FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

Course Material

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Lecture -1

Classification of Energy sources

About 70% of India's energy generation capacity is from fossil fuels, with coal accounting for 40% of India's total energy consumption followed by crude oil and natural gas at 24% and 6% respectively. India is largely dependent on fossil fuel imports to meet its energy demands — by 2030, India's dependence on energy imports is expected to exceed 53% of the country's total energy consumption. In 2009-10, the country imported 159.26 million tonnes of crude oil which amount to 80% of its domestic crude oil consumption and 31% of the country's total imports are oil imports. The growth of electricity generation in India has been hindered by domestic coal shortages and as a consequence, India's coal imports for electricity generation increased by 18% in 2010.

Due to rapid economic expansion, India has one of the world's fastest growing energy markets and is expected to be the second-largest contributor to the increase in global energy demand by 2035, accounting for 18% of the rise in global energy consumption. Given India's growing energy demands and limited domestic fossil fuel reserves, the country has ambitious plans to expand its renewable and nuclear power industries. India has the world's fifth largest wind power market and plans to add about 20GW of solar power capacity by 2022. India also envisages to increase the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9% within 25 years. The country has five nuclear reactors under construction (third highest in the world) and plans to construct 18 additional nuclear reactors (second highest in the world) by 2025.

Types of Energy

Basically energy can be classified into two types:

Potential Energy

Kinetic Energy

Potential Energy

Potential energy is stored energy and the energy of position (gravitational). It exists in various forms.

Kinetic Energy

Kinetic energy is energy in motion- the motion of waves, electrons, atoms, molecules and substances. It exists in various forms.

Various Forms of Energy

Chemical Energy

Chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are examples of stored chemical energy.

Nuclear Energy

Nuclear energy is the energy stored in the nucleus of an atom - the energy that holds the nucleus together. The nucleus of a uranium atom is an example of nuclear energy.

Stored Mechanical Energy

Stored mechanical energy is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of stored mechanical energy.

Gravitational Energy

Gravitational energy is the energy of place or position. Water in a reservoir behind a hydropower dam is an example of gravitational energy. When the water is released to spin turbines, it becomes rotational energy.

Radiant Energy

Radiant energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Solar energy is an example of radiant energy.

Thermal Energy

Thermal energy (or heat) is the internal energy in substances- the vibration and movement of atoms and molecules within substances. Geothermal energy is an example of thermal energy.

Electrical Energy

Electrical energy is the movement of electrons. Lightning and electricity are examples of electrical energy.

Motion

The movement of objects or substances from one place to another is motion. Wind and hydropower are examples of motion.

Sound

Sound is the movement of energy through substances in longitudinal (compression/rarefaction) waves.

Light Energy

Light energy is a type of wave motion. That is, light is a form of energy caused by light waves. It enables us to see, as objects are only visible when they reflect light into our eyes

Nuclear Energy

Nuclear energy is a controversial energy source. It is not a renewable energy source, but because it is a technology not based on fossil fuels many people think nuclear power plants could play an important role in reducing carbon emissions and battling climate change. However, many others feel the risk of accidents and the issues of storing nuclear waste for thousands of years are too significant to warrant the development of this energy source.

Sources of Energy

In simple terms we can say that anything out of which usable energy can be extracted is a source of energy. There is a variety of sources that provide us energy for different purposes. You must be familiar with coal, petrol, diesel kerosene and natural gas. Similarly you must have also heard about hydroelectric power, wind mills, solar panels, biomass etc.

Fossil Fuels – Conventional Source of Energy

A fossil fuel is a fuel formed by natural processes, such as anaerobic decomposition of buried dead organisms, containing energy originating in ancient photosynthesis. Millions of years ago the remains of dead plants and animals were buried under the ground. Over the years by the action of heat from the Earth‟s core and pressure from rock and soil, these buried and decomposed organic materials have been converted into fossil fuels.. Fossil fuels contain high percentages of carbon and include petroleum, coal, and natural gas. Coal, crude oil and natural gas are common examples of fossil fuels. They are used to run the vehicles, cooking, lighting, washing, to generate electricity, for making plastics and paints etc.

Energy from the Atom – Nuclear Energy

Nuclear power is the use of nuclear reactions that release nuclear energy to generate heat, which most frequently is then used in steam turbines to produce electricity in a nuclear power plant. Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion. The atoms of a few elements such as radium and uranium act as natural source of energy. In fact atoms of these elements spontaneously undergo changes in which the nucleus of the atom disintegrates. The energy stored in the nuclei of atoms can be released by breaking a heavy nucleus such as uranium into two lighter nuclei. The splitting of the nucleus of an atom into fragments that are roughly equal in mass with the release of energy is called nuclear fission. When a free neutron strikes a Uranium (235) nucleus at a correct speed, it gets absorbed. A

Uranium (235) nucleus on absorbing a neutron becomes highly unstable and splits into nuclei of smaller atoms releasing huge amount of energy in the process. During this process, a few neutrons are also released. These neutrons split other nuclei of the Uranium (235). The reaction continues rapidly and is known as the chain reaction. In this process a large amount of energy is released. This energy is used for boiling water till it becomes steam. Steam so generated is used to drive a turbine which helps in generating electrical energy.

Sun - The Ultimate Source of Energy

Solar energy is energy derived from sun in the form of solar radiation. It is hardness by either direct sources (like solar cooker, solar steam systems, solar dryer, solar cells, etc.), or indirect sources (biomass production, wind, tidal, etc.). The output of the sun is 2.8 x 1023 Kwy1. The energy reaching the earth is 1.5x 108 Kwy-1. It is used for drying, cooking, heating, generating power etc.

Wind Energy

Wind power is another alternative energy source that could be used without producing by-products that are harmful to nature. Like solar power, harnessing the wind is highly dependent on weather and location. However, it is one of the oldest and cleanest forms of energy and the most developed of the renewable energy sources. There is the potential for a large amount of energy to be produced from windmill.

Biomass Energy

Organic material made from plants and animals (microorganisms). Biomass has an existing capacity of over 7,000 MW. Biomass as a fuel consists of organic matter such as industrial waste, agricultural waste, wood, and bark. Biomass can also be used indirectly, since it produces methane gas as it decays or through a modern process called gasification. Methane can produce

power by burning in a boiler to create steam to drive steam turbines or through internal combustion in gas turbines and reciprocating engines.

Geothermal Energy Geothermal energy is energy derived by tapping the heat of the earth itself like volcano, geysers, hot springs (etc.). These volcanic features are called geothermal hotspots. Basically a hotspot is an area of reduced thickness in the mantle which expects excess internal heat from the interior of the earth to the outer crust. The heat from these geothermal hotspots is altered in the form of steam which is used to run a steam turbine that can generate electricity.

Ocean Tidal and Wave energy

Tidal power or tidal energy is a form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity.

- Wave energy, also known as ocean energy is defined as energy harnessed from oceanic waves. As the wind blows across the surface of the ocean, it creates waves and thus they can also be referred to as energy moving across the surface of the water
- Tides are defined as the rise and fall of sea level caused by the gravitational pull of the moon and the sun on the Earth. They are not only limited to the oceans, but can also occur in other systems whenever a gravitational field exists.
- Ocean thermal energy (OTE) is the temperature differences (thermal gradients) between ocean surface waters and that of ocean depths. Energy from the sun heats the surface water of the ocean. In tropical regions, surface water can be much warmer than deep water. This temperature difference can be used to produce electricity and to desalinate ocean water

Energy resource	Advantages	Disadvantages
Fossil fuels	Provide a large amount of thermal energy per unit of mass Easy to get and easy to transport Can be used to generate electrical energy and make products, such as plastic	Nonrenewable Burning produces smog Burning coal releases substances that can cause acid precipitation Risk of oil spills
Nuclear	Very concentrated form of energy Power plants do not produce smog	Produces radioactive waste Radioactive elements are nonrenewable
Solar	Almost limitless source of energy Does not produce air pollution	Expensive to use for large-scale energy production Only practical in sunny areas
Water	Renewable Does not produce air pollution	Dams disrupt a river's ecosystem available only in areas that have rivers
Wind	Renewable Relatively inexpensive to generate Does not produce air pollution	Only practical in windy areas
Geothermal	Almost limitless source of energy Power plant require little land	Only practical areas near hot spots Waste water can damage soil
Biomass	Renewable	Requires large area of farmland Produces smoke

Classification of energy resources

The various sources of energy can be conveniently grouped as

Commercial primary energy resources: Non-renewable sources of energy or conventional sources of energy are being accumulated in nature for a very long time and can't be replaced if exhausted. Nature gifted resources which are consumed can't be replaced. Eg: coal, petroleum, natural gas, thermal power, hydro power and nuclear power are the main conventional sources of energy.

Renewable sources of energy: Energy sources, which are continuously and freely produced in the nature and are not exhaustible, are known as the renewable sources of energy. Eg: solar energy, biomass and wood energy, geo thermal energy, wind energy, tidal energy and ocean energy. But main attention has to be directed to the following sources of renewable namely, a) solar photovoltaic, b) wind, and c) hydrogen fuel cell.

Classification of energy sources

Based on usability

i. ***Primary resources:*** Primary sources can be used directly, as they appear in the natural environment: coal, oil, natural gas and wood, nuclear fuels (uranium), the sun, the wind, tides, mountain lakes, the rivers (from which hydroelectric energy can be obtained) and the Earth heat that supplies geothermal energy.

ii. ***Secondary resources:*** They are derived from the transformation of primary energy sources: for example petrol that derives from the treatment of crude oil and electric energy obtained from the conversion of mechanical energy (hydroelectric plants, Aeolian plants), chemical plants (thermoelectric), or nuclear (nuclear plants). Electric energy is produced by electric plants, i.e. suitable installations that can transform primary energy (non-transformed) into electric energy.

Based on transaction

i. ***Commercial Energy:*** The energy sources that are available in the market for a definite price are known as commercial energy. By far the most important forms of commercial energy are electricity, coal and refined petroleum products.

ii. **Non Commercial Energy:** The energy sources that are not available in the commercial market for a price are classified as non-commercial energy. Non-commercial energy sources include fuels such as firewood, cattle dung and agricultural wastes, which are traditionally gathered, and not bought at a price and used especially in rural households. These are also called traditional fuels. Non-commercial energy is often ignored in energy accounting.

Based on energy storage or cycling time involved

i. ***Renewable energy (inexhaustible)*** are mostly biomass based and are available in unlimited amount in nature. Since these can be renewed over a relatively short period of time, energy sources that are replenished more rapidly are termed as renewable. These include firewood or fuel wood from forest, petro plants, plant biomass ie. agricultural waste like animal dung, solar energy, wing energy, water energy in the form of hydroelectricity and tidal energy and geothermal energy etc.

ii. ***Non-renewable energy*** (exhaustible) are available in limited amount and develop over a longer period of time. As a result of unlimited use, they are likely to be exhausted one day. These include coal, mineral, natural gas and nuclear power. Coal, petroleum and natural gases are common sources of energy being organic (biotic) in this origin. They are also called fossil fuels.

Based on traditional use

i. **Conventional energy sources:** The sources of energy which have been in use for a long time, e.g., coal, petroleum, natural gas and water power. They are exhaust able except water and cause pollution when used, as they emit smoke and ash.

ii. **Non-conventional energy sources:..** The resources which are yet in the process of development over the past few years. It includes solar, wind, tidal, biogas, and biomass, geothermal. They are inexhaustible, pollution free, easy to maintain and less expensive due to local use.