Energy Resources

Energy may be defined as any property which can be produced from or converted into work.
Or
Energy is capacity of doing work
Or
Energy can be in the form of light, sound, heat, and sound, mechanical and chemical energy

Energy is the key input for domestic needs, industrial and economic development

Use of energy

- ✓**In power plants**
- ✓**In transportation sector**
- ✓**In space technology**
- ✓**In military uses**
- ✓**In industrial sectors**
- ✓**For domestic purposes**

The world energy consumption in the past four decades (Between 1960 – 2000):

India = 13.3×10^{18} J

Japan = 22.6×10^{18} J

Russia = 27.5×10^{18} J

China = 36×10^{18} J

USA = 100.5×10^{18} J

Rest of world = 215.5×10^{18} J

Classification of energy resources

Energy sources classified broadly as primary and secondary energy resources:

(I) Primary energy sources: are those which are broadly obtained from environment.

a) **Fossil fuels**: coal, crude oil, natural gas etc.

b) **Nuclear fuels**: uranium, thorium, deuterium etc.

c) **Hydro energy:** The energy falling water used to turn turbines or mill wheels

d) **Geothermal energy:** the heat form the underground streams or the heat stored in the hot rock beneath the earth's surface.

e) **Solar energy:** electromagnetic radiation from the sun

f) **Wind energy:** the energy form moving air used by wind mills.

g) **Tidal energy:** The energy associated with rise and fall of the tidal waves.

(II) Secondary energy sources: are those which do not occur in nature but are derived from primary energy resources.

Ex. Petrol or gasoline, electrical energy from coal burning etc.

The primary energy resources can be further classified as renewable resources and non-renewable resources.

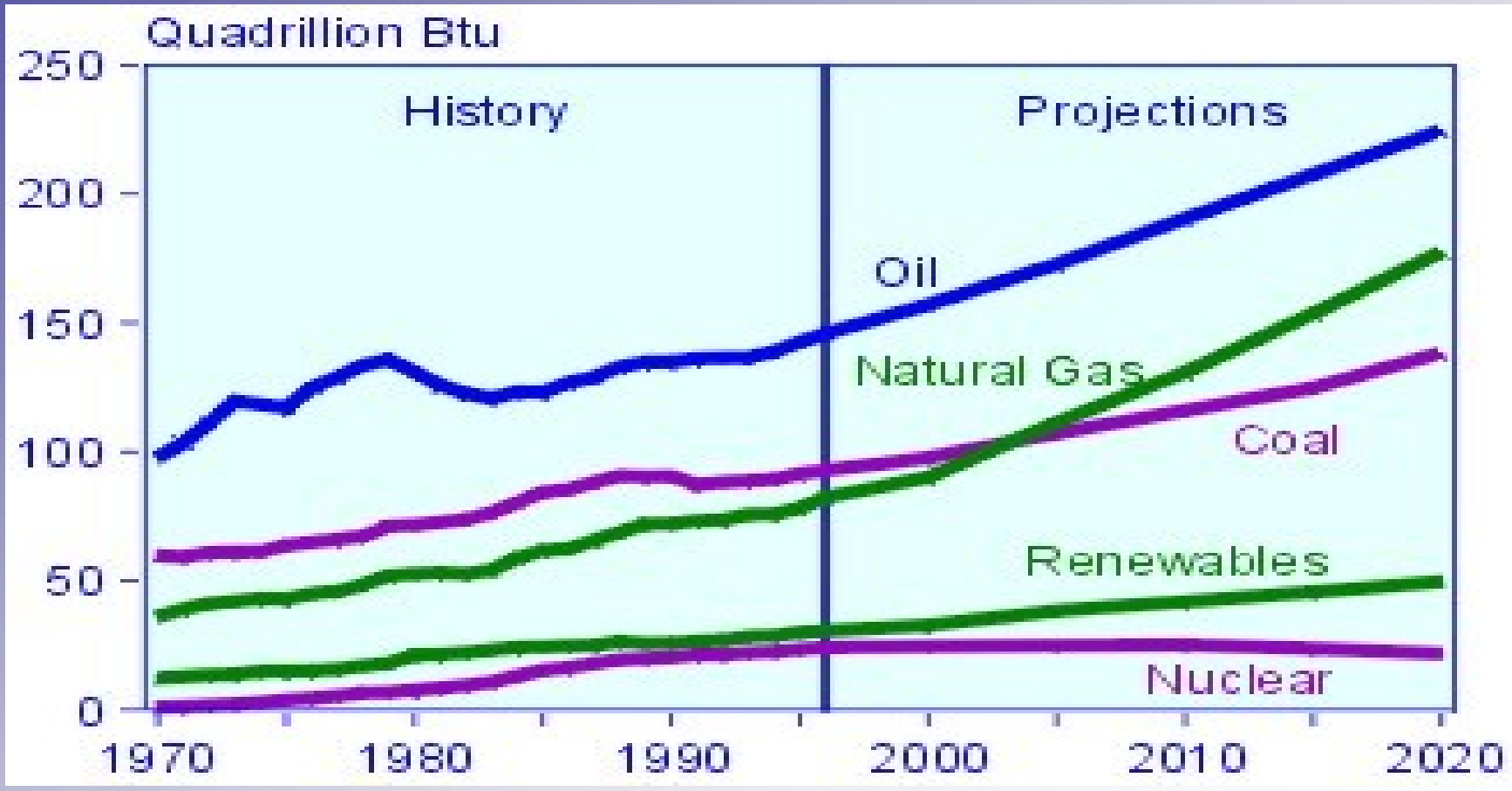
Renewable energy resources: are those which not exhaustible and which can hence provide continuous supply. E.g. wood, tidal energy, solar energy, wind energy, geothermal energy.

Non-renewable energy resources: are those which are finite and exhaustible. E.g. Fossil fuels (coal, petroleum, natural gas), nuclear fuels etc.

Energy Source Categories

	Non renewable	Renewable
Conventional	Coal Oil Gas Nuclear Fission	Wood Hydro Human/Animal
Alternative	Geothermal Oil Shale Tar Sands Methane Hydrates	Wind Solar Biomass Wave/Tide Ocean Current

WORLD ENERGY CONSUMPTION



Electromagnetic Radiation

- Electromagnetic radiation behaves as consisting of discrete **wave-like particles called Quanta or Photons.**
- Photon possess the characteristics of a wave and travel with the velocity of light in the direction of the beam
- Electromagnetic radiation are so named because they consists of waves which have electrical and magnetic properties

Eg., Uv., alpha, beta and gamma rays, etc.

- The classification of radiation types is base on wavelength.
- The energy associated with a particular radiation **depends upon its wavelength**. The shorter the wavelength the higher the frequency and energy:

Wavelength = Velocity / Frequency

Property	Alpha rays	Beta Rays	Gamma Rays
Nature	+ ve charged Helium nuclei	-ve charged fast moving electrons	Electrically neutral
Mass	4 times the mass of hydrogen atom	1/ 837 of hydrogen atom	Negligible
Velocity	1/10 of that of light	Almost same as that of light	Same as that of light
K.E	Very high	High	Low
Ionizing Power	Very High	High	Low (Neigligible)
Biological effect	Dangerous	Very Dangerous	Extremely Dangerous

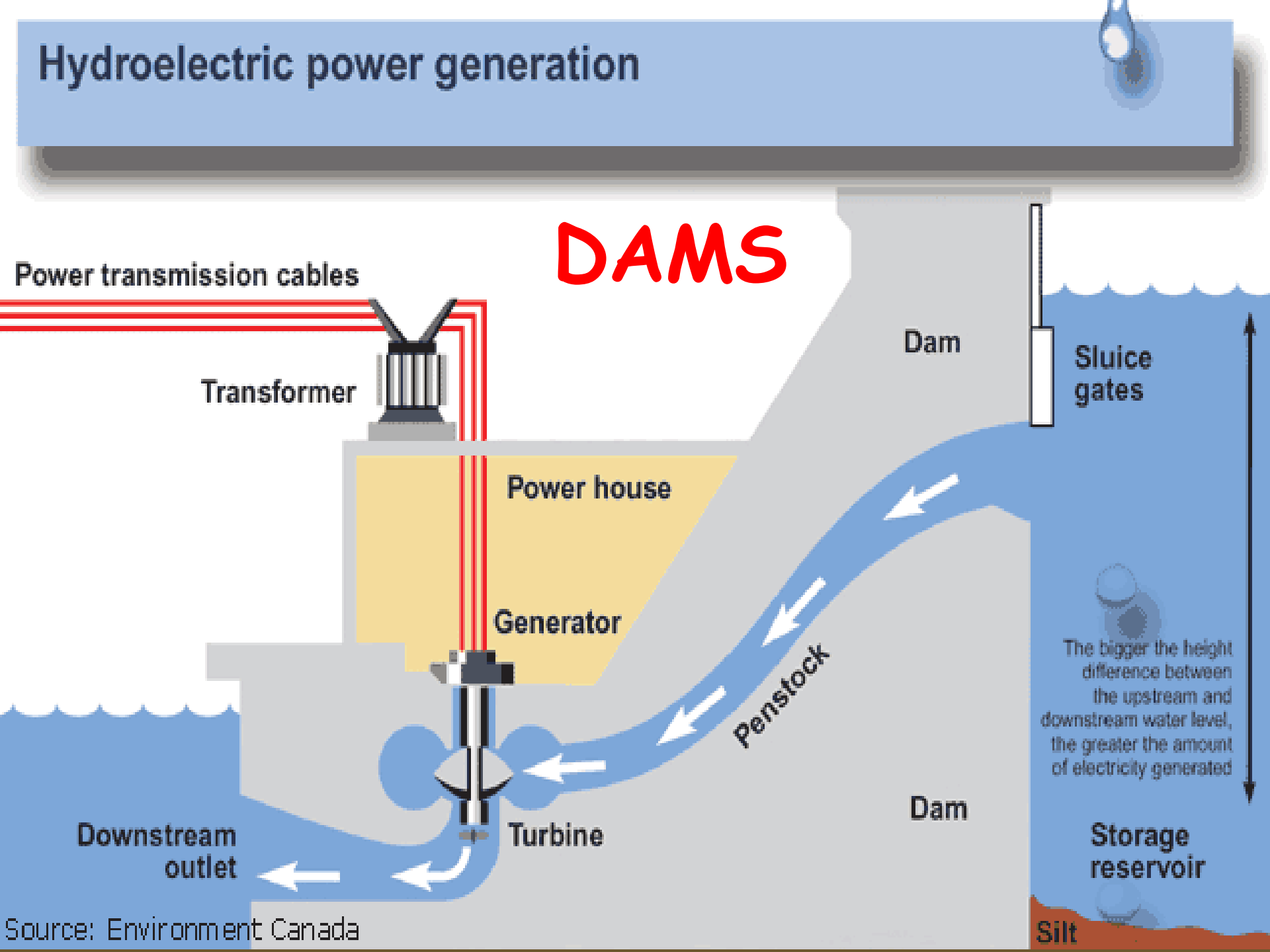
Hydroelectric Dams

- Energy obtained form flowing water or falling water from a height.
- This stored water energy has long been used for generation of electricity

Introduction to Hydro Power

- Hydroelectricity is produced by the ability of moving water to do work.
- This work (energy) can then be transformed into electricity.
- The main mechanism for this is power plants located in dams on major rivers.
- In order for the kinetic energy generated by moving water to be converted into electricity, dams must be built.
- A dam works by blocking up the water flow.

Hydroelectric power generation



Source: Environment Canada

Introduction to Hydro Power

- This creates a reservoir of potential power.
- On the upper side of the dam, there is an opened gate that allows the water to surge through a tunnel.
- When the water reaches the bottom of the tunnel, it turns the turbines.
- The turbines then spin the generators that produce electricity.
- The electricity is then carried through cables to be distributed to wherever it is needed (Hydro Power).

Dams: Merits and Demerits

Dam are structure those are made to restrict Water of beneficial purposes.

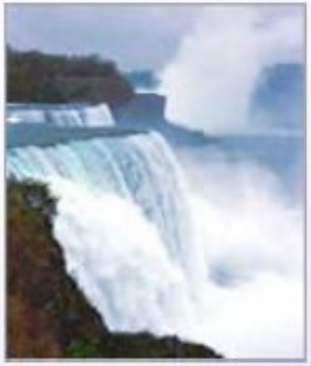
Merits of Dams:

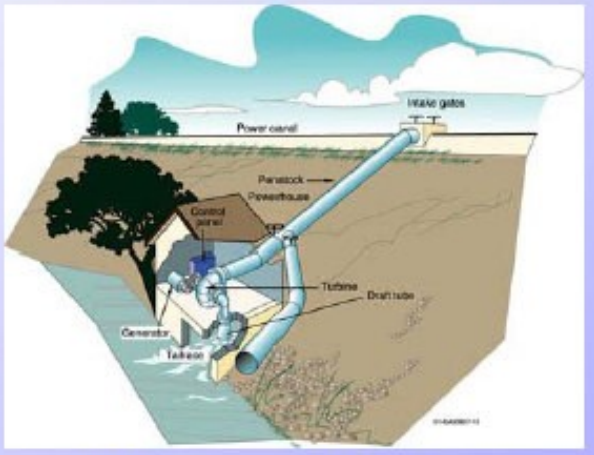
- For irrigation
- To generated electricity
- For flood control
- For industrial and domestic supply
- For Farming
- To protect soil erosion

Demerits

- Loss of species and ecosystem
- Loss of forest and wildlife habitat
- Loss of aquatic biodiversity
- Displacement of large number of people who resettled form dam area

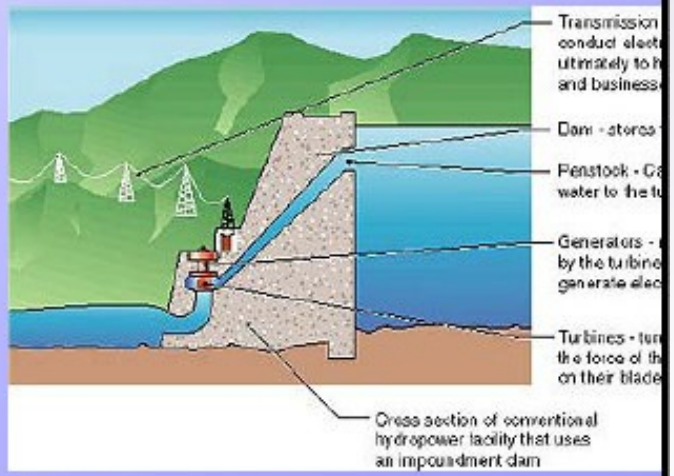
Hydropower





Micro Hydropower Plant

The Tazimina project in Alaska is an example of a diversion hydropower plant. No dam was required.



An impoundment hydropower plant dams water in a reserv

RENEWABLE ENERGY

Solar energy

Solar energy is currently used in a number of applications:

- Heat (hot water, building heat, cooking)
- Electricity generation (photovoltaics, heat engines)
- Desalination of seawater.

Energy from the Sun

The heat equivalent of the solar radiation reaching the earth is estimated to be about 2.68 X 10^{24} Joule per year.

India receives abundant sunshine with about 1648-2108 KW/m^2/ year with nearly 250-300 days of useful sunshine.

The daily solar energy irradiance is between 5 to 7 KW/m^2 at different part country.

There are three methods of harnessing solar energy direct heating (e.g solar cookers) Solar driers, solar water heaters etc), thermoelectric conversion or solar thermal Power plants and photo- voltaic conversions.

Photovoltaic cells:

They are small semiconductors of silicon, gallium arsinide or cadmium Telluride which have electron surplus and electron deficient region.

A photovoltaic cell has only 0.5 volt energy, therefore number of photovoltaic cells
are arranged in series as films, ribbons or panels to obtain requisite high voltage.

Photovoltaic are used in calculators, solar lanterns, water pumps, transistors, satellites and electrification of far off areas.

Solar cookers

- Solar thermal devices like solar cooker, solar water / air heaters, solar dryers.

- A soar cookers consisting aluminum reflectors

- It has been tried in extreme cold and remote areas.

In solar cookers about 1 m^2 collectors area at 17.3 % efficiency would give a saving of 663 kg of wood at 4708 X 10^3 K cal. / Kg.

Wind energy

Moving air is known as wind. The wind has energy. The energy possessed by wind is because of it high speed.

The most important advantage of wind energy is that it is produced without causing harm to the environment.

The blowing wind on specially designed blades of a windmill's rotor causes this rotation, which produces mechanical energy, when coupled to a turbine, derives a power generator.

An ideal wind speed for wind turbine is considered to be in the range of 4.0 to 25 m/sec.

The Indian sub-continent is a high wind zone with energy potential estimated at about 20,000 MW.

Wind farms have turbines with an installed capacity of about 45 MW. These farms are mainly located in Tamil Nadu, Gujarat and Andhra Pradesh.

Applications:

The wind energy is utilizes by means of a wind mills or a 'series of wind mills'. It consists of few vanes (3 to 6) which rotate about their axis. The roational motion (i..e mechanical energy) thus created is utilized for various applications such as :

Lifting of water from the well, battery charging, water pumping, operating Simple machine

Wind Energy Advantages

- Abundance availability for no price.
- Non-polluting and Eco-friendly
- Useful at remote places also for electricity generation

Wind Energy Limitations

- Less favorable in city locations.
- Wind energy may not be available regularly and uniformly
- Large area required for its installation

Energy from biomass

Biomass is organic matter that can be burnt directly as a fuel or converted to a more convenient form and then burnt.

Or

Biomass energy or bioconversion refers to the direct burning of wood, waste paper, manure, agriculture or any form of biomass or converting them to a fuel

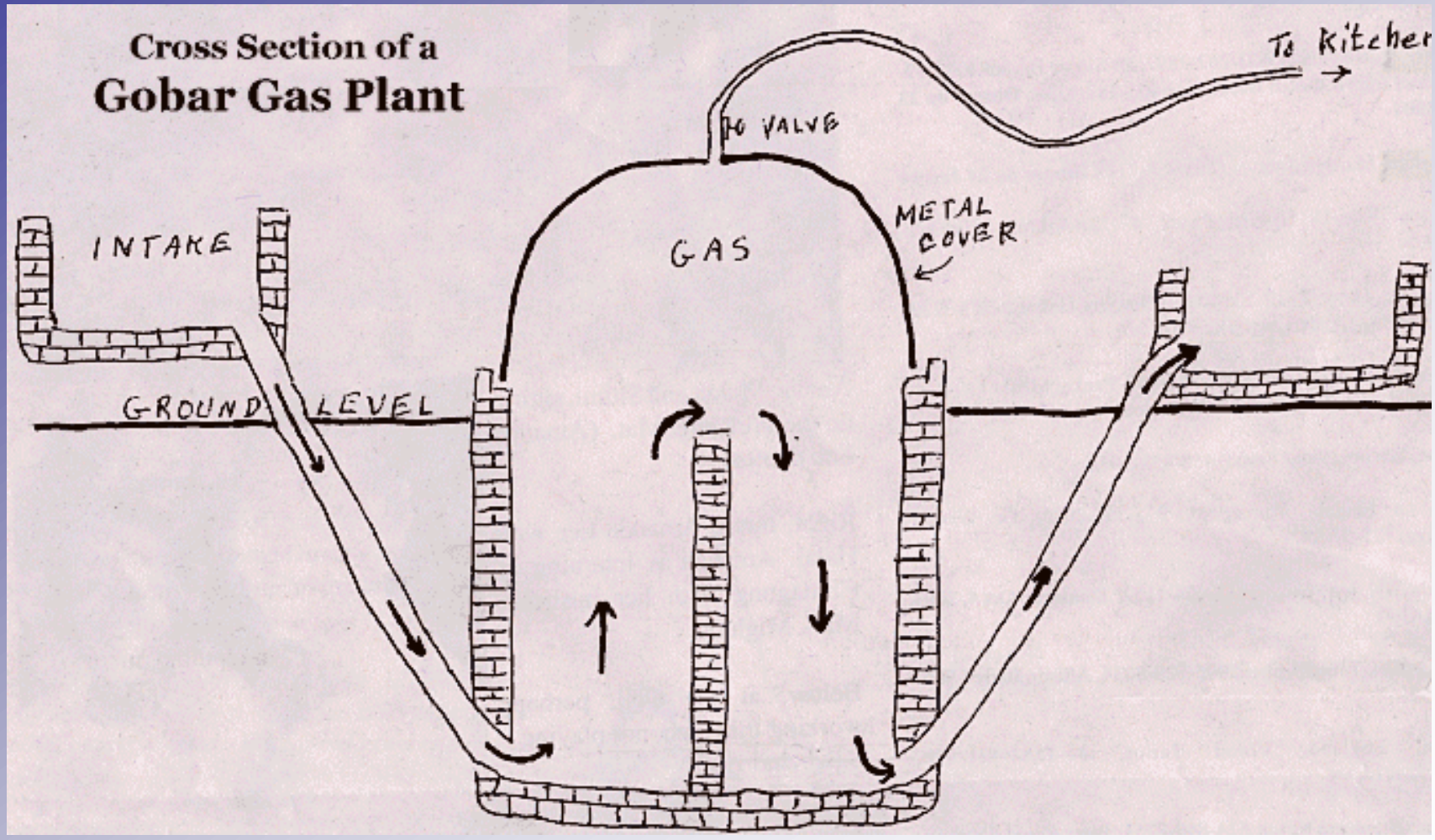
Types of Biomass Energy

- **Petroplants:**Plant species as source of liquid hydrocarbons, a substitute of liquid fuel. e.g *Jaitropha,*
- Highest bio-crude oil potential (10 %) lies in resinous species of **Compositae family.**

- **Energy from urban waste:**

A pilot plant for demonstration has already been setup in Delhi to treat solid municipal waste for conversion into energy.

Biogas or Gobar Gas



The average composition of biogas or Gobar gas is :

CH_4 = 55 %,

H_2 = 7.4 %,

CO_2 = 35 %,

N_2 = 2.6 %,

H_2O = trace.

The average gross calorific value of the gas is about 5300 K.cal/m3.

--- *Methanococcus* and *Methanobacterium* species are involved in the formation of methane.

About 160 liters of gobar gas is produced per kg of cow dung and the heating value of the gas is 490 k. cals on 160 liters basis.

The biogas generator consists of a steel digester, dung in and set under ground by a cement concrete work.

The tank is closed one, receiving the charge of bacterial and the cow dung.

The generator is connected with a pipe line with the gas holder which is made up of mild steel.

The charge consists of cow dung and water in the form of slurry. The fermentation carried out between 35 - 50 ^{0}C.

USE OF ALTERNATIVE ENERGY RESOURCES

Main among them are the following:

1-Natural gas and Liquefied petroleum gas (LPG)
2-Alcohols
3-Compressed natural gas (CNG)
4-Hydrogen
5-Methane
6-Fuel cells of various kinds

Fossil Fuel Based Energy

- Ex. Coal, crude oil and natural gas etc.

Coal (Black Diamond):

Coal mainly of two types:

Lignite Coal : 70 % C

Bituminous Coal : 80 % C

Anthracite Coal : 90 % C

- **Chemical Composition of Coal:**

70 % Carbon

6 % Hydrogen

10 % Oxygen

2 % Sulphur

1 % N & P

Natural gas and Liquefied petroleum gas (LPG)

Natural gas, which is a mixture of methane, ethane, propane, butane, pentane, carbon dioxide, nitrogen etc. is the most important fuel belonging to this class and is found mainly in the vicinity of coal mines or oil fields.

In India, natural gas derived from Naharkati oil fields in Assam has actually been utilized for raising electric power.

The **natural gas** derived from oil wells may be either **dry or wet**.

- When there is **no oil but only gas in a petroleum well, the natural gas said to be Dry**

- When natural gas occurs along with petroleum in oil wells, it is called **wet gas** (contains gaseous hydrocarbons from C 1 to C 4).

- The gas is associated with crude oil it is called **dry or lean gas** (contains mainly methane and ethane with small amounts of CO, CO_2, H_2, N_2 and inert gas).

The composition of such gas gas is:

CH_4 = 83.5 %
C_2H_6 = 12.5 %
CO_2 = 0.2 %
and N_2 = 3.8 %

The wet gas is suitable treated to remove propane, **butane** , then , it is used as **LPG**.

The approximate composition of natural gas is :

CH_4 = 70-90 %,
C_2H_6 = 5-10 %,
H2 = 3 %,
CO + CO_2 = Rest.
The calorific value varies form 1200-1400 k.cal/ m^3.

HYDROGEN AS A ENERGY

- Hydrogen is a perfect fuel which can be manufactured by decomposition of water.
- After combustion, it can be recovered to water .
- Presently, Hydrogen fueled I.C. engines are available in which combustion occur by injection of hydrogen into the cylinder.

- These engines use some other **gases such as air, oxygen, argon etc**. for mixing in hydrogen, based on the mixing of gases are:

1- Hydrogen-air engines 2- Hydrogen-oxygen engines 3- Hydrogen –oxygen-argon engine

- Hydrogen is used in liquid from. A liquid – hydrogen powered light duty **car named Musashi III has already been developed in Japan , with maximum speed 118 Kmph.**

Consumption Features of Hydrogen

- Its calorific value is 2.7 times higher than gasoline, but volume proportion of hydrogen in the mixture is greater than gasoline vapor.
- Heat transfer loss is more in hydrogen engine
- Hydrogen has a wider flammability range and a higher burning velocity.

PERFORMANCE: The power of hydrogen engines is lower than petrol engines due to lower volumetric efficiency.

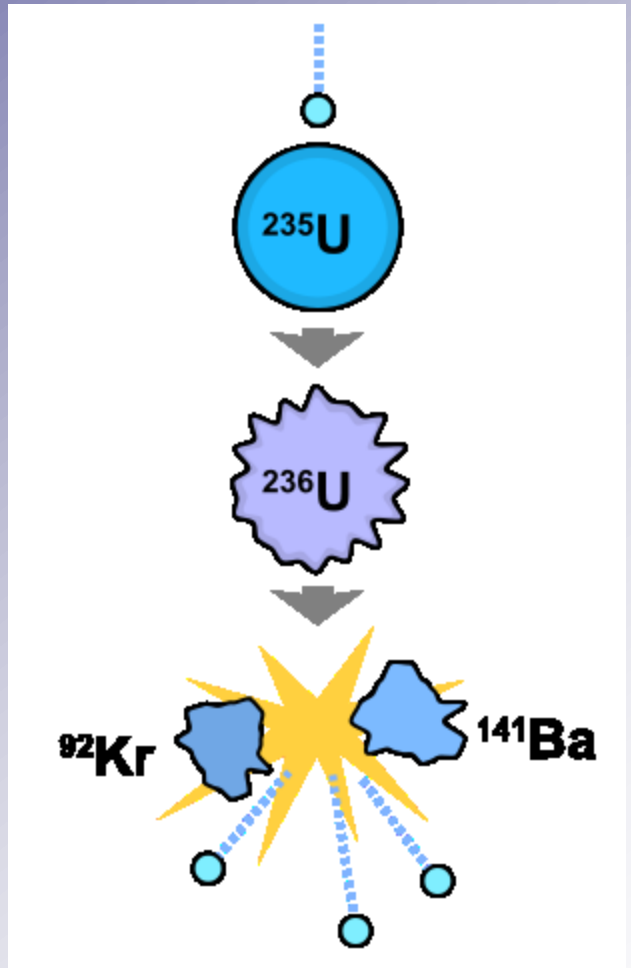
NUCLEAR ENERGY

Nuclear energy originates from the splitting of uranium atoms in a process called fission.

At the power plant, the fission process is used to generate heat for producing steam, which is used by a turbine to generate electricity.

- **nuclear fission** is either a nuclear reaction or a radioactive decay process in which thenucleus of an atom splits into smaller parts (lighter nuclei), often producing free neutrons and photons (in the form of gamma rays), and releasing a very large amount of energy

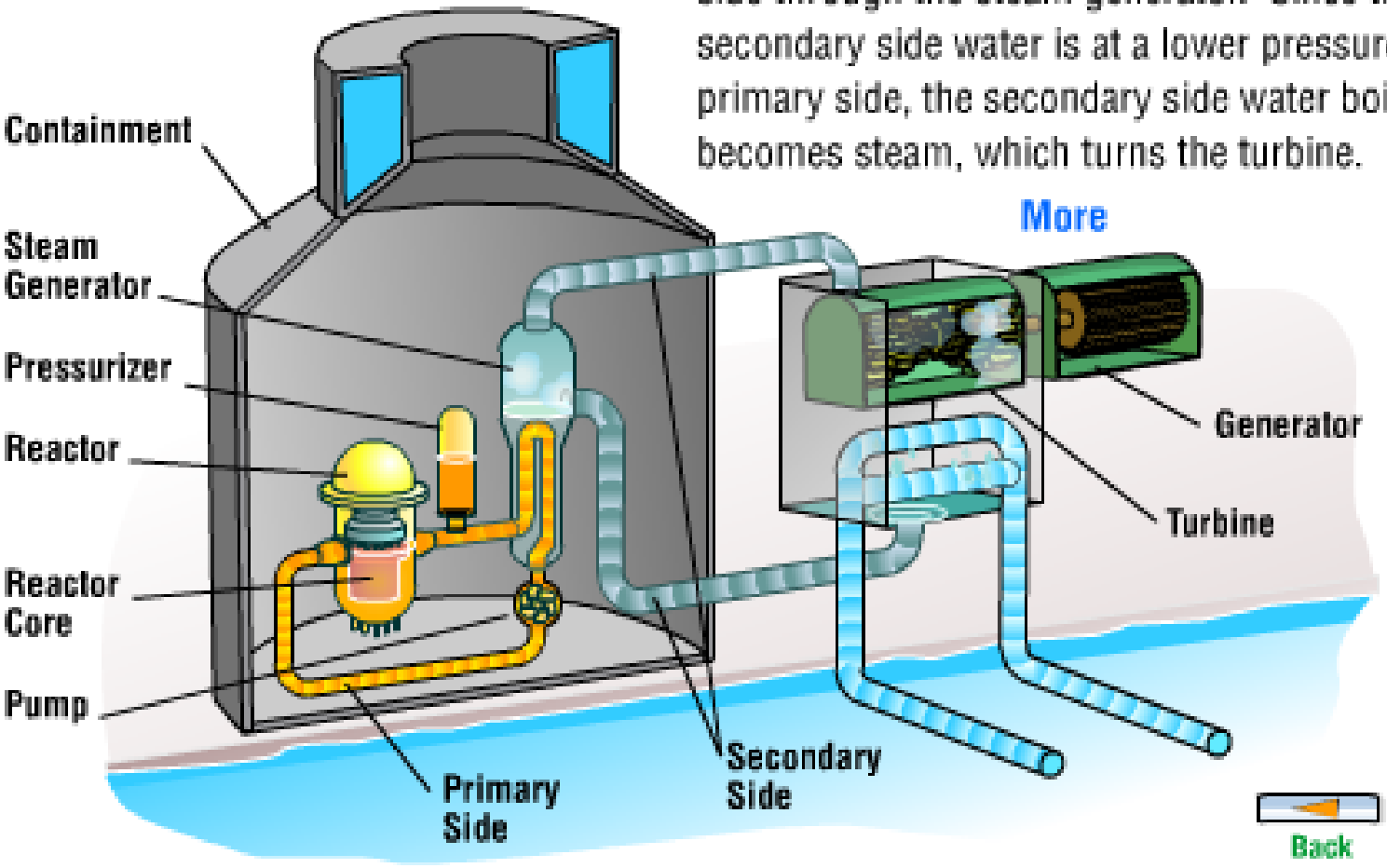
An induced fission reaction. A neutron is absorbed by a uranium-235 nucleus, turning it briefly into an excited uranium-236 nucleus, with the excitation energy provided by the kinetic energy of the neutron plus the forces that bind the neutron. The uranium-236, in turn, splits into fast-moving lighter elements (fission products) and releases three free neutrons. At the same time, one or more "prompt gamma rays" (not shown) are produced, as well.



Electricity from Nuclear Power

In a nuclear power plant, a vessel known as a pressurizer keeps the primary side at high pressure to prevent boiling, yet allowing water temperatures to reach 600 degrees Fahrenheit. Heat from the primary side water is transferred to the secondary side through the steam generator. Since the secondary side water is at a lower pressure than the primary side, the secondary side water boils and becomes steam, which turns the turbine.

More



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