**LECTURE 3**

## Hydroelectric Power Generation:

Hydroelectric facilities can supply significant amounts of electricity for irrigation or water pumping, lighting, health or educational purposes. Hydro power is a renewable energy source. It is essentially non-polluting and releases no heat. With the development of compact efficient machines, the investment per KW is not very high. Compared to other conventional energy generation schemes, it has low gestation period ranging from 8-24 months. Operating costs are low and the equipment does not need trained and skilled personnel. Most of the schemes in India can be constructed on existing canals and irrigation system with minor modification.

The basic components of a hydroelectric schemes are :

a) Diversion and Intake
b) Desilting Chamber
c) Water conductor System
d) Forebay/balancing reservoir
e) Penstock
f) Surge tank(if necessary)

g) Power house including turbine, generator, protection & control equipment, dewatering, drainage system, auxiliary power system; emergency & standby power system, lighting & ventilation.
h) Tail race channel

Dams and barrages are employed to divert the required flow from the river bed / streams to the intake structure (see figure)

Desilting Chamber is necessary where the water contains large quantities of course silt to minimize erosion to the turbine.

Abrasion effect increases with increasing head. The desilting chamber may be designed to exclude the coarse particles to achieve a power draft free of abrasion effects.

Water conductor system should be designed to ensure least loss of head and loss of water due to seepage. Further, flow velocity should be adequate enough to prevent reduction of discharging capacity due to settling of silt. The canal can be lined with tiles. When the length of the water conductor conduit is > 5 times the head on the machines, surge tank is necessary. Water conductor system is a very important component of the hydropower scheme.

Penstocks can be made from steel pipes, hume pipes and PVC pipes depending on the design pressure. Due to the variation in the load, the water entering into the turbine may be pushed back. This increases the pressure in the pipe called hammering. To prevent this, surge tank is used. A smooth entry of water is ensured from the forebay tank in to the Penstocks.

**Dam :** is used to increase the level of water stored in the reservoir. The level of water surface is called the head race.

**Turbine:** Converts Kinetic Energy of water to Mechanical energy.

**Generator :** Converts Mechanical Energy to Electrical Energy.

**Step - Up Transformer :** increases the voltage so that the power produced can be transmitted to the load area.

**Tail Race :** is a simple water channel or cover conduit with a maximum water velocity of m/s transporting the water from the turbine outlet (or draft tube) to the river

Efforts must be taken to reduce the cost of equipment and civil works from a major part of the total cost of the project.

**Fore bay :** is usually constructed in reinforced concrete of stone masonry. It is provided so that a minimum lead over the penstock is always there.

**Spill way :** In the case of load rejection the water level may rise and flood the area. Therefore, a spillway is provided keeping its crest at the permissible water level so that water level may not rise above the maximum permissible level. Spillway can be provided in the form of channel or pipe.

Power house building : accommodates turbine, generator, control panels, auxiliary equipment, etc., It must be a simple structure constructed either in RCC or stone masonry.

**Conduit :** carries water from head race to tail race. At the head race, the gravitational potential energy is converted into kinetic energy due to the head.

The turbine is essentially of kaplan type or propeller type. The generator may be directly coupled to the turbine shaft or driven through a set of gear for increasing the speed to reduce the generator size. The generator is usually on the upstream side of the turbine. The turbine at the downstream end is connected to the generator by means of a sealed shaft. Water flows in the axial direction to the turbine runner with propeller type blades.

Conventionally hydroelectric A.C.synchronous generators are used. The generator (rotor) should withstand turbine runaway speed.

**Advantages of hydroelectric power plant**

1) The running expenditure is almost negligible.
2) The operation and maintenance of hydroelectric power plant is the simplest
3) These energy sources are free from pollution.

**Introduction:**

The energy sources are classified in following way:

1. Non commercial fuel or natural fuels which include wood, animal waste and agricultural waste.
2. commercial fuel which include the fossil fuels(coal, oil, natural gas)
3. Hydraulic energy (Energy obtained through the use of Potential energy water).

**Conventional energy sources:**

Non-Commercial fuel: These flue include woods, leaves ,agro waste, dung of animal etc.

Commercial fuel: Coal, Petroleum, Natural gas:

| Commercial fuel | |
|---|---|
| 1. Fossil fuels | Coal, Natural Gas ,Petroleum |
| 2. Atomic Fuel | Uranium,Radium,Plutonium |

**Hydraulic Energy:** Hydraulic energy is also known as water power. When river water falls from the mountain, its potential energy is converted into kinetic energy

The major **potentials and limitations** of the conventional sources of energy:

1 Major portion of the energy requirement in the world today is met by the conventional sources of energy like coal, petroleum, natural gas and atomic fuels.

2 The conventional sources of energy exists in finite reserves in the world they are rapid ally depleting due to increase consumption of energy . they are likely to exhausted in future.

3 There are always danger of fire and accidents during use of conventional sources of fuel.

4 The conventional sources of fuel have great polluting effect on environments.

5 Transportation and distribution of conventional sources of fuel are very costly.

**The Non Conventional Sources of Energy are:**

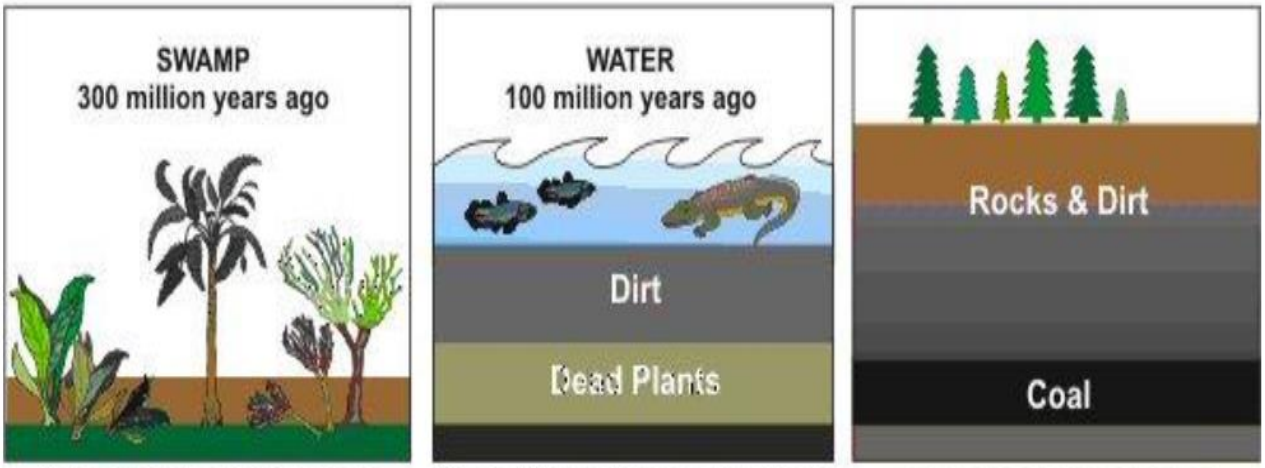
1. Tidal energy.
2. Energy from sea waves.
3. Geothermal energy or terrestrial heat energy.
4. Hydel energy using small size power plants.
5. Solar energy.
6. Wind energy

**The formation of Natural Resources**

**Coal**

Most coal was formed from plants which grew 300 million years ago.The time period is called CARBONIFEROUS ERA

# HOW COAL WAS FORMED



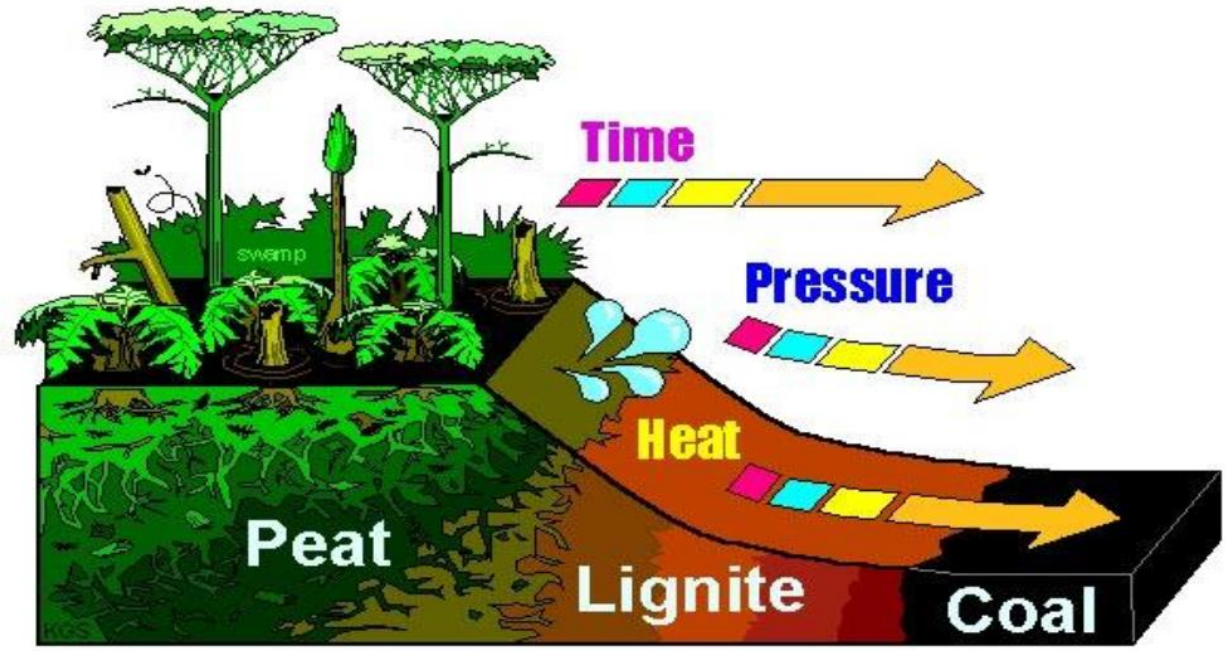

Before the dinosaurs, many giant plants died in swamps.

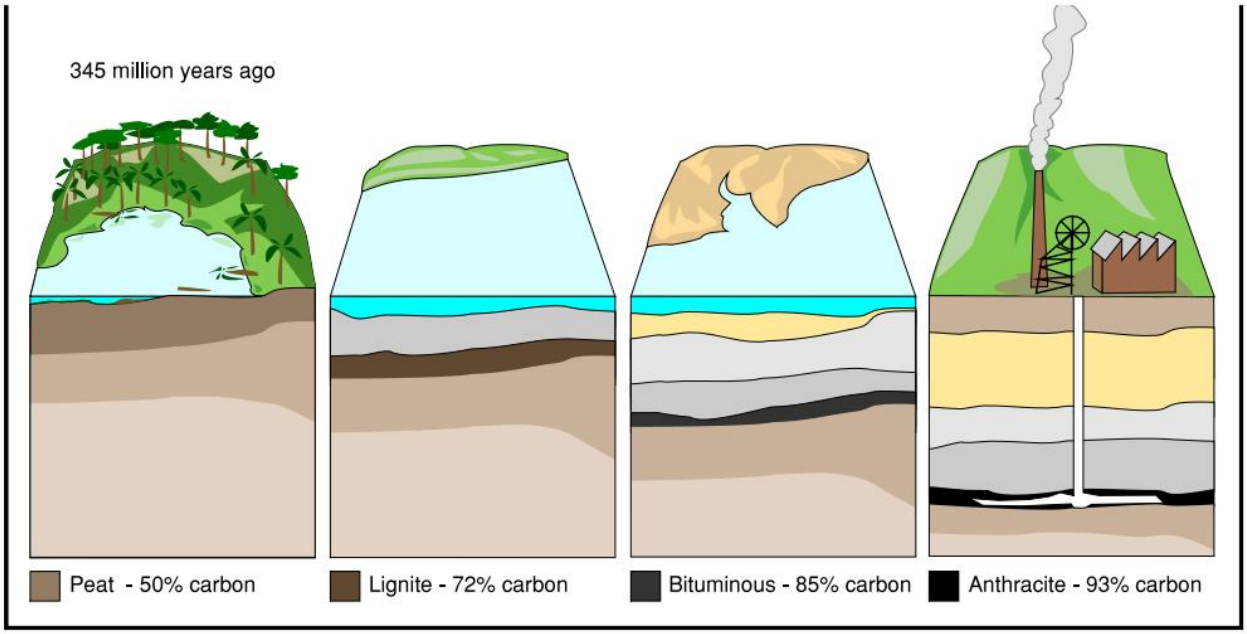
Over millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

# Stages of coal formation

1. **Peat** is a fibrous, soft, spongy substance in which plant remains are easily recognizable. It contains a large amount of water and must be dry before use.
2. **Lignite** is formed when peat is subjected to increased vertical pressure from accumulating sediments. It crumbles with no trouble and should not be shipped or handled before use.
3. **Bituminous Coal** is greatly used in industry as a source of heat energy.
4. **Anthracite** is also known as "hard coal" because it is hard and has a high lustre.




The ranking sequence is:

Wood
Peat
Lignite (brown coal)
Bituminous Coal
Anthracite

In general, deposits close to the surface which can be worked by strip mining produce a more economical fuel than deep mined coal.

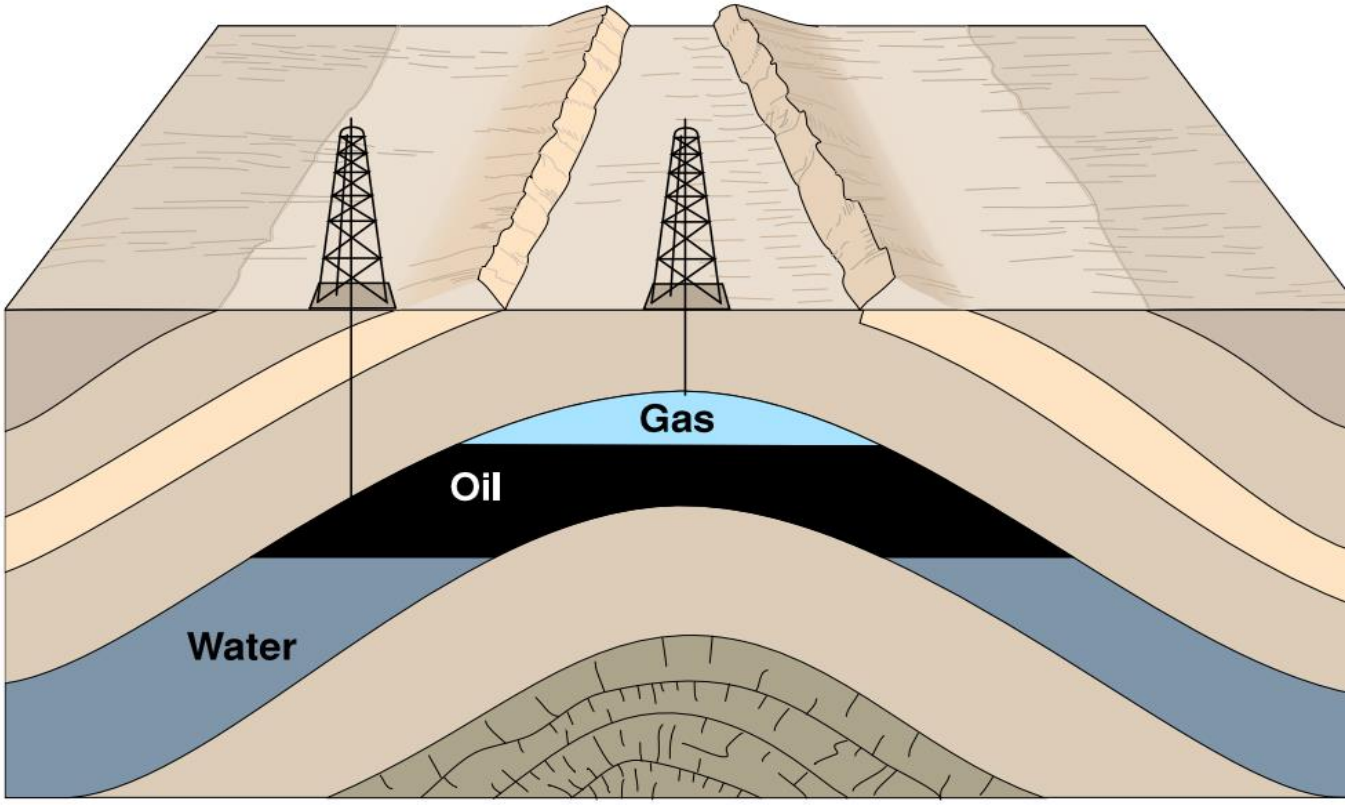
## OIL (PETROLEUM)

Buried organic matter rich in hydrocarbons

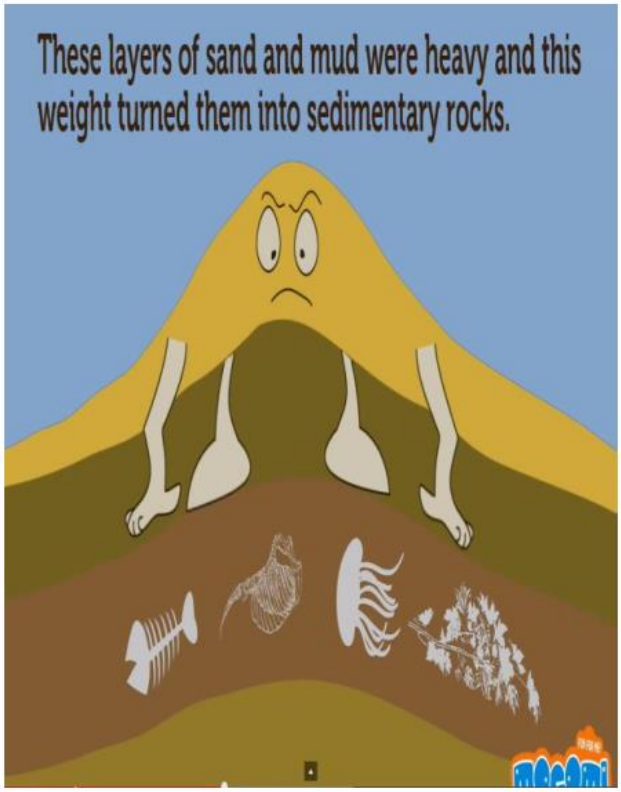
How oil and gas were formed

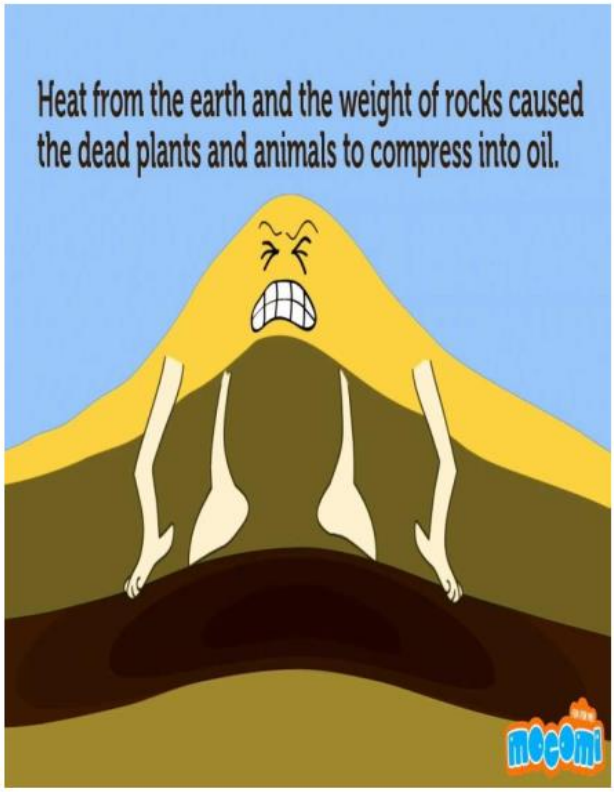
1. In the ocean - Plants use sun's energy to survive and animals get their energy by eating plants
2. Plants and animals in ocean die. The one's that are not eaten fall to the bottom of the sea.
3. A few millions of years later - layers of mud forms on top of the dead animals and plants
4. Another few millions of years later - layers of sand builds up on top of the mud
5. Pressure of all these layers of mud and sand squashes and turns in to mud stone
6. Pressure of all these layers of mud and sand squashes and turns plants and animals to oil and natural gas
7. Now, scientist burn oil and gas in power stations but this releases harmful gases

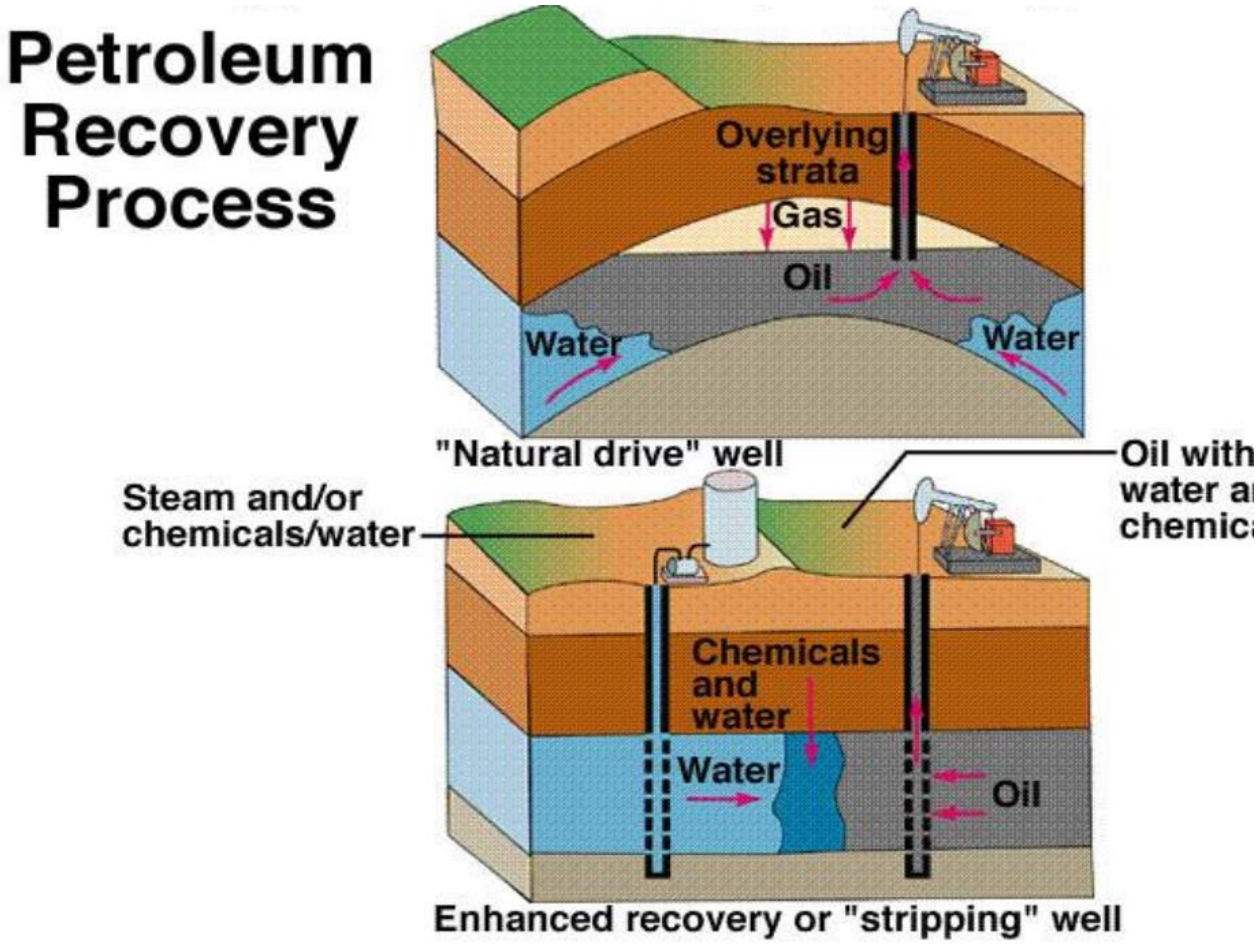
OIL and NATURAL GAS (Methane)




Even though it was not made from dead plants or animals, nuclear fuel is considered to be a fossil fuel because it comes from the ground and is running out.






**ENERGY SCENARIO**

India is the ninth largest economy in the world, driven by a real GDP growth of 8.7% in the last 5 years (7.5% over the last 10 years).

In 2010 itself, the real GDP growth of India was the 5th highest in the world. This high order of sustained economic growth is placing enormous demand on its energy resources. The demand and supply imbalance in energy is pervasive across all sources requiring serious efforts by Government of India to augment energy supplies as India faces possible severe energy supply constraints.

The share of Coal and Petroleum is expected to be about 66.8 percent in total commercial energy produced and about 56.9 percent in total commercial energy supply by 2021-22. The demand for coal is projected to reach 980 MT during the Twelfth Plan period (2012-2017), whereas domestic production is expected to touch 795 MT in the terminal year (2016-17).

Even though the demand gap will need to be met through imports, domestic coal production will also need to grow at an average rate of 8 percent compared to about 4.6 percent in the Eleventh Five Year Plan.

The share of crude oil in production and consumption is expected to be 6.7 percent and 23 percent respectively by 2021-22.

In 2011-12, India was the fourth largest consumer in the world of Crude Oil and Natural Gas, after the United States, China, and Russia. India's energy demand continued to rise inspite of slowing global economy.
Combustible renewables and waste (Combustible renewables and waste comprise solid biomass, liquid biomass, biogas, industrial waste, and municipal waste) constitute about one fourth of Indian energy use.
This share includes traditional biomass sources such as firewood and dung, which are used by more than 800 million Indian households for cooking.

The power sector in India had an installed capacity of 236.38 Gigawatt (GW) as of March 2012 recording an increase of 14% over that of March 2011.
Captive power plants generate an additional 36.5 GW. Thermal power plants constitute 66% of the installed capacity, hydroelectric about 19% and rest being a combination of wind, small hydro-plants, biomass, waste-to-electricity plants, and nuclear energy.
India generated about 855 BU electricity during 2011-12 fiscal.

As of March 2012, the per capita total consumption in India was estimated to be 879 kWh.
India's electricity sector is amongst the world's most active players in renewable energy utilization, especially wind energy.
As of March 2012, India had an installed capacity of about 24.9 GW of new and renewable technologies-based electricity.
During the Eleventh Five Year Plan, nearly 55,000 MW of new generation capacity was created, yet there continued to be an overall energy deficit of 8.7 per cent and peak shortage of 9.0 per cent.
Resources currently allocated to energy supply are not sufficient for narrowing the gap between energy needs and energy availability.

## NATURAL GAS:

Natural Gas is generally associated with petroleum deposits and is obtained from well dug in the oil-bearing regions. When Natural gas occurs along with petroleum in oil wells , it is called 'Wet Gas ' and contains gaseous hydrocarbons from $C_1$ to $C_4$. The Wet gas is then suitably treated to remove propane , propene , butene , butane , which is used as LPG .On the other hand , when the gas is associated with crude oil , it is called 'Dry Gas' and consists almost entirely of methane , ethane , with small concentration of impurities such as $CO_2$ , CO , $H_2S$ , $N_2$ and inert gases . Before use , the natural gas is purified to remove objectionable ingredients such as water , dust , grit , $H_2S$ , $CO_2$ , $N_2$ and heavier liquefiable hydrocarbons . The approximate composition of natural gas is : $CH_4$ = 70-90% , $C_2H_6$ = 5-10% ,
$H_2$ = 3%, CO + $CO_2$ = rest . The calorific value varies from 12000 to 14000 kcal/$m^3$.

It is an excellent domestic fuel and is conveyed over very large distance in pipelines. In America , it is available to a great extent and , is quite popular as a domestic fuel . It has recently been used in the manufacture of a number of chemicals by synthetic processes .