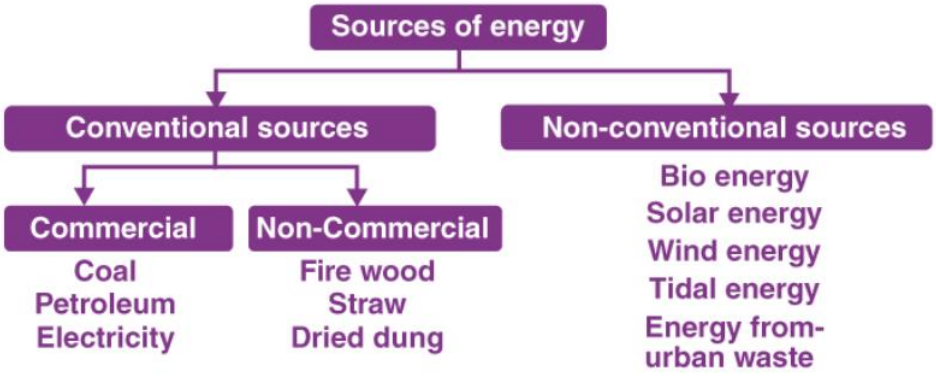
CAI335 SOLAR AND WIND ENERGY SYSTEM

UNIT I NOTES

ENERGY

Energy is the ability of a physical system to perform work. We use energy in our daily lives from various sources for doing work. We use muscular energy for carrying out physical work, electrical energy for running multiple appliances, chemical energy for cooking food, etc. For this, we need to know the different energy sources to obtain energy in its usable form. This article will familiarize you with two important sources of energy: conventional energy and non-conventional energy.



COMMERCIAL ENERGY SOURCES

Coal, electricity and petroleum are known as commercial energy since the consumer needs to pay its price to buy them.

Coal

Coal is the most important source of energy. There are more than 148790 coal deposits in India, and between 2005-2006, the annual production went up to 343 million tons. India is the fourth-largest coal-producing country, and the deposits are primarily found in Bihar, Orissa, Madhya Pradesh, Jharkhand and Bengal.

Oil and Natural Gas

Oil is considered liquid gold and one of the crucial energy sources in India and the world. Oil is primarily used in planes, automobiles, trains and ships. The total oil production in India was 0.3 million tons in 1950-51, which increased up to 32.4 million tons in 2000-01. It is mainly found in Assam, Gujarat and Mumbai.

Electricity

Electricity is a common form of energy used for domestic and commercial purposes, and it is mainly utilized in electrical appliances like fridges, T.V, washing machines and air conditioning.

The major sources of power generation are:

- Nuclear Power
- Thermal Power
- Hydro-electric power

Thermal Power Thermal power is generated at various power stations utilizing oil and coal. It is a vital source of electric current, and its share in the nation's total capacity in 2004-05 was 70 percent.

Hydroelectric Power Hydroelectric power is produced by constructing dams above flowing rivers like Damodar Valley Project and Bhakra Nangal Project. The installed capacity of hydroelectric power was 587.4 mW in 1950-51 and went up to 19600 mW in 2004-05.

Nuclear Power The fuel used in nuclear power plants is Uranium, which costs less than coal. Nuclear power plants can be found in Kaiga (Karnataka), Kota (Rajasthan), Naroura (UP) and Kalapakam(Chennai).

Non-commercial Energy Sources

Generally, the freely available energy sources are considered non-commercial energy sources. Examples of non-commercial energy sources include straw, dried dung, firewood

Non-Conventional Sources of Energy

Non-conventional sources are also known as renewable sources of energy. Examples of non-conventional sources of energy include solar energy, bioenergy, tidal energy and wind energy.

Solar Energy

Solar Energy is produced by sunlight. The photovoltaic cells are exposed to sunlight based on the form of electricity that needs to be produced. The energy is utilized for cooking and distillation of water.

Wind Energy

Wind energy is generated by harnessing the power of wind and mostly used in operating water pumps for irrigation purposes. India stands as the second-largest country in the generation of wind power.

Tidal Energy

Tidal energy is generated by exploiting the tidal waves of the sea. This source is yet to be tapped due to the lack of cost-effective technology.

Limitations of RE sources

Despite of advantages when it comes to renewable energy, the positives outweigh the negatives. Some of the limitations of renewable energy sources are;

- Some type of renewable energy sources is location-based and commercially feasible
- These types of energies need storage capacities
- Some energy sources cause pollution.
- Renewable energies frequently need funding for making them reasonable

SOLAR ENERGY

Solar energy is one of the purest and clean forms of energy we receive on earth, without any environmental degradation. Thanks to the never-ending solar radiations we receive, it is responsible for all the life processes taking place on earth. If we tap into this energy systematically, this can be the largest source of energy, and even a tenth of energy from solar rays on earth can solve the entire energy crisis

In India, however, the potential of energy from solar rays is about 750GW. If this energy is utilized, we won't need any other source of energy in our country. There are many ways converting solar energy to electricity, but most widely used ones are by using photo-voltaic cells (also called solar cells) and concentrated solar power, where solar rays are focused and the concentrated power generates heat to run the solar plant.

SOLAR RADIATION

Visible light has a wavelength of between 0.40 to 0.71 micrometers (μm). The sun emits only a portion (44 %) of its radiation in this range. Solar radiation spans a spectrum from approximately 0.1 to 4.0 micrometers. About 7 % of the sun's emission is in 0.1 to 0.4 micrometers wavelength band (UV). About 48 % of the sun's radiation falls in the region between 0.71 to 4.0 micrometers (near infrared : 0.71 to 1.5 micrometers; far infrared: 1.5 to 4.0 micrometers)

The Earth is a planet with an atmosphere and is largely transparent to the incoming solar radiation. There are constituents in the atmosphere which prevent some kinds of radiation from reaching the surface, such as ozone which stops the ultraviolet. A fair proportion of the Earth is covered by clouds which reflect a lot of the Sun's radiation and thus affecting the surface temperature. The process of scattering occurs when small particles and gas molecules diffuse part of the incoming solar radiation in random directions without any alteration to the λ of the electromagnetic energy. Scattering does, however, reduce the amount of incoming radiation reaching the Earth's surface.

A significant proportion of scattered shortwave solar radiation is redirected back

to space. The amount of scattering that takes place is dependent on two factors: λ of the incoming radiation and the size of the scattering particle or gas molecule. In the Earth's atmosphere, the presence of a large number of particles with a size of about 0.5 μm results in shorter wavelengths being preferentially scattered. This factor also causes our sky to look blue because this color corresponds to those wavelengths that are best diffused. If scattering did not occur in our atmosphere the daylight sky would be black.

If intercepted, some gases and particles in the atmosphere have the ability to absorb incoming insolation. Absorption is defined as a process in which solar radiation is retained by a substance and converted into heat. The creation of heat also causes the substance to emit its own radiation. In general, the absorption of solar radiation by substances in the Earth's atmosphere results in temperatures that get no higher than 1800° C.

Bodies with temperatures at this level or lower would emit their radiation in the longwave band. Further, this emission of radiation is in all directions so a sizable proportion of this energy is lost to space. The third process in the atmosphere that modifies incoming solar radiation is reflection. Reflection is a process where sunlight is redirect by 180° after it strikes an atmospheric particle. This redirection causes a 100 % loss of the insolation. Most of the reflection in our atmosphere occurs in clouds when light is intercepted by particles of liquid and frozen water. The reflectivity (albedo) of a cloud can range from 40 to 90 %

Radiation is heat transfer by the emission of electromagnetic waves which carry energy away from the emitting object. The solar energy moves through empty space from the Sun to the Earth and is the original energy source for Earth’s weather and climate.

Importance of Radiation Transfer

- Virtually all the exchange of energy between the Earth and the rest of the universe takes place by radiation transfer.
- Radiation transfer is also a major way of energy transfer between the atmosphere and the underlying surface and between different layers of the atmosphere.