Dr Kanchan Singh (Paper- Environmental Sciences (AECC-I)

Lecture-1

(For B.Sc. (H) Physical Science, Computer Science, Electronics, and Anthropology)

Chapter 3: Natural Resources

Topics to cover

ENERGY RESOURCES

Capacity to do work, transfer heat or to set things in motion is call energy.All living organism need energy in the form of food. Sun is the primary source of energy and we used in various forms in our lives. But humans require huge amount of energy to sustain their civilization:

1. To run their cars and industries
2. To process materials
3. To keep their houses warm or cool ….etc.

Growing energy needs

Electricity use has shown 100-fold increase during last 2-3 decades in many countries. Due to continuous electricity requirement, the fossil fuel based electricity generation has increased from 20-30%. The consumption and demand of energy is much higher in developed countries. Countries like U.S.A. and Canada constitute only 5% of the world's population but consume 25% of global energy resources. Energy consumption of a single person in these countries is about 300 GJ (Giga Joules) per year. Whereas an average man in a poor country like Bhutan, Nepal or Ethiopia consumes less than 1GJ in a year. So a person in a rich country consumes almost as much energy in a single day as one person does in a whole year in a poor country. This clearly depicts that

our modernised way of life needs much more energy. it indicates very high demands of energy in the world in future as the world as a whole is shifting from a simple way of life to a modern and sophisticated way of life. Thus there is very high pressure on the existing conventional sources of energy. But, unfortunately, these sources of energy are limited.

Sources of Energy

A source of energy is a substance or means that can provide adequate amount of energy in a +usable form over a long period of time. These sources can be of two types:

A**. Renewable Energy Resources** are those which can generate energy continuously in nature and are inexhaustible or regenerable e.g. wood, solar energy, wind energy, tidal energy, hydropower, biomass energy, bio-fuels, geo-thermal energy and hydrogen. They are also known as non-conventional sources of energy and they can be used again and again in an endless manner.

B. **Non-renewable Energy Resources** are those 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 and thorium.

A. Renewable forms of energy resources (Non-conventional forms of energy resources)

1. **Wood or Dendrothermal Energy:** Wood is a renewable source of energy. It gives immense heat on burning that can be used for various purposes. Different types of wood or plant species give different amount of energy per unit of wood burnt.

2. **Solar energy:** Sun is the ultimate source of energy, directly or indirectly on our planet. The nuclear fusion reactions occurring inside the sun release

enormous quantities of energy in the form of heat and light. The solar energy received by the near earth space is approximately 1.4 kilojoules/second/m2. This is also known as solar constant. We have developed several techniques for harnessing solar energy. Solar energy has successfully been used in solar water heaters, solar cookers, photovoltaic cells or PV cells and solar power plants.

National Solar Mission: The National Action plan on climate change ((NAPCC) aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar competitive with fossil-based energy options. It also includes the establishment of a solar research center, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

1. **Wind Energy:** It refers to the kinetic energy present in high speed winds due to their. 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 can be used to drive a number of machines like electric generators, flour mills and water pumps. A large number of wind mills are installed in clusters called wind farms, which are used to produce a large amount of electricity. The minimum wind speed required for satisfactory working of a wind generator is 15 km/hr. The wind power potential of our country is estimated to be about 20,000 MW, while at present we are generating about 1020 MW. Wind energy is an environment friendly form of energy as it does not cause any air pollution. After the initial installation cost, the wind energy is also very cheap.

2. **Hydropower:** It refers to the generation of electricity from water. In this process kinetic energy of water is converted to electric energy through the use of turbine and other devices. The water flowing in a river is collected and stored

in a big dam. This water is then allowed to fall from a height and rotate a turbine connected with a generator to produce electricity. Due to side effects of big dams it is more appropriate to construct mini or micro hydel power plants on the rivers in hilly regions for harnessing the hydro energy on a small scale to meet local energy needs. It does not cause any pollution and is renewable source of energy. The hydropower potential of India is estimated to be about 4 × 1011 KW-hours.

3. **Tidal Energy**: It refers to the energy present in oceans due to gravitational effects of sun and moon. Rise and fall of water in seas and oceans is known as high tide and low tide. The tidal energy can be harnessed by constructing a tidal barrage. During high tide, the sea-water flows into the reservoir of the barrage and turns the turbine placed there, which in turn produces electricity by rotating the generators. During low tide, when the sea-level is low, the sea water stored in the barrage reservoir flows back into the sea and again turns the turbines. Thus electricity can be generated using tidal energy of the oceans. Tidal energy is, however, not available everywhere and there are very few sites in the world where it can be effectively harnessed for useful purposes.

6. **Geothermal Energy**: The energy harnessed from the heat produced inside the earth is called geothermal energy. There is high pressure and temperature inside the earth. At some places, the steam or the hot water comes out of the ground naturally through cracks in the form of natural geysers. Sometimes it does not find any place to come out and we can artificially drill a hole up to the hot rocks and by putting a pipe in it make the steam or hot water gush out through the pipe at high pressure. It turns the turbine of a generator to produce electricity. There are several geothermal plants working successfully in certain countries of the world such as USA and New Zealand.

7. **Biomass Energy:** Biomass means the organic matter produced by the plants or animals. It includes wood, crop residues, cattle dung, manure, sewage, agricultural wastes etc. Biomass energy is of the following types:

(a.) Energy Plantations: Several fast growing plants may be grown and then used for providing energy either by burning directly or by getting converted into burnable gas or may be converted into fuels by fermentation.

(b) Petro-crops: Certain latex-containing plants like Euphorbias and oil palms are rich in hydrocarbons and can yield oil like substance under high temperature and pressure. This oily material may be burned in diesel engines directly or may be refined to form gasoline. These plants are popularly known as petro-crops.

(c) Agricultural and Other Waste Biomass: In our homes in rural settings we burn various types of biomass in open or household furnaces called Chullahs to produce heat and cook food. Animal dung cakes are also commonly burnt to produce heat in rural areas. Crop residues, bagasse (sugarcane residues), coconut shells, peanut hulls, cotton stalks etc. are some of the common agricultural wastes which produce energy by burning. Animal dung, fishery and poultry waste and even human refuse are examples of biomass energy. In Brazil 30 % of electricity is obtained from burning bagasse. In rural India about 80 % of rural heat energy requirements are met by burning agricultural wastes, wood and animal dung cakes. The direct burning of biomass in open often causes air pollution and produces a lot of ash as waste residue. It is therefore, more useful to convert the biomass into biogas or bio fuels.

(d) Biogas: Biogas is the burnable gas obtained from biomass in a particularly designed fermentation plant. It is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide, the major constituent being methane. Biogas

is produced by anaerobic degradation of animal and plant wastes in the presence of water. All wastes are directed to a dome shaped or other structure made for the purpose. After sometime microbial action on biomass wastes in presence of plenty of water produces biogas which can directly be used for cooking and heating purposes. Biogas is a non-polluting, clean and low cost fuel which is very useful for rural areas where a lot of animal waste and agricultural waste are available. The sludge left over after use of gas from plant is a rich fertilizer containing bacterial biomass with most of the nutrients preserved as such.

Lecture-2

Topics to cover

B. Non Renewable Sources of Energy (Conventional Forms of Energy)

Fossil fuels like coal, petroleum and natural gas are the major sources of energy in the present world. They are used as fuels and are non renewable. These were formed by the decomposition of the remains of plants and animals buried under the earth millions of years ago. Nuclear energy is another form which is very effective but has also its own demerits.

1. **Coal:** Coal is the most abundant fossil fuel in the world. There are mainly three types of coal, namely anthracite (hard coal), bituminous (Soft coal) and lignite (brown coal). Anthracite coal has maximum carbon (90%) and calorific value (8700 kcal/kg.) Bituminous, lignite and peat contain 80, 70 and 60% carbon, respectively. India has about 5% of world's coal though Indian coal is not very good in terms of heat capacity. Major coal fields in India are Raniganj, Jharia, Bokaro, Singrauli, and Godavari valley. Anthracite coal occurs only in our state i. e J & K in India. On burning coal causes serious

environmental pollution including release of carbon dioxide a major green house gas.

2. **Petroleum:** It is the most important energy source in the world. There are 13 countries in the world having 67% of the petroleum reserves which together form the OPEC (Organization of Petroleum exporting countries). About 1/4th of the oil reserves are in Saudi Arabia. Crude petroleum is a complex mixture of alkane hydrocarbons. Hence it has to be purified and refined by the process of fractional distillation, during which process different constituents separate out at different temperatures and we get a large variety of products from this, namely, petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin wax, asphalt, plastic etc. LPG we use at home is a liquefied form of petroleum gas which mostly consists of Butane. In India in India oil fields are located at Digboi (Assam), Gujarat Plains and Bombay High, offshore areas in deltaic coasts of Gadavari, Krishna, Kaveri and Mahanadi. Petroleum also cause pollution on burning but it is cleaner than coal as it left no residue after burning.

3. Natural gas: It is also a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. It is mainly composed of methane (95%) with small amounts of propane and ethane.Natural gas is the cleanest fossil fuel. It can be easily transported through pipelines. It has a high calorific value of about 50KJ/G and burns without any smoke. Natural gas is used as a domestic and industrial fuel. It is used as a fuel in thermal power plants for generating electricity. Compressed natural gas (CNG) is used as an alternative to petrol and diesel for transport of vehicles. It is much cleaner and causes no or very little pollution. In Delhi all buses and auto rickshaws run on this new fuel.

4. Nuclear energy: Nuclear energy is the tremendous energy present in the nucleus of an atom. This energy can be harnessed from the atoms of some elements and can be utilised for fulfilling energy requirements at large scale. It can be generated by two types of reactions: Nuclear Fission: It is the nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons and a large amount of energy is released through a chain reaction. As in the example below Uranium atom is bombarded with a neutron and it releases huge amount of energy and Uranium atoms gets converted to Krypton and Barium.

92U235 + 0n1□ □36Kr92 + 56Ba141 + 3 0n1 + Energy

Uranium-235 nuclei are most commonly used in nuclear reactors. Nuclear Reactors make use of nuclear chain reaction. Only 1 neutron is allowed to strike for splitting another nucleus in order to control the rate of fission. Nuclear fusion: Here two isotopes of a light element are forced together at extremely high temperatures until they fuse together to form a heavier nucleus. This reaction also releases enormous energy in the process. It releases more energy than nuclear fission.

1H2 + 1H2 □ 3He2 + 0n1 + Energy

In the example shown above, two hydrogen (Deuterium) atoms fuse to form the nucleus of Helium at very high temperature. The process releases a neutron a huge amount of energy. Nuclear energy has tremendous potential but very serious risks of leakage from nuclear reactor are associated with it. Disposal of the nuclear waste also poses a big problem. There are several nuclear power stations in India located at Tarapur (Maharashtra), Kota (Rajasthan), Kalpakkam (Tamil Nadu) and Narora (U.P.). India has uranium from mines in Bihar. There are deposits of thorium in Kerala and Tamil Nadu.

References:

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