# CHAPTER-1
# Introduction

## Role of Electricity in Modern Society.

Progress of human ~~civ~~ civilization has historically been in proportion to the ability of humans to use energy. The operation of our technology society depends upon the production and use of large amount of energy. The use of electrical energy has reached such a scale that it is unimaginable to live without it. Per capita consumption of energy has become an indicator of the development of a country. The per capita consumption of energy of countries like USA, Canada, UK and Russia are in the range of 4000 - 6000 kWh per annum whereas the consumption in developing countries are merely in the range of 30-60 kWh per annum and least developed countries get hardly 10 kWh per annum per capita.

The problem is not ~~to~~ that of having insufficient energy, it is incredibly abundant, rather infinite. What is needed is exploring these available forms of energy into beneficial applications and use it for development. As mentioned earlier, energy plays a vital role in the development process. We need energy for any activities right from lighting or cooking food to any high technological processes. Thus tapping off of energy available in the nature and challenging it into benificial applications or requirements to the maximum extent is the prime need for any society or country to be developed

## Need of Energy:-

1. Lighting.
2. Cooling, heating and ventilation.
3. Transportation system.
4. Communication system.
5. Industrial and manufacturing processes
6. Construction applications
7. Agriculture productions.

## Advantages of Electrical Energy

1. It can be controlled efficiently.
2. It can be transmitted at the speed of light.
3. It is inherently pollution free.
4. Conversion to other forms is directly and easy.
5. It can be stored efficiently.
6. It can be converted to other forms at typically high efficiencies.

It is because of these advantages that electrical energy has become the most common forms of energy and its generation, transmission, distribution has become of fundamental importance to a modern society and to any developing country.

# Electrical energy Resources and production

There are some basic energy sources that can be used to produce bulk electrical energy. The only practical device for generation of electrical energy in large scale is called "generator" which essentially converts mechanical energy into electrical energy.

A brief discussion of some sources are as follows:-

1. Thermal:-

a) Coal:-

Coal has been the major energy source for power generation in the countries where its diposits are substaintial. Beeause of low cost and good calorific value, it is used in most of thermal power stations of the world. However, in Nepal, we donot have any diposits of this source and therefore there is no power station using coal as the source.

b) Oil and Natural gas:-

These sources, espicially liqurd fuels like petroleum and diesel oil are used in internal combustion engines. Because of the cost and scarcity and its major use in automobiles, these fuels are not used for bulk electrical energy generation.

iii) Nuclear fission:-

Nuclear fission of atomic materials such as 'Uranium' produces heat which is utilized to produce steam to run steam

turbines. Such a power station is called a nuclear power station. The speciality of this source of energy is the quantity of fuel required. About 30,000 metric tons of coal produces the same amount of heat as 1kg of nuclear fuel.

When an atom of U-235 ($^{235}_{92}U$) is bombarded with slow moving neutrons, it breaks up into two smaller atoms and three fast neutrons releasing heat. This process is called nuclear fission.

2)

Nuclear power station:-

In nuclear reactor, the chain reaction is controlled by movable control rods made of boron. These absorb neutrons to slow down or stop the chain reaction. The heat produced is used to make steam to drive generators in a power station.

Solar:-

It is possible to collect solar energy directly and concentrate it on boilers for steam production. The major problem is its diffuse nature requiring large amount of land for collectors and the unreliability caused by atmospheric and weather conditions.

Geothermal:-

Heat from the earth's interior and sub-surface water is combined to produce natural steam,

which can be used to run a turbine and thereby produce electrical energy. This source is also rare and not of much importance as far as commercial power generation is concerned. One such installation is in California operating at a capacity of about 400MW, which is the biggest of its kind.

2) Non thermal:-

Hydropower:-

It has historically been an economical and pollution free source of energy. Especially in the countries like Nepal where there are number of high current flowing rivers, streams and water falls, This source of energy is extremely important. Almost 95% of the electrical energy generation in Nepal is by hydropower. The initial capital investment in dams, transmission and generation is quite high but recurring cost afterward is very low so that the overall system will be very economical in the long run.

Tidal:

A dam with large gates is made across the mouth of the bay in the ocean and low head water turbines are used for generation of electric power. At the time of high tide, the gates are opened and after the water level reaches its maximum extent, the gates are closed and water is trapped is allowed to pass through turbine generating electricity.

Wind:-

The wind can be used to drive turbines (air turbines) that, in turn, drive generators to produce electricity. Because of its inherent intermittent characteristics, the use of this source of energy is also rare. In certain places where the strong winds are a common feature, this source of energy may be very attractive. China's wind power generation is developing very fast.

Direct solar Conversion:-

Semiconductors exposed to solar radiation produce electricity through the so-called photovoltaic mechanism. Because of the high cost of solar cells and low efficiencies of the conversion, this source for the commercial production of electrical energy has not been feasible.

# Generation, Distribution and Consumption of Electrical energy.

Generating stations, transmission lines and distribution systems are the main components of an electrical power system. Generating stations and distribution system are connected through transmission lines, which also connect one power system to another. A distribution system connects all the loads in a particular area to the transmission lines. Electric power is generated at a voltage of 11 to 25KV which then is stepped up to the transmission levels in the range of 66 to 132KV. As the transmission capability of a line is proportional to the square of its voltage, research is continously being carried out to raise the transmission voltage. Some of the countries are already employing 750KV for transmisson. The voltages are expected to raise to 1000KV in near future in advanced countries. In Nepal, 132KV is the highest voltage used for transmission of electricity.

For very long distances (over 400km) it is economical to transmit bulk power by dc transmission at 400KV and above. The line is connected to the AC systems at the two ends through a transformer and converting and inverting equipment (silicon controlled rectifiers are employed for this purpose). Several dc transmission lines have been constructed in Europe, the USA and in Asia.

The first step-down of voltage from the transmission level is to a range of 33 to 66 KV depending upon the transmission line voltage. Some industries may require

power at these levels. This step down is from the transmission and grid level to sub transmission level.

The next step down in voltage is at the distribution sub stations. Normally, two distribution voltage levels are employed:

- The primary or feeder voltage (11kV)
- The secondary or consumer voltage (440V) three phase / 230V single phase.

The distribution system, fed from the distribution transformer stations, supplies power to domestic or industrial and commercial consumers. Thus, a power system operates at various voltage levels separated by transformers.