ENERGY RESOURCE AND MANAGEMENT

UNIT-1

INTRODUCTION

Energy is defined as the capacity to perform, or act of performing, work. We measure energy in Joules, just like work. Energy exists in several forms. All forms or energy fall into one of two categories: kinetic energy and potential energy. Kinetic energy is any kind of energy that is in motion. Moving water and wind are good examples of things with kinetic energy that are easy to see. Other types of kinetic energy include heat and electricity, which include motion at a molecular level, which cannot be seen by the naked eye. Potential energy is stored energy that is not in motion, but can be used to do work. Examples of potential energy are oil sitting in a barrel, or water in a lake in the mountains. This energy is referred to as potential energy, because if it were released, it would do work.

There are different forms of kinetic and potential energy, including heat, light, electrical, chemical, nuclear, mechanical, and radiant energy. The diagram below summarizes some of the main forms of energy.

VARIOUS FORMS OF ENERGY

There are two types of energy - stored (potential) energy and working (kinetic) energy. For example, the food we eat contains chemical energy, and our body stores this energy until we release it when we work or play.

POTENTIAL ENERGY

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

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 the turbines, it becomes motion energy.

KINETIC ENERGY

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

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.

MOTION

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

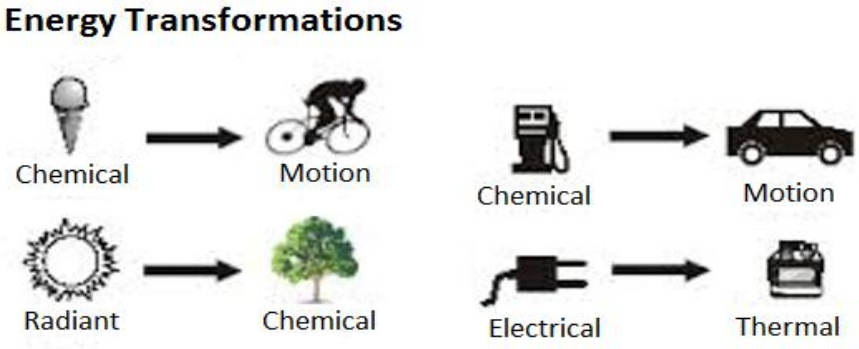
SOUND

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

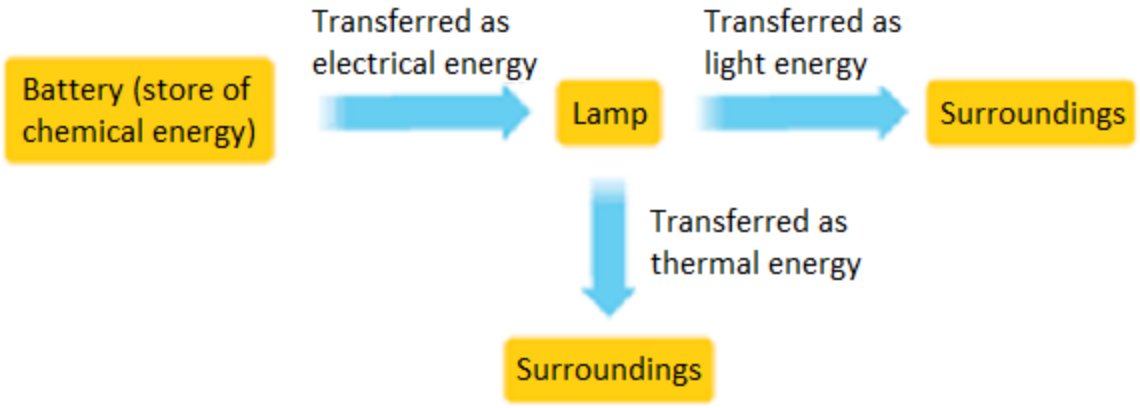
ELECTRICAL ENERGY

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

SOME COMMON TRANSFORMATIONS ARE SHOWN IN THE DIAGRAM BELOW:



The following diagram shows some transfers of energy involved in the operation of a lamp:



While energy can be transferred from one place to another, and transformed from one form to another, the total amount of energy in a closed system must remain constant. A closed system is one in which energy cannot enter or leave. This principle is known as the law of conservation of energy. The law of conservation of energy states that the total energy of a closed system cannot change—it is said to be conserved over time. Energy can be neither created nor destroyed.

HIGH-GRADE ENERGY

Electrical and chemical energy are high-grade energy, because the energy is concentrated in a small space. Even a small amount of electrical and chemical energy can do a great amount of work. The molecules or particles that store these forms of energy are highly ordered and compact and thus considered as high grade energy. High-grade energy like electricity is better used for high grade applications like melting of metals rather than simply heating of water.

LOW-GRADE ENERGY

Heat is low-grade energy. Heat can still be used to do work (example of a heater boiling water), but it rapidly dissipates. The molecules in which this kind of energy is stored (air and water molecules), are more randomly distributed than the

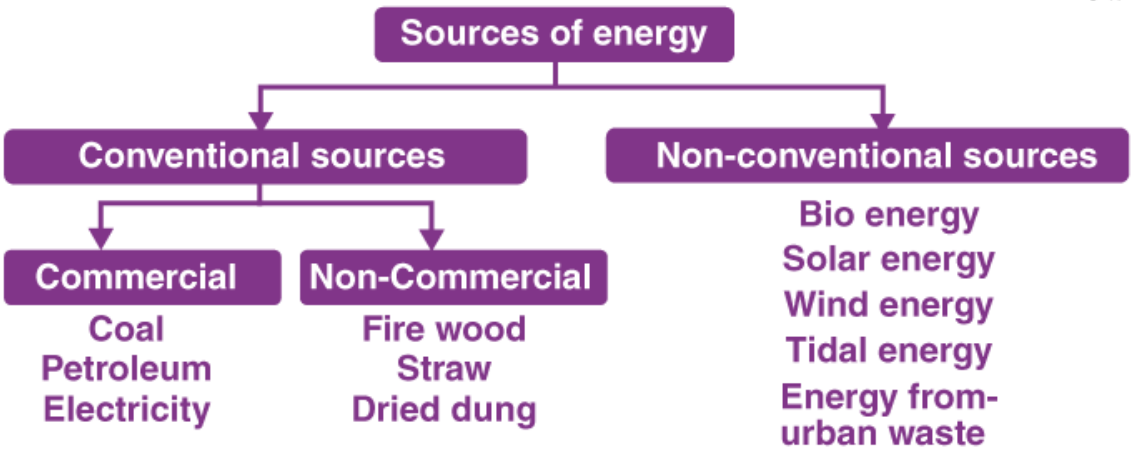
molecules of carbon in a coal. This disordered state of the molecules and the dissipated energy are classified as low-grade energy.

SOURCES OF ENERGY OR ENERGY SOURCES

Sources of energy or energy sources refer to how and where the different types of energy are derived. There are two sources of energy- primary energy sources (primary energy) and secondary energy sources (secondary energy). Primary energy is the form of energy that is found in nature which has not been transformed or converted to other forms of energy. Primary energy are converted by energy systems to yield secondary energy which are carried by energy carriers. Primary energy can be renewable energy and non-renewable energy. Renewable energy is the energy that can be replenished or regenerated. Examples of renewable energy are solar energy (energy from the sun),wind energy (energy from the wind), hydro energy, hydro power or hydroelectric energy which is also called tidal energy (energy resulting from falling of water and flowing of water with the help of gravitational energy), biomass energy(energy derived from living organisms or recently living organisms such as plants and animals. Biofuels are derived from biomass) and geothermal energy (thermal energy generated and stored in the earth and geothermal energy determines the temperature of matter). Then non renewable energy sources are fossil energy which yields fossil fuels (petroleum or crude oil and natural gas and coal) and mineral energy which yields mineral fuels (natural uranium). All these are made possible by the quest for energy development to produce conventional energy sources, alternative energy sources or renewable energy sources for energy recovery and energy reuse to prevent waste of energy.

CONVENTIONAL AND NON-CONVENTIONAL SOURCES OF ENERGY

Below you could see the difference between conventional and non-conventional sources of energy.



CONVENTIONAL SOURCES OF ENERGY

These sources of energy are also known as non-renewable sources of energy and are available in limited quantity apart from hydro-electric power. Further, it can be classified under commercial and non-commercial energy.

COMMERCIAL ENERGY SOURCES

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

a) COAL

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

b) OIL AND NATURAL GAS:

Today oil is considered to be the liquid gold and one of the crucial sources of energy in India and the world. Oil is mostly used in planes, automobiles, trains, and ships. It is mainly found in Assam, Gujarat, and Mumbai.

The total production of oil in India was 0.3 million tons in 1950-51, which increased up to 32.4 million tons in 2000-01.

c) ELECTRICITY:

Electricity is a common source of energy and used for domestic and commercial purposes. The electricity is mainly utilized in electrical appliances like Fridge, T.V, washing machine, and air conditioning.

The major sources of power generation are mentioned below:

- Nuclear Power
- Thermal Power
- Hydro-electric power

1. **THERMAL POWER:**

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

2. **HYDROELECTRIC POWER:**

The 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.

3. **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 energy sources that are freely available are considered non-commercial energy sources. The examples of non-commercial energy sources are, Straw, dried dung, firewood.

NON-CONVENTIONAL SOURCES OF ENERGY

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

1. **SOLAR ENERGY**

This is the energy that 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.

2. **WIND ENERGY**

This kind of 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.

3. **TIDAL ENERGY**

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

4. **BIO-ENERGY**

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (anaerobically), primarily consisting of methane and carbon dioxide. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste.

Biogas is a renewable energy source. In India, it is also known as “Gobar Gas”.

5. **Geothermal Energy**

Geothermal energy is heat derived within the sub-surface of the earth. Water and/or steam carry the geothermal energy to the Earth’s surface. Depending on its characteristics, geothermal energy can be used for heating and cooling purposes or be harnessed to generate clean electricity.

THE COMPARISON BETWEEN THE CONVENTIONAL AND NON-CONVENTIONAL SOURCES OF ENERGY IS MENTIONED BELOW:

Conventional sources of energy	**Non-conventional sources of energy**
These sources of energy are also known as a non-renewable source of energy.	These sources of energy are also known as a renewable source of energy.
They find both commercial and industrial purposes.	They are mainly used for household purposes.
These can be considered to be one of the reasons for the cause of pollution.	These are not responsible for the cause of pollution.
Generation of energy is expensive.	Initial cost of generation is high but cheaper in the long run.
Necessary to conserve.	No need to conserve.
Coal, fossil fuels are the two examples	Nuclear energy, solar energy are the two examples

ADVANTAGES OF CONVENTIONAL ENERGY SOURCES

Conventional energy sources are also known as a non-renewable energy source and have the following advantages:

- The efficiency of the energy source is high
- This energy source is a well-known source
- The production expenses are low

DISADVANTAGES OF CONVENTIONAL ENERGY SOURCES

Following are the two disadvantages of conventional energy sources:

- It is not environmentally friendly
- When used on a longer run, can deplete soon

ADVANTAGES OF NON-CONVENTIONAL SOURCES OF ENERGY

Below are some advantages of non-conventional sources of energy:

- These sources of energy are environmentally friendly
- They are inexhaustible
- They are easy to operate

DISADVANTAGES OF NON-CONVENTIONAL SOURCES OF ENERGY

- Wind energy is one of the non-conventional sources of energy which is expensive and can be a cause of noise pollution
- Radioactive wastes are produced in nuclear energy

THE IMPORTANCE OF THE NON-CONVENTIONAL SOURCE OF ENERGY

Non-conventional sources of energy are considered to be important as they are renewable, pollution-free, availability of them is in abundance, and they are environmentally friendly.

NEED FOR NON-CONVENTIONAL ENERGY

OIL (PETROLEUM)

Oil is the life line of global economy. The identified deposits from which oil can be extracted profitably at present prices with current technology are known as oil resources. Thirteen countries of the world make up the **Organization of Petroleum Exporting Countries** (OPEC), which have 67% of these reserves. About one fourth of the oil reserves are located in Saudi Arabia. It is further estimated that the undiscovered oil will also be just located in Middle East Thus, the world oil supplies and prices are likely to be controlled by OPEC over a long period of time.

United States of America is the world's largest consumer of oil using 30% of global total, whereas it has only 4% of the world's oil reserves.

Maximum use of oil is in transportation (63%), followed by industry (24%), residential and commercial buildings (8%) and electric utilities (8%).

At the present rate of consumption, the world's crude oil reserves are estimated to be depleted in 40 years and there may be enough undiscovered oil lasting for another 40 years.

COAL

About 68% of worlds proven coal reserves and 85% of the estimated undiscovered coal deposits are located in U.S.A., C.I.S. and China. About 55% of U.S. coal reserves are found west of Mississippi River.

Coal is the most abundant conventional fossil fuel in the world. Identified world reserves of coal should last about 210 years at the current rate of usage and just 65 years, if the rate, of usage increases by 2% per year.

The world unidentified coal reserves are however, projected to last about 900 years at current rate and 150 years, if usage rate increases by 2%.

NATURAL GAS

About 40% of the world's natural gas reserves are in CIS countries. Other countries with proven natural gas reserves are Iran (14%), United States (5%), Qatar (4%), Saudi Arabia (3%) and Nigeria (3%). Geologists expect to find more natural gas, especially in unexplored LDCs (less developed countries). Most of the natural gas reserves are located in same area as crude oil.

Presently we are passing through the peak period of fossil age. The fossil age may last for a few more decades, as the reserves are getting depleted very fast. The fossil fuel age is likely to last from 1850 to 2850 and then all the reserves will be exhausted.

ENERGY RESOURCES OF INDIA

The major commercial (non-renewable) sources of energy are coal, oil, natural gas and nuclear power. The share of commercial and non-commercial sources of energy in our country in 1980’s was in a ratio of 1: 1. However, following rapid industrial growth, the ratio changed to 4: 1 in 2000.

COAL

India has about 5% of world's coal production. Coal, besides a prime source of industrial energy is also a raw material. Coal including lignite even today accounts for 60% of country's commercial requirements.

Major coal fields in India are Raniganj, Jharia, East Bokaro and West Bokaro, Panch-Konkan (Tawa Valley), Singrauli, Takhar, Chanda-Wardha and Godavari

Valley. The major states known for coal reserves are Bihar, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra.

OIL AND NATURAL GAS

Mineral oil is very unevenly distributed over space like any other mineral. India has a large proportion of tertiary rocks and alluvial deposits particularly in the extra peninsular India. Such potential oil bearing area is estimated to be over a million square kilometers. It covers the northern plains in the Ganga-Brahmaputra Valley, the coastal strips together with their off-shore continental shelf (Bombay High), the plains of Gujarat, the Thar desert and the area around Andaman and Nicobar Islands.

In India oil was first found at Makum (North East Assam) but drilling of oil was started at Digboi in Lakhimpur district. After independence, at Gujarat plains and Bombay High, major oil reserves were found. Lately, oil deposits were found in offshore areas off the deltaic coasts of Godavari, Krishna, Kaveri and Mahanadi.

Natural gas reserves are generally found in association with oil fields. However, exclusive gas reserves are also located in Tripura, Rajasthan and almost all the offshore oil fields of Gujarat, Maharashtra,Tamil Nadu, Andhra Pradesh and Orissa.

In 1951, our total petroleum production was 269,000 tons while in 1990 it was 40 million tons. Natural gas production was 2,500 million, m^3 in 1980-81 which rose to 9,810 million m^3 in 1987 and 15,000 million m^3 in 2000. Total gas reserves of India are estimated to be 5,41,000 million m^3.

NUCLEAR POWER

A small quantity of radioactive material can produce an enormous amount of energy. For instance one ton of Uranium-235 would provide as much energy as produced by 3 million tons of coal or 12 million barrels of oil.

India is rich in certain radioactive materials. Uranium mines are located in Singhbhum in Bihar and parts of Rajasthan. Most abundant Monazite sands are present on the shores of' Kerala.

Thorium is derived from the monazite sands. The major nuclear power plants in our country are located in Tarapur (Maharashtra), Kota (Rajasthan), Kalpakkam (Tamilnadu), Kakarpara (Gujarat), Kaswar (Karnataka) and Narora (Uttar Pradesh).

ENERGY SCENARIO OF INDIA

About 75% of population of India lives in rural areas and uses about 40% of total energy of the country. Consumption pattern of rural areas is

Sector	**Energy use (%)**
Domestic	64%
Agriculture	22%
Industrial/Commercial	7%
Lighting	4%
Transportation	3%