

LECTURE 2

Energy Consumption:

Energy is very important in all sectors of any country's economy. Energy crisis is due to population of the world and also the increase in the standard of living. The Standard of living of any country is directly related to per capita energy consumption.

The per capita consumption in India is (1/50th that of USA) 150RWH. India has a population of 20% of the world's population and consumes only 1% of the total energy consumed in the world. Products such as food, coffee, tea, jute, and ores etc., should be processed to get better value. The present consumption of energy is estimated to be about 40 million mega watts.

World Energy Futures :

The world population may reach 7 billion by 2000 AD The conventional sources of energy are depleting and may be exhausted by the beginning of the next century. Nuclear energy requires skilled technicians and poses danger as regards to radioactive waste disposed.

Solar energy and other non-conventional energy sources are the sources which are to be utilized in future.

Conclusions of the Study on alternate energy strategies are :

- 1) The Supply of oil will not be sufficient to meet increasing demand before the year 2000, even if the energy price rise. Additional constrain on oil production will hasten this shortage.
- 2) Demand for energy will grow even if vigorous policies are taken to conserve energy.
This growth must increasingly be satisfied by energy resources other than oil, which can be consumed for use that oil alone can satisfy.

- 3) The continued growth of energy demand requires that oil energy resources be developed with the utmost vigour. The need for replacement fuels will increase rapidly as time proceeds.
- 4) Electricity from nuclear power is capable of making an important contribution to the global energy supply. Fusion power will be significant in future.
- 5) Coal has the potential to contribute substantially to future energy supplies. Coal reserves are abundant and requires an active programme of development by both producers and consumers to tap them.
- 6) Natural gas reserves are large to meet projected demand.
- 7) The resource base of fossil fuels such as oils sands, heavy oil and oil shale is very large but at present they supply only small amount of energy.
- 8) While hydroelectric power contributes large amount of energy, now renewable alternate resources of energy e.g. solar, wind, wave are likely to contribute significant quantities of additional energy only in the 21st Century.
- 9) Energy efficiency improvements along with energy conservation assumptions can further reduce energy demand and shorten the gaps between energy demand and supply. Policies for achieving energy conservation should continue to be key elements of all future energy strategies.

World oil production is likely to travel off very shortly and alternative fuels will meet the growing demand for energy. Large investments and long lead times are required to produce alternative fuels on a large scale. Oil is the fuel that currently furnishes most of the world's energy. The task for the world will be to manage a transition from dependence on oil to dependence on other fossil fuels, nuclear energy and later renewable energy sources.

Energy Sources and their availability :

Every country derives energy from various sources- commercial and non-commercial. The commercial sources include the fossil fuels (Coal, Oil and Natural gas), hydroelectric power and nuclear power. The non-commercial sources include wood, animal waste and agricultural waste.

Industrialized countries like the USA meet the energy requirements from commercial sources of energy whereas industrially less-developed countries like

India meets the requirements from commercial and non-commercial sources almost equally.

Commercial sources of energy:

The major sources of

- 1) Fossil fuels: This comprises solid fuels such as Coal including Anthracite, Bituminous, Lignite and Peat; liquid fuels such as Petroleum and its derivatives: gaseous fuels such as Natural gas.
- 2) Water power (hydro) or energy stored in water.
- 3) Energy of nuclear fission.

The minor sources of energy are solar, wind, tidal (tides in the sea), geothermal, ocean thermal electric conversion, fuel cells, thermionic, thermo electric generators, etc.

Wood was the dominant source of energy in the pre-industrialization era. Coal later became the dominant source of energy in the early part of the 20th century. Later, Oil became the major source of energy. Wood is no more regarded as a conventional source. Hydroelectricity has already grown to a stable level in developed countries. The % use of various sources for the total energy consumption in the world is given in the table.

Type of source	Energy sources	Total energy consumption in the world
Commercial sources	Oil	38.3%
	Coal	32.5%
	Gas	19.0%
	Hydro	2.0%
	Nuclear(Uranium)	0.13%
Non-commercial sources	Wood	6.6%
	Dung	1.2%
	Waste	0.3%

Coal, oil, gas, Uranium and hydro are commonly known as commercial (or) conventional energy sources. World's energy supply comes mainly from fossil fuels (from above).

Firewood, animal dung and agricultural waste represent 8% of total energy consumption in the world.

Gas :

It is economical to run long distance pipe lines for the gas to be transported several hundred kilometers to the place where it can be used. This is a very significant improvement. Any organic waste can be used for the production of biogas

The worldwide energy:

Globally, the contributions to current energy resources come from oil, coal and natural gas, hydroelectricity and traditional biofuels(firewood, cropwaste, peat and dung). The contribution of solar, wave, tidal and geothermal power can make limited. This is because reasonable energy depends on the development of means of capturing and concentrating it. In addition, renewable energy is not always available when needed - rivers can dry up; the unit does not always blow.

Future Demands :

It is clear that, in the future, demand for energy will be higher than at present, due to population growth and increased industrialization. Furthermore, the energy available must be at a reasonable cost or economic growth will be held back. This is especially important for developing countries, where the inability to meet high energy costs hinders developments.

Future Solutions :

In principle, known resources of non-renewable energy should be sufficient for several hundred years or more.

At the present rate of consumption, oil reserves will last about 40 years; gas reserves will last about 60 years; coal will last about 250 years; and U reserves if used in fast reactors, would last for more than 1000 years. It is also likely that further fossil fuel reserves will be discovered as currently known supplies run out. However, in practice, the outlook is uncertain.

Increasing concern about pollution might make dirty coal-fired power stations unacceptable in the future.

One alternative is to make greater use of nuclear power, moving to fast reactors and then developing nuclear fusion plants that would mimic the power production process occurring in the sun. However, anxiety about safety and waste disposal is already limiting the use of nuclear energy, so it is unlikely to provide an answer in the future.

There is considerable room for development in the use of renewable resources, but with most of the world's energy production based around non-renewable fuel supplies, the wide spread introduction of efficient renewable energy will require a complete restructuring of the ways we produce and use energy.

Nuclear Energy :

In a pressurized water nuclear power station, water at high pressure is circulated around the reactor vessel where it is heated. The hot water is pumped to the steam generator where it boils in a separate circuit ; the steam drives the turbines coupled to the electricity generator. This is the most likely widely used type of reactor. More than 20 countries have pressurized water reactors.

Nuclear Reactors :

Nuclear Reactor is a device for producing nuclear energy in a controlled manner. There are various types of reactors in use, all using nuclear fission in a gas cooled reactor, a gas under pressure (such as CO_2) removes heat from the core of the reactor, which usually contains natural U. The efficiency of the fission process is increased by slowing neutrons in the core by using a moderator such as Carbon. The reaction is controlled with neutron-absorbing rods made of Boron. An advanced Gas-cooled reactor(AGR) generally has enriched U as its fuel. A water cooled reactor such as the steam generating heavy water (deuterium oxide) reactor, has water circulating through the hot core. The water is converted to steam, which drives turbo-alternators for generating electricity. The most widely used reactor is the PWR(Pressurized Water Reactor) which contains a sealed system of pressurized water that is heated to form steam in the heat exchanger in an external circuit.

The fast reactor has no moderator and uses fast reactions to bring about fission. It uses a mixture of Plutonium (or) Uranium oxide as fuel. When operating U is converted to Plutonium which can be extracted and used later as fuel. It is also called the fast breeder reactor because it produces more Plutonium than it consumes. Heat is removed from the reactor by a coolant of liquid Sodium. The safest system allows for the emergency cooling of a reactor by automatically flooding an overheated core with water.

Nuclear fission:

Nuclear fission is the splitting of a heavy atomic nucleus into two or more major fragments. It is accompanied by the emission of 2 or 3 neutrons and the release of large amounts of nuclear energy.

Fission occurs spontaneously in nuclei of U^{235} , the main fuel used in nuclear reactors. However, the process can also be induced by bombarding nuclei with neutrons because a neutron that has absorbed a neutron becomes unstable and soon splits. The neutrons released spontaneously by the fission of U nuclei may therefore be used in turn to induce further fissions, setting up a chain reaction that must be controlled if it is not to result in a nuclear explosion.

Chain Reaction:

In nuclear physics, a fission reaction that is maintained because of neutrons released by the splitting of some atomic nuclei themselves go on to split others, releasing even more neutrons. Such a reaction can be controlled (as in a nuclear reactor) by using moderators to absorb excess neutrons. Uncontrolled, a chain reaction produces a nuclear explosion (as in an atom bomb).

In nuclear reactions, the sum of the masses of all the products (on the atomic mass unit scale) is less than the sum of the masses of the reacting particles. The lost mass is converted to energy according to Einstein's Equation.