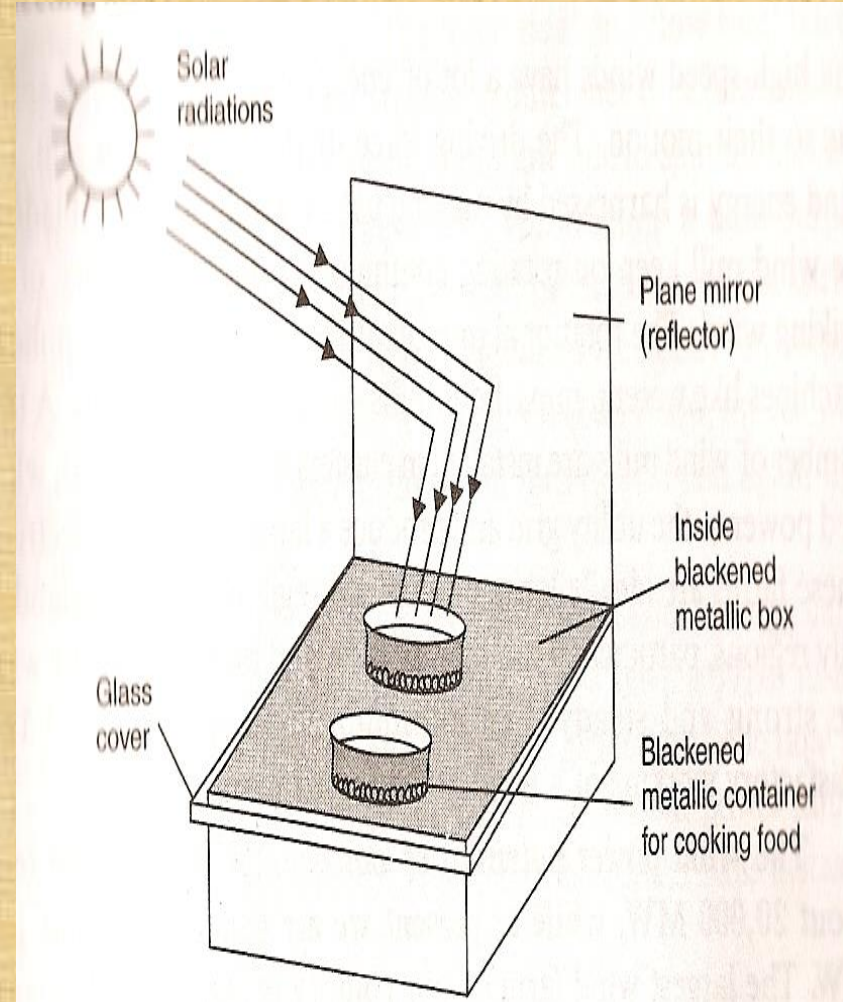
➤ The potential difference produced by a single PV cell of 4 cm^2 size is about 0.4-0.5 volts and a current of 60 mA is produced.

A solar pump run by electricity produced by solar cells



Simple box type solar cooker

- Make use of solar heat by reflecting the solar radiations using a mirror directly on to a glass sheet which covers the black insulated box within which the raw food is kept.
- The food cooked in a solar cooker is more nutritious due to slow heating .



- ✘ Limitation: It cannot be used at night.

Solar Water Heater

- Consists of an insulated box painted black from inside and having a glass lid to receive and store solar heat.
- Inside the box it has black painted copper coil through which cold water is made to flow in, which gets heated and flows out into storage tank.

Solar Furnace

- Thousands of plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce a high temperature.

Solar Power Plants

- Solar energy is harnessed on a large scale by using concave reflectors which cause boiling of water to produce steam; the steam turbine drives a generator to produce electricity

Wind Energy

- The high energy winds have lot of energy - kinetic energy due to motion.
- The driving force of wind is sun.
- The wind energy is harnessed by making use of wind mills.
- The blades of the wind mill keep on rotating continuously due to the force of the striking wind.
- The rotational motion of the blades drive a number of machines like water pumps, flour mills and electricity generators .

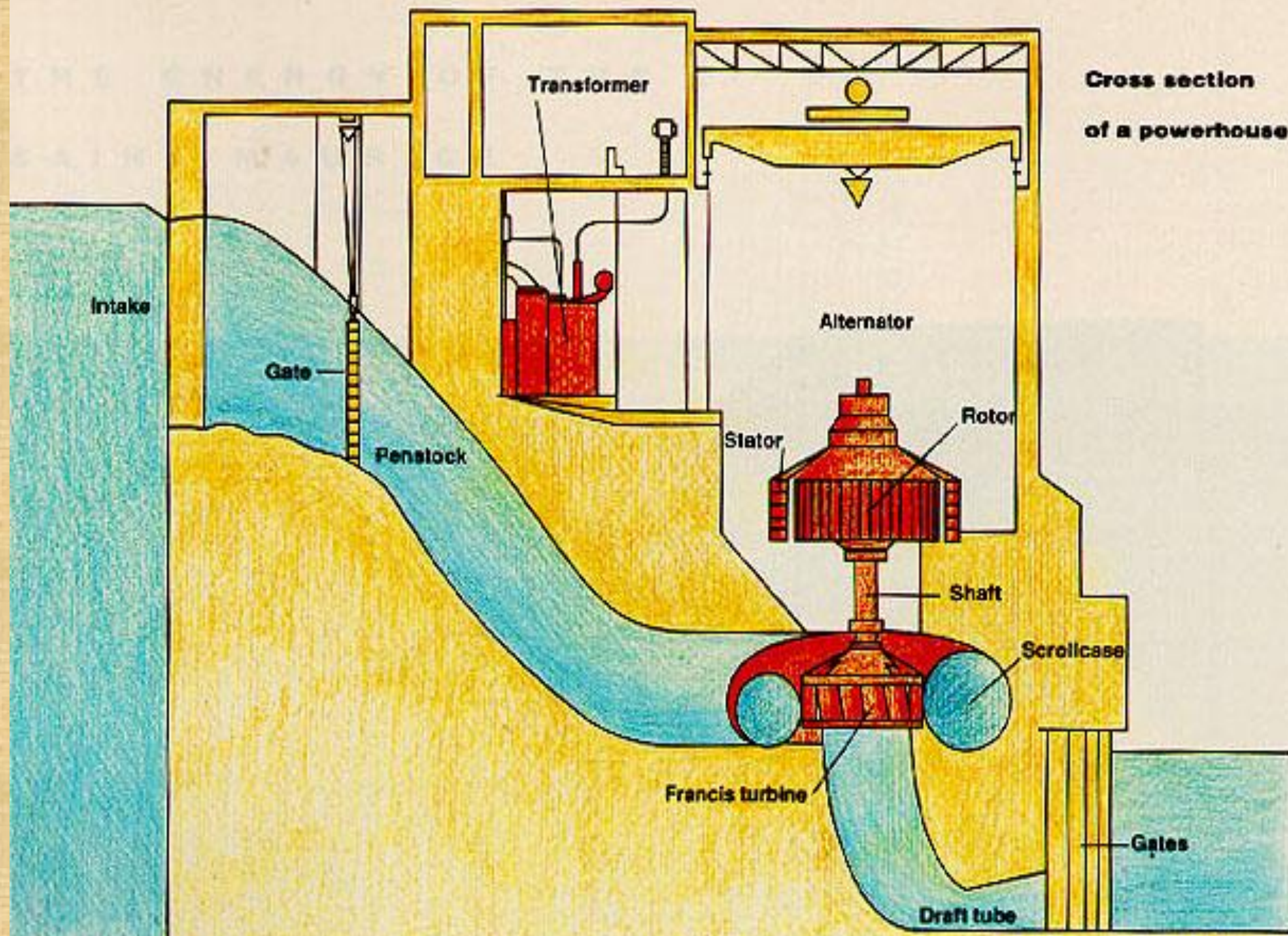


- Wind farms - A large number of wind mills installed in clusters, feed power to the utility grid and produce a large amount of electricity.
- The minimum wind speed required for satisfactory working of a wind generator is 15 km/hr.
- Wind energy is very useful as it does not cause any air pollution; after initial installation cost, the wind energy is very cheap.



Hydro Power

- Water enters the plant when an intake gate is opened, and moves through the penstock.
- Water exits the turbine and is returned to the river. The turbine spins a rotor directly above it, and electricity produced by the interaction of rotor and stator is transmitted through a transformer at the station and thence to the grid.
- Hydro power does not cause any pollution - it is renewable
- The hydro power projects are multi-purpose projects helping in controlling floods, used for irrigation etc.



Cross section of a powerhouse

Intake

Gate

Penstock

Transformer

Alternator

Stator

Rotor

Shaft

Scrollcase

Francis turbine

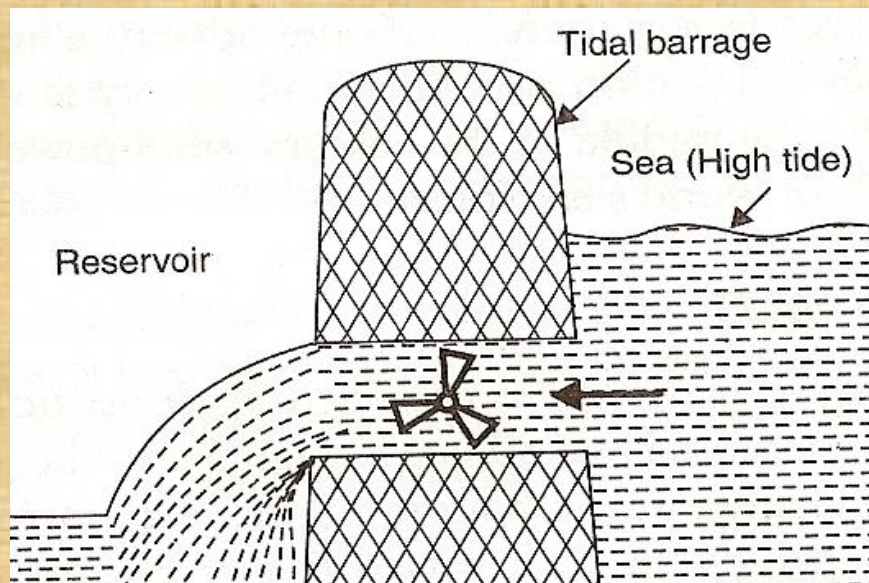
Draft tube

Gates

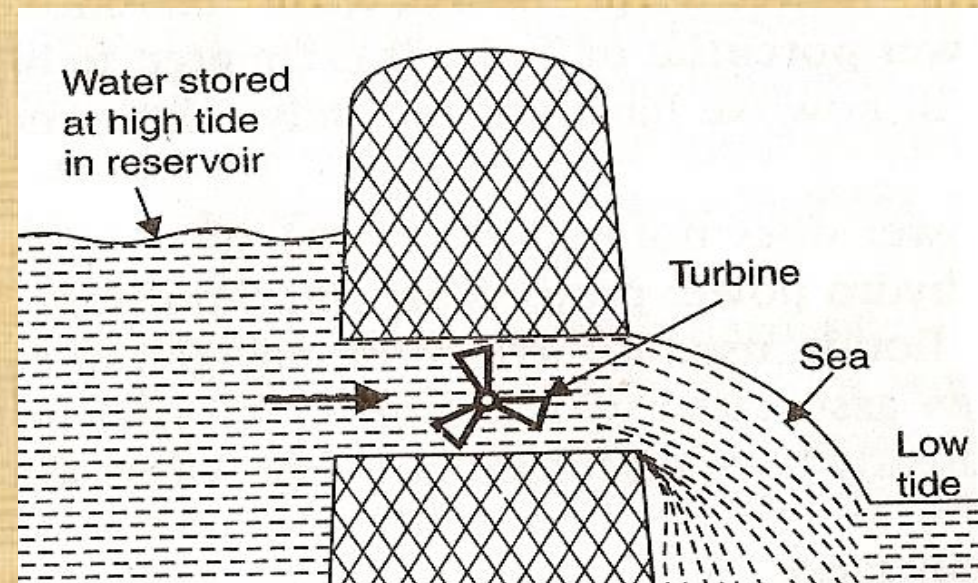
Tidal Energy

- Ocean tides are produced by gravitational forces of sun and moon, and contain enormous amount of energy.
- The tidal energy can be harnesses by constructing tidal barrage.

High Tide



Low Tide



Geothermal Energy

- The energy harnessed from the hot rocks present inside the earth is called geothermal energy.
- High temperature, high pressure steam fields exist below the earth's surface in many places, this heat comes from the fission of the radioactive material naturally present in the rocks.
- Holes are drilled artificially up to the hot rocks and pipes are put through which the steam comes out at high pressure that turns the turbine of a generator to produce electricity.

Biomass Energy

- Biomass is the organic matter produced by the plants or animals which include wood, crop residues, cattle dung, manure, sewage etc.
- The biomass is directly used as a fuel but the efficiency of such furnaces is very low and it produces lot of smoke causing air pollution.
- Converting the biomass into biogas or biofuels is more useful.

Biogas

- Biogas is mixture of methane, carbon dioxide, hydrogen and hydrogen sulfide; the major constituent being methane.
- Biogas is produced by anaerobic degradation of organic wastes.
- Biogas is non-polluting, clean and low cost fuel.
- 1 ton of food waste can produce 85 m³ of biogas.
- Germany: 25% of the landfills for garbage produce power from biogas.
- Japan – uses 85% of its waste for biogas conversion

Biofuels

- Biomass can be fermented to alcohols like ethanol and methanol which can be used as fuels.
- Ethanol can be easily produced from carbohydrate rich substances like sugarcane, it is non-polluting.
- Gasohol is a mixture of ethanol and gasoline.
- Methanol is very useful as it burns at a lower temperature than gasoline or diesel.

Hydrogen as a Fuel

- As hydrogen burns in air, it forms water and liberates a large amount of energy (150 kJ/gm).
- Due to its high calorific value, hydrogen can serve as an excellent fuel; it is non-polluting and can be easily produced.
- Production of hydrogen is possible by thermal dissociation (at 3000 °K or above), photolysis (breakdown of water in presence of sunlight) or electrolysis of water (passing electric current).
- Hydrogen is highly inflammable and explosive in nature.

Nuclear power

- Nuclear power industry - born in late 1950s.
- The first large-scale nuclear power plant in the world became operational in 1957 in Pennsylvania, US.
- Dr. Homi Bhabha - father of Nuclear Power development in India.
- Bhabha Atomic Research Center, Mumbai.
- 10 nuclear reactors in India - 5 nuclear power stations (Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh and Gujrat).
- 2% of India's electricity
- Uranium mines in Bihar and thorium mines in Kerala and Tamil Nadu.

- Energy released from 1kg of Uranium 235 = burning 3,000 tons of coal.
- U235 is made into rods are fitted into a nuclear reactor.
- Production of electricity by the heat energy produced in the reaction (steam drives turbines).
- Disposal of nuclear waste - impacts on the environment (Ex: Nuclear accidents at Chernobyl in USSR, recent accident in Japan).
- Release of hot wastewater damages aquatic ecosystems (Thermal pollution).

Case Study: (Oil tanker disaster)

Exxon – Valdez oil-tanker:

- The most well-known disaster occurred when the Exxon Valdez sank in 1989 in Alaska.
- Many of the birds, sea otters, seals, fish and other marine life along the coast of Alaska was seriously affected.
- The oil company took months to clear up the worst of the damage and paid millions of dollars in damage suits.

Oil- related disasters:

- During the Gulf War, oil installations burned for weeks polluting the air with poisonous gases including SO_2 - a major cause of acid rain.
- The gases moved to a height of 3 km and spread as far as India.
- Oil also polluted coastlines, killing birds and fish.

Forest management :

- Social Forestry, Farm Forestry and Joint Forestry Management are some examples which involve and train people to play a role in Energy Management.
- Nearly 50% of the world's population is dependent on fuel wood as a source of energy.
- Rural women, and even women from the lower economic strata in towns, still have to spend a large part of their lives collecting fuel wood.
- Use of fuel-efficient stoves ('chulas') can be used which burn wood extremely slowly and do not waste the heat, and also produce less smoke and ash than normal 'chulas'.
- There have also been several efforts to grow fuel wood by involving local people in these efforts.

Hydel power:

- First hydroelectric power dams in India - late 1800s by the Tata in the Western Ghats of Maharashtra.
- Permission by the British Government to develop dams in the Western Ghats to generate electricity.
- The four dams are the Andhra, Shirowata, Valvan and Mulshi hydel dams.
- An important feature of the Tata power projects is that they use the high rainfall in the hills as storage areas.
- Large turbines in the power plants generate electricity for Mumbai and its giant industrial belt.

Narmada project:

- Narmada Bachao Andolan - an example of a movement against large dams.
- The gigantic Narmada River Project has affected the livelihoods of hundreds of extremely poor forest dwellers.
- The rich landholders downstream from the Sardar Sarovar dam will derive the maximum economic benefit, whereas the poor tribal people have lost their homes and traditional way of life.
- The disastrous impact that this project has on the lives of the poor, and the way in which they are being exploited.

Solar challenger:

- ‘The Solar Challenger’ - The plane flew from Paris to England in 5 hours, 20 minutes, in 1981.
- 16,000 solar cells glued to the wings and tail of the plane and they produced enough power to drive a small electric motor and propeller.
- Since 1987, every three years there is a World Solar challenge for solar operated vehicles in Australia where the vehicles cover 3000 km.

Energy consumption in Indian industries:

Steel and energy: India - 9.5 million kcal/ tonne of steel.
Italy - 4.3 million kcal/ tonne of steel.
Japan - 4.1 million kcal/ tonne of steel.

Cement industry: India - >2 million kcal/ tonne of cement.
Germany - 0.82 million kcal/ tonne of cement.
USA – 0.92 million kcal/ tonne of cement.

Vehicles: Lighter materials can reduce the weight by 15 % and increase the fuel economy by 6 to 8%.

Refrigerators: Better technologies reduced the annual energy needed by a typical Danish 200 liter refrigerator (with no freezer) from 350 kilo Watt hour (kWh) to 90 kWh.

Lighting: An 18-watt modern, compact fluorescent lamp, can replace a standard 75-watt incandescent lamp.