

Energy and Power Resources

Chapter 6

KEY CONCEPTS

- Sources of energy.
- Renewable energy resources.
- Non-renewable energy resources.
- Hydroelectric projects.
- Conservation of energy and power resources.

Resources are useful and valuable gifts of nature that satisfy our needs. Energy resources are those gifts which provide energy to do various activities. Energy is the capacity to do work and is required for all human activities. In fact, energy forms the basis of life on earth. Sun is the ultimate source of energy on the earth. Energy lights our homes and streets, powers vehicles, computers, machinery in factories, transportation, communications, medical equipment and much more.

There are many energy resources that enable us to accomplish various activities. Some of these resources are *conventional* or *traditional resources*, which have been used since ages like coal, wood, mineral oil, etc. Besides these, there are some *non-conventional resources*, which serve as an alternative to traditional resources. These include solar power, hydel power, wind power, etc.

Based on their dependability and stock, resources are of two types:

1. *Renewable Resources* are those which can be generated continuously in nature and are *inexhaustible*. They can be used again and again in an endless manner.

These resources are solar energy, wind energy, hydropower, tidal energy, biomass energy, bio-fuels and geo-thermal energy.

2. *Non-renewable Resources* are those which cannot be quickly replenished when exhausted, e.g., coal, petroleum, natural gas and nuclear fuels like uranium and thorium.

RENEWABLE SOURCES OF ENERGY

Solar Power

Solar energy is an important non-conventional source of energy. The energy derived from the Sun in about two weeks is the same as the amount of energy in all the world's supply of oil and gas. In fact, in one hour, the sun pours as much energy on to the earth as we use in a whole year.

Solar power is the conversion of energy from sunlight into electricity, by using *photovoltaic*



Solar Water Heater

DO YOU KNOW

Bengaluru has the largest deployment of roof-top solar water heaters in India, generating an energy equivalent of 200 MW. Pune has also made solar water heaters mandatory in new buildings.

cells. It is also produced by using sunlight to make steam, which is then converted into electricity by a turbine.

A number of solar devices like solar cooker, solar water/air-heater, solar dryers, solar wood seasoning kilns, etc. have been developed.

Solar cooker is one of the simplest solar thermal devices used for the purpose of cooking. A typical solar cooker consists of a large box with glass windows to let the sunlight in. The sunlight is directed through the windows with the help of reflectors or mirrors. The inside walls of the sides are painted black for efficient absorption of light. The box is insulated on the outside so that the heat cannot escape. The heated inside of the box emits infra-red radiation to which the glass window is opaque. In this way a significant amount of the energy entering the oven is retained. The

cooking pot is placed inside the box and cooking is made possible.

Solar cells are made of thin wafers of semi-conductor materials from silicon and gallium. When the sun's radiations strike on them, solar energy is converted into electricity. Solar cells are widely used in calculators, electronic watches, street lighting, traffic signals, water pumps, etc. A group of solar cells joined together in a solar panel can provide enough power to supply power to lighthouses, warning lights for aircraft, traffic signals and radio and TV stations.

Advantages of Solar Energy

1. Solar energy is virtually unlimited and non-polluting source of energy.
2. Solar energy has none of the disadvantages found in the combustion of fossil fuels such as coal, oil or gas.
3. Once installed, solar energy has close to zero costs.
4. Solar energy is a reliable source of energy. It can provide back up power during periods of grid breakdown.



Cooker



Water Pump



Traffic Lights



Dryer

Solar Powered Devices

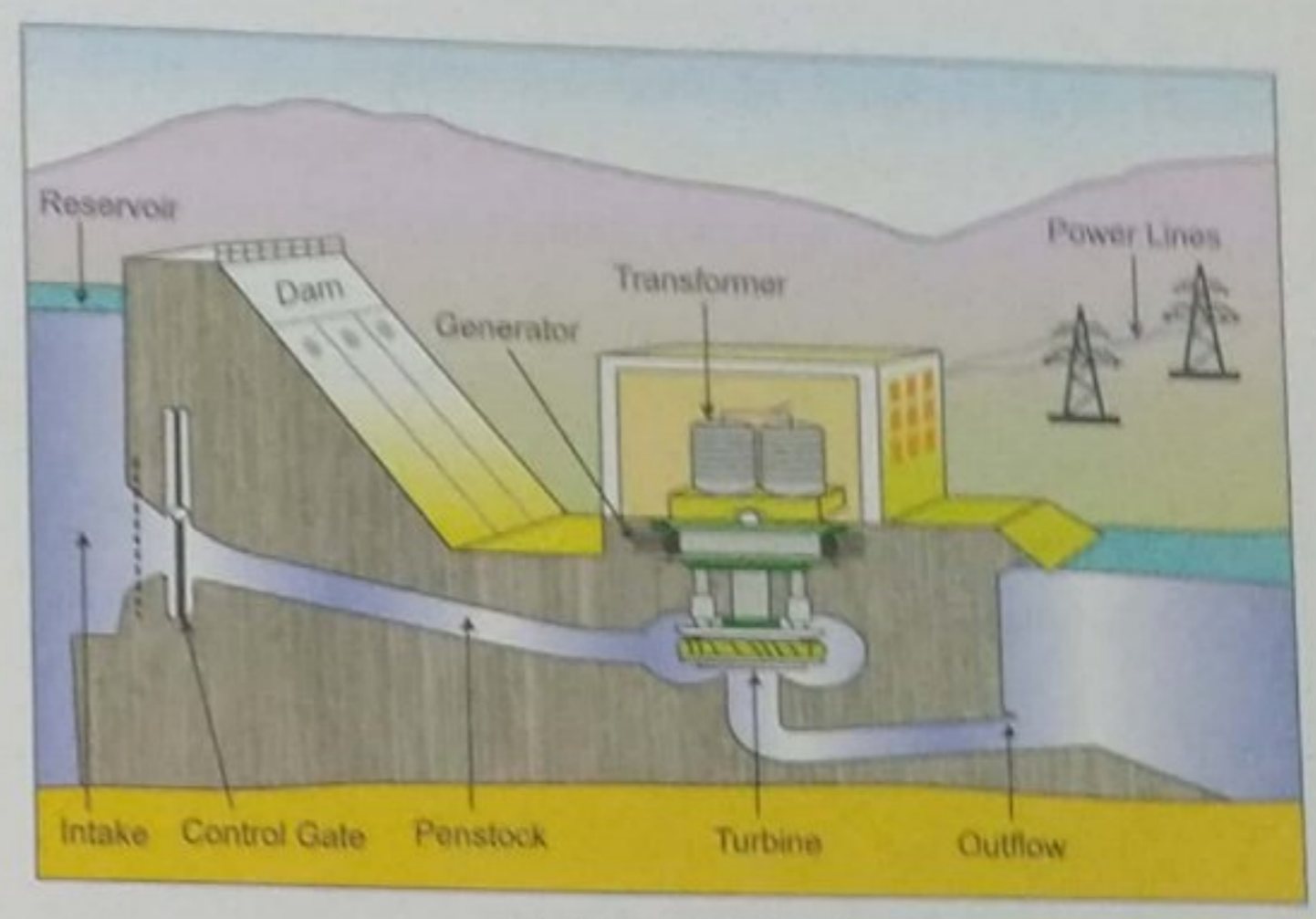
5. Solar energy equipment can be easily installed.

The one main disadvantage of solar power is that it is not available during cloudy and rainy days and at night. Besides, the initial cost of installation and storage is quite high.

Hydropower

The word 'hydro' means water and energy obtained from falling water is called **hydropower**. Since ancient times, hydropower has been used by man as a renewable source of energy. It was only in the late 19th century that hydropower became a source for generating electricity. The first commercial hydroelectric power plant was built at Niagara Falls in 1879. The first hydroelectric power plants in India were established at Darjeeling (West Bengal) and Shivanasamudra (Karnataka) in 1898 and 1902, respectively.

Hydroelectricity is produced from the energy that is released when water falls from a high level with great force. The water flowing in a river is collected by constructing a big dam where the water is stored. Then it is allowed to fall from a



Hydropower Plant

height. The blades of the turbine located at the bottom of the dam move with the force of falling water, which in turn rotates the generator and produces electricity.

For the development of hydroelectric power the following conditions are necessary:

- * A mountainous area or an upland region, from where water falls from a height. Force of the falling water moves the turbines to generate electricity.



A Hydroelectric Project

- * The climate should be temperate so that there is a continuous flow of water and the water does not get frozen because of severe cold.
- * The water to be used for producing electricity should be free from impurities or silt.
- * Flow of streams should be uniform. This is possible by building storage dams and artificial reservoirs for regulating the flow.
- * Rivers should be perennial. This is possible when the catchment area gets enough rainfall or the river-source is a natural lake or a glacier.
- * Suitable sites must be there for building dams.
- * Industrial zones must be located in the close vicinity of the hydroelectric project so as to reduce the loss of electricity in the transmission.

Initially dams used to be built to impound rivers and rain water that could be used later to irrigate fields. But gradually dams gave way to **Multipurpose river valley projects**. Besides irrigation, they serve a number of purposes like electricity generation, flood control, soil conservation, water supply for domestic and industrial uses, recreation, inland navigation and fish breeding.

Multipurpose river valley projects are being criticised for a number of reasons. These are the following:

- (i) Construction of a multipurpose river valley project leads to the submergence of a variety of flora and fauna and human settlements.
- (ii) The displacement of local people has an adverse effect on their livelihood, physiological and psychological health.
- (iii) The fertility of the soil is adversely affected. Due to construction of dams, there are no annual floods in the river. Because of this the soil does not get nutrient rich silt.
- (iv) Deforestation of a large area as forests are cleared for the space required to build these projects.

- (v) A dam fragments the river thus disturbing the aquatic ecosystem. A dam does not allow the aquatic animals downstream to get sufficient nutrients, nor does it allow fish to swim upstream.
- (vi) The reservoirs that are created on a floodplain submerge the existing vegetation and soil leading to its total decomposition over a period of time.
- (vii) There is excessive deposition of sediments at the bottom of the reservoir, which make river beds rockier downstream.

Advantages of Hydel Power

1. Hydroelectricity is a renewable energy source because it is generated from water, which is an inexhaustible and renewable resource.
2. It is a pollution-free source of energy.
3. It constitutes the cheapest source of energy, with the cost of generation ranging from 1.5 to 3.0 paise per unit compared to a minimum of 4.5 paise per unit of coal-based thermal power.
4. It has little maintenance or recurring costs.
5. The water used for producing hydel power can be used for other purposes such as irrigation.
6. There is no waste material in case of hydel power projects, whereas thermal power plants have to get rid of the wastage.



Mettur Dam

India is the seventh largest producer of hydroelectric power in the world. The public sector accounts for 92.5% of India's hydroelectric power

production. Some of the important multipurpose river valley projects in India are given below:

Major River Valley Projects in India

Project	River	Related State/States
Bansagar Project	Son	Bihar, Uttar Pradesh, Madhya Pradesh
Beas Project	Beas	Haryana, Punjab, Rajasthan
Bhakra Nangal Project	Sutlej	Punjab, Himachal Pradesh, Haryana, Rajasthan
Chambal Project	Chambal	Rajasthan, Madhya Pradesh
Damodar Valley Project	Damodar	Jharkhand, West Bengal
Farakka Project	Ganga, Bhagirathi	West Bengal
Gandhi Sagar Dam	Chambal	Madhya Pradesh
Hirakud Project	Mahanadi	Odisha
Idduki Project	Periyar	Kerala
Indira Gandhi Canal Project	Sutlej	Rajasthan, Punjab, Haryana
Jawahar Sagar Project	Chambal	Rajasthan
Jaykwadi Project	Godawari	Maharashtra
Kakrapar Project	Tapti	Gujarat
Koyana Project	Koyana	Maharashtra
Mahanadi Delta Project	Mahanadi	Odisha
Malprabha Project	Malprabha	Karnataka
Matatilla Project	Betwa	Uttar Pradesh, Madhya Pradesh
Mayurakshi Project	Mayurakshi	West Bengal
Mettur Dam	Cauvery	Tamil Nadu
Nathpa Jhakri Project	Sutlej	Himachal Pradesh
Panchet Project	Damodar	Jharkhand, West Bengal
Pong Project	Beas	Punjab
Pochampad Project	Godawari	Andhra Pradesh
Rana Pratap Sagar Project	Chambal	Rajasthan
Rihand Project	Rihand	Uttar Pradesh
Salal Project	Chenab	Jammu & Kashmir
Sardar Sarovar Project	Narmada	Gujarat, Madhya Pradesh, Maharashtra, Rajasthan
Sarhind Project	Sutlej	Haryana
Sharawati Project	Sharawati	Karnataka
Sharda Project	Sharda, Gomti	Uttar Pradesh
Shivsamundram Project	Cauvery	Karnataka
Sutlej Project	Chenab	Jammu & Kashmir
Tawa Project	Tawa	Madhya Pradesh
Tehri Dam Project	Bhagirathi	Uttarakhand
Tulbul Project	Chenab	Jammu & Kashmir
Tungbhadra Project	Tungbhadra	Andhra Pradesh, Karnataka
Ukai Project	Tapti	Gujarat
Uri Power Project	Jhelum	Jammu & Kashmir

Wind Energy

Moving air is known as wind. The wind has energy. The energy possessed by wind is because of its high speed. Wind energy is fast emerging as the most cost effective source of power because it combines the abundance of a natural source (wind) with modern technology.

Wind energy is as old as the first sailing ship. The use of windmills for generating electricity on a small scale is not new. The Netherlands, famous for its windmills, had 8000 windmills in the 18th century. Wind is an inexpensive reliable non-polluting source of energy for generating electricity. The windmills with four or even eight blades are used on a farm for generating small amounts of direct current to run water pumps. The Indian wind energy programme is the fourth largest in the world after China, the USA and Germany.

India is now regarded as a 'wind super power' in the world. The largest wind farm cluster is located in Tamil Nadu from Nagarcoil to Madurai. *The Muppandal Wind Farm*, located in Kanyakumari district, Tamil Nadu is India's largest operational onshore wind farm in India. *The Jaisalmer Wind Park* is India's second largest operational onshore wind farm, located in Jaisalmer district in Rajasthan. These two wind farms are among the largest wind farms in the world. Besides, Rajasthan, Andhra Pradesh, Karnataka, Gujarat, Kerala, Maharashtra, Madhya Pradesh and Lakshadweep have wind farms.

Wind Mills

At present, electricity is generated using modern windmills, which are high tubular towers with blades. Wind moves these blades attached to a turbine, which in turn is connected to a generator. This is how electricity is generated using a windmill.

For generating power using a windmill, the wind should blow at a steady speed of at least 20 km per hour. The blades used in the wind mill should be light but strong enough to retain their shape even when subjected to high velocity of winds. The generator, that is connected to the windmill, produces energy to pump up water, grind mills and produce power for lights and fans.



Wind Farm

Importance of Wind Energy

Wind energy can be utilised for a number of purposes like to propel sail-boats, to run pumps to draw water, to run flour-mills to grind the grains and to generate electricity. Some of the advantages of using wind energy are given below:

1. Wind energy is environment friendly and pollution free.
2. The gestation period is low and power generation begins immediately after installation of the wind mills.
3. Power generation is cheaper because there is no shortage of input cost and recurring expenses are almost nil.
4. Once the turbines start generating power, they remain operational up to about 20 years.

NON-RENEWABLE SOURCES OF ENERGY

Non-Renewable Sources are those which do not have the ability to recycle and get replenished. These include coal, petroleum and natural gas, which are obtained from the deeper layers of the earth. Since these fuels were formed millions of years ago from the remains of plants and animals, they are also known as *fossil fuels*.

Coal

Coal is a combustible solid stratified rock of organic and mineral matter. It is composed of carbon



Coal based thermal Power Plant

(60 to 90 percent), hydrogen (one to 12 percent), oxygen (two to 20 percent), nitrogen (one to three percent) and small amounts of phosphorus and sulphur. Depending on the amount of carbon, moisture and volatile matter, coal is divided into four varieties:

1. **Anthracite Coal:** It is hard coal, black in colour and is ideal for domestic use since it burns slowly without smoke. It has a high energy value (i.e. gives off a lot of heat when burned). This is the best quality of coal.
2. **Bituminous Coal:** It has 50 per cent to 80 per cent carbon, with a good energy value. Bituminous coal can be subdivided into (a) coking coal, which is used in blast furnaces; (b) gas coal, which is used for making gas; and (c) steam coal, which is nearly smokeless and is used as household coal, and in steam powered vessels.
3. **Lignite:** It is brown in colour. It has 60 per cent carbon and has relatively low heat content. It is used in the production of thermal electricity.
4. **Peat:** It is loose in structure. It gives less heat, and leaves a lot of ash after burning.

Importance of Coal

1. Coal provides about 28 per cent of all commercial energy used in the world. Coal is used chiefly to produce electricity and

steel. Coal also provides heat and power for many other industries.

2. Besides being used as fuel, coal is also used for obtaining products like coal gas (a mixture of hydrogen, methane and carbon monoxide), *ammonical liquor* (ammonia gas dissolved in water) *coal tar* (from which various industrially important compounds are obtained) and *coke* (which is 98 per cent carbon).
3. Coke burns without giving smoke and has a higher calorific value (heat produced per gram of coal). It is used as major fuel in several industries.
4. It is cheaper than petroleum as a source of energy.

Coal is a non-renewable source of energy that leaves a lot of ash and pollutes the environment.

Petroleum

The word 'petro' means rock and 'oleum' means oil. The name petroleum indicates that this oil is obtained from rocks. Petroleum is present between two layers of non-porous rocks deep in earth. Petroleum is extracted by drilling holes into earth's crust through these rocks.

Petroleum furnishes about 40 per cent of the commercial energy used in the world. It provides most of the energy used for transportation and heats millions of houses as well.

Petroleum is a dark oily liquid, which surprisingly does not burn. It has an unpleasant odour. It is insoluble in water and floats on it. It is called crude petroleum or simply crude oil.

Petroleum extracted from the drilled oil well is taken through pipes to refineries to obtain the useful products known as *fractions*. There is not even a tiniest part of petroleum which goes waste or remains unused. That is why petroleum is called 'Liquid Gold'. The liquid petroleum is called crude oil, petroleum gas is called natural gas and the semi-solid to solid forms of petroleum are known as asphalt, tar, pitch, bitumen, etc.

Petrol, diesel, kerosene and petroleum gas are the main products or main petrochemicals.

Fraction (Product)	Use
Diesel	Used as fuel for trucks, cars, railway engines, motor pump sets, generators, etc.
Kerosene Oil	Used as fuel in the homes and for lighting lamps. A special grade of kerosene is used in aeroplanes as fuel.
Petrol	Used as fuel for cars and other light motor vehicles.
Petroleum Gas	This is a mixture of gases which burn very rapidly giving lot of heat. Liquefied Petroleum Gas (LPG) is obtained by condensing these gases, and is used as fuel in homes, hotels, etc.

Importance of Petroleum

Petroleum and its by-products are used in various sectors like agriculture, industry, transport and communication.

- (i) Petroleum is used in motor vehicles, air planes, jet planes, tractors, ships, railways and other automobiles.
- (ii) Liquefied Petroleum Gas (LPG) and kerosene are used for cooking and heating activities.
- (iii) It is used in moving parts of different machines, steam turbines, steam engines, cylinders, textile mills, spindles and looms as lubricant.
- (iv) Carbon black (by-product of petroleum) is used in the manufacturing of automobiles tyres and other rubber products, printing inks, paints and photographic records.
- (v) Petroleum coke is used in refining of various metals, manufacturing of calcium carbide, etc.

Natural Gas

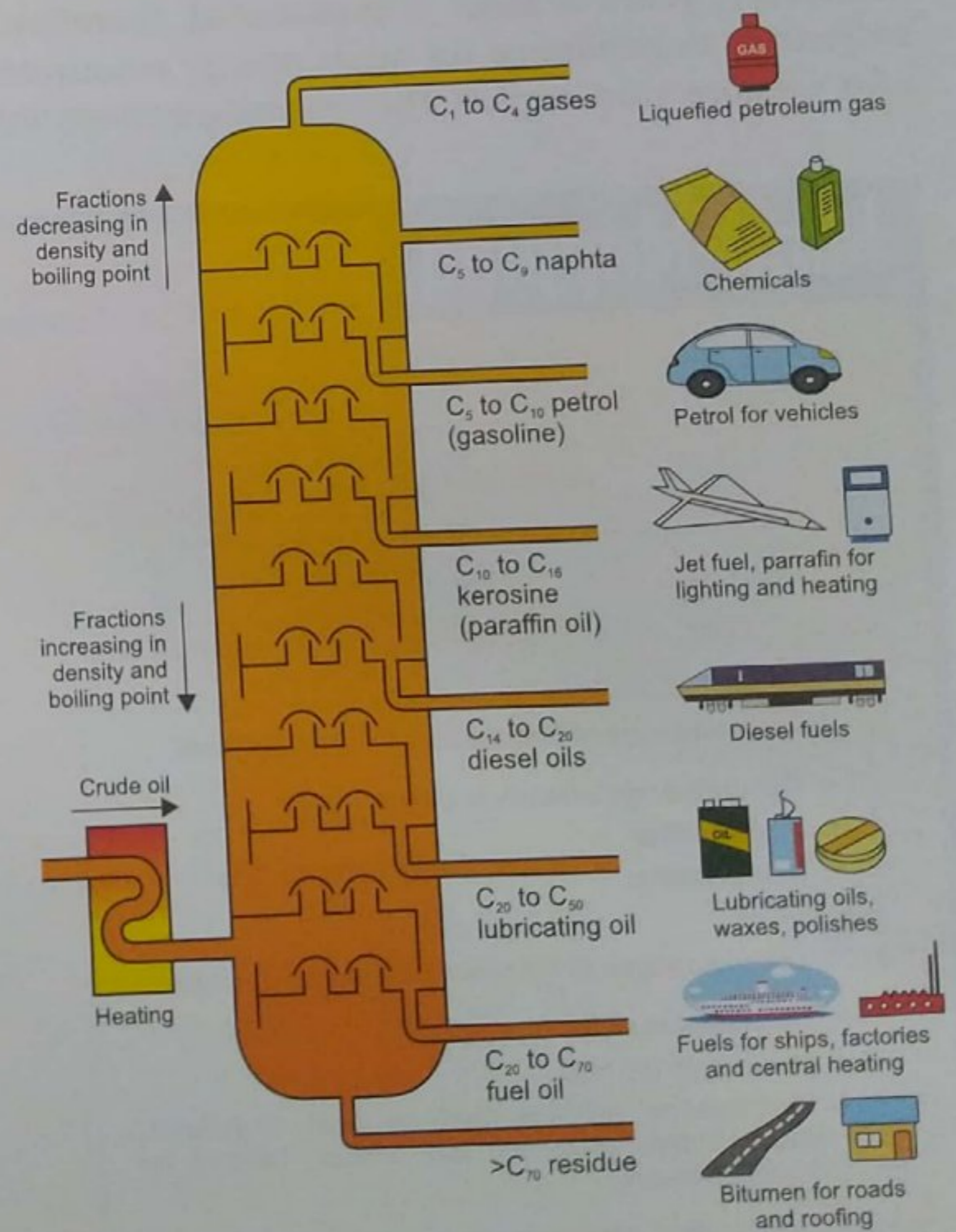
Natural gas is a fossil fuel which is found along with petroleum in the oil wells. However, some oil wells yield only natural gas.

The main components of natural gas are methane, ethane, propane, butane, carbon dioxide, nitrogen and oxygen. Methane (85-90 per cent) is the main constituent.

Importance of Natural Gas

- (i) Natural gas accounts for about 20 per cent of the commercial energy used in the world.
- (ii) Millions of people use natural gas to heat their homes, cook their meals and dry their laundry.

- (iii) Many industries use natural gas for heat and power.
- (iv) Natural gas burns easily to produce heat. It is a smokeless fuel and is non-polluting. It is supplied directly through pipes for domestic and industrial use.
- (v) The compressed form of natural gas, known as CNG (Compressed Natural Gas) is used as an alternative to petrol or diesel in the automobiles. It does not produce pollutants like nitrogen, sulphur dioxide



Fractions of Petroleum

and particulate matter. This gas is known as an eco-friendly gas.

CONSERVATION OF ENERGY AND POWER RESOURCES

Energy is a basic necessity for economic development of a nation. It is required by all the sectors of economy — agriculture, industry, transport, commercial and domestic. Over the years, consumption of energy in all forms has been steadily increasing throughout the world.

Fossil fuels (petroleum, coal and natural gas) provide about 85 per cent of all commercial energy in the world. Biomass fuels like peat, wood, charcoal contribute about 60 per cent of commercial energy. As a result of growing demand the fossil fuels are being depleted at a rate of 100,000 times faster than they are being formed. At the present rate of usage, the coal reserves are likely to last for about 200 years. Similarly, at the present rate of usage, the world's crude oil reserves would be exhausted in just 50 years. These resources are non-renewable and take millions of years to form. It is essential, therefore, to reduce dependence on such energy resources and explore and exploit the enormous potential

of alternative sources of energy like solar energy, wind energy and biomass based energy. They are not only renewable sources of energy but are environmentally clean and safe to use.

We have to adopt a cautious approach for the judicious use of our limited energy resources. We need to reduce dependence on non-renewable sources of energy and use measures to conserve energy. For example, each one of us can do his bit by undertaking the following measures:

- (i) Turning off lights, fans, etc., when not in use.
- (ii) Using heat from natural resources, e.g., dry the clothes in the Sun instead of using a drier.
- (iii) Using air-conditioners wisely.
- (iv) Using a car pool system if three to four persons are going to the same place. Using public transport, wherever possible. Walking to a nearby place instead of taking a vehicle.
- (v) Using tubelights, instead of bulbs, as they save up to 40 per cent of electricity.
- (vi) Practising the recycling of materials. It helps in maintaining the ecological balance.

