1.1 INTRODUCTION:

Energy is one of the basic ingredients required for development. With the rapid development in almost all sectors of economy in recent years, the demand for energy has to be increased accordingly, to keep pace with the demand. While augmenting energy resources, efficient use of the available resources and long term sustainability and including ecological balance and self-reliance are the two basic objectives need to be kept in view.

A striking feature of our energy scene is that the bulk of the increases in supply and demand for fossil fuel-based energy, particularly electricity, is concentrated in the urban areas. Only about 30% of rural households even have access to electricity while about 80,000 villages are yet to be electrified.

Furthermore, even such commercial sources of energy as electricity, kerosene and diesels are made available to the rural areas are at a heavy cost to the economy because of large subsidies. We, therefore, have the paradox of commercial energy being scarce and unaffordable for rural people and yet carrying heavy subsidies.
Thus, in the overall energy scenario of the country there is need to conserve such fuels and by developing new and renewable energy sources. Non-conventional energy technologies have the potential and capability to provide energy in sites in a decentralized manner for various energy needs in rural, semi-urban, and even urban areas, and to supplement grid quality power generation using locally available renewable resources. These technologies are environment friendly, modular in nature, and have low gestation periods for realization. The hydro power is the cheap and best technology for providing the means of the decentralized power supply. With the beginning of the Industrial revolution, France did not have access to large coal deposit and had to rely on its water resources to generate the energy needed for industrial expansion. (To this day, water power is still called houille balance, or white coal, in France). Much theoretical work was done during this period by mathematicians and engineers such as Bernard Forest de Validor, John Smeaton, Jean Victor Poncelet, Leonhard Euler, Claude Burdin, and Benoit Fourneyron. Their work resulted in significant improvements in turbine efficiency and laid the ground work for the development of modern turbines of Francis, Kaplan and Pelton type. As an example of the progress achieved, the original vertical-axis turbine designed by Belidor attained an efficiency of 15 to 20 percent. By the mid 1850s this rose turbines, the Francis and Kaplan turbines, now achieve efficiencies of 90 to 95 percent.

In the early part of the nineteenth century, water provided mechanical power for industrial application. With the invention of the dynamo or generator in the 1880s, and the popularization of electricity as a source of energy, many water turbines were
converted to electricity production. The first hydro electric unit in the United States was installed in 1982. The first hydel power station in India and reportedly in Asia too was commissioned at Sidrapong near Darjeeling town, North Bengal. Since ancient times, hydro power has been used by the people for their daily local needs. The most elementary use of hydro power has been in the Himalayan and sub-Himalayan regions in India in the form of traditional water mills or popularly known as Gharats traditionally used for grinding or milling agricultural crops such as paddy, maize, wheat etc. These traditional devices are known by different names in various parts of the North east Region, sometimes differing in design also. Prayer wheels driven by the falling water head in hilly terrain are profusely used by the Buddhist tribes like Monpas, Lepchas etc. in the Sub-Himalayan states in Sikkim and Arunachal Pradesh Religious sentiments of these tribes are very much attached with these prayer wheels which are rotated continuously to deliver the message of Lord Buddha, powered by the gift of nature which has been abundantly bestowed upon this region of the eastern Himalayas. Traditionally, people in the interior villages of Arunachal Pradesh used these devices for processing of some of the produce like the hulling of rice and milling of grain with the help of the water mills. It is estimated that around 5000 such water wheels are operational in the districts of Kameng, Tawang and Upper Subansiri of Arunachal pradesh, the local people in Manipur, traditionally people use traditional milling devices called 'PANI DHEKI" operated by falling water in hilly areas where paddy or other crops are milled or crushed with the help of pounding hammer operated by the falling water from a certain head.
1.2 Basic Characteristics of Micro Hydro Power Project:

The basic elements needed for a Micro Hydro Power Projects are:


In the small and Micro Hydro Power Projects, a part of the water flow is diverted from the original flow by means of intact structure and the diverted flow is carried through water conducting system to the forebay tank. The required flow from the forebay tank is then regulated through penstock pipe to the inlet of the turbine in the power house. The powerhouse shelters the turbines, generating units, and control and auxiliary equipment. Draft tubes convey water from the discharge side of the turbine to the tailrace. (1) The tailrace maintains a minimum tail water elevation below the power plant and keeps the draft tube submerged.

1.3 Selection Criteria of Turbine:

A turbine converts energy in the form of falling water into rotating shaft power. The selection of the best turbine for any particular hydro site depends on the site characteristics, the dominant factors being the head available and the power required. Selection also depends on the speed at which it is desired to run the generator or other device loading the turbine. Other considerations, such as whether or not the turbine will be expected to produce power under part-flow conditions, also play an important role in the selection. All turbines have a power speed characteristics, and an efficiency speed characteristic. For a particular head they will tend to run most efficiently at a particular speed, and require a particular flow rate.
The hydraulic turbine selection influences the operating performance, the amount of construction and installation work, investment and future economic benefits. The following preliminary parameters are essential for selection of the suitable turbine.

- The power rating (size)
- The site head
- The type (shape of turbine).

Further the turbine correct design speed depend upon the following:

a) The basic data and parameters of the hydropower station.

b) Data of the electrical system.

c) The characteristic curve of operation of the prototypes.

All the turbines have a power-speed characteristic. They will tend to turn most efficiently at a particular speed, head and flow combination.

1.4 Operation of TURBINES:

The operating principle also divides the turbine into two groups:

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The turbines convert energy in the form of falling water into rotating shaft power. Turbines can be classified in many ways. Based on head, they are classified as high head, medium head or low head machines. Turbines are also divided by their principle way of operating and can be either impulse or reaction turbines.

1.5 **Impulse Turbines**:

An impulse turbine runner operates in air, driven by a jet (or jets) of water. Here the water remains at atmospheric pressure before and after making contact with the runner blades. In this case a nozzle converts the pressurized low velocity water into a high-speed jet. The runner blades deflect the jet so as to maximize the change of momentum of the water and thus maximizing the force on the blades.

A pelton turbine, a good example for impulse turbine, consists of a set of specially shaped buckets mounted on a periphery of a circular disc. It is turned by jets of water, which are discharged from one or more nozzles and strike the buckets. The buckets are split into two halves so that the central area does not act as a dead spot incapable of deflecting water away from the oncoming jet.

In large scale hydro installation Pelton turbines are normally only considered for head above 150 m, but for micro-hydro applications Pelton turbines can be used effectively at heads down to about 20 m. Pelton turbines are not used at lower heads because their rotational speeds becomes very slow and the runner required is very large and unwidely. Impulse turbines are usually cheaper than reaction turbines.
because there is neither a need for a specialist pressure casing nor for carefully engineered clearances.

The major disadvantage of impulse turbines is that they are mostly unsuitable for low-head sites because of their low specific speeds, too great an increase in speed would be required of the transmission to enable coupling to a standard alternator.

Impulse turbines are generally more suitable for micro-hydro applications compared with reaction turbines because they have the following advantages:

- Greater tolerance of sand and other particles in the water.
- Better access to working parts,
- No pressure seals around the shaft.
- Easier to fabricate and maintain
- Better part-flow efficiency.

If runner size and low speed do not pose a problem for a particular installation, then a Pelton turbine can be used efficiently with fairly low heads. If a higher running speed and smaller runner are required then there are two further options:

- Firstly the number of jets can be increased.

Having multiple i.e. two or more jets enables a smaller runner to be used for a given flow and increases the rotational speed. The required power can still be
attained and the part flow efficiency is especially good because the wheel can be run on a reduced number of jets with each jet in use still receiving the optimum flow.

Secondly, there can be provision of Twin runners.

Two runners can be placed on the same shaft either side by side or on opposite sides of the generator. This configuration is unusual and would be used if the number of jets per runner had already been maximised, but it allows the use of smaller diameter and hence faster rotating runners.

1.6 Turgo Turbine:

The Turgo turbine is an impulse machine similar to a Pelton turbine but which was designed to have a higher specific speed. In this case the jets aimed to strike the plane of the runner on one side and exists on the other. Therefore the flow rate is not limited by the discharged fluid interfering with the incoming jet (as is the case with Pelton turbines). As a consequence, a Turgo turbine can have a smaller diameter runner than a Pelton for an equivalent power. With smaller faster spinning runners, it is more likely to be possible to connect Turgo turbines directly to the generator rather than having to go via a costly speed-increasing transmission.

Like the Pelton, the Turgo is efficient over a wide range of speeds and shares the general characteristics of impulse turbines listed for a Pelton, including the fact that it can be mounted either horizontally or vertically. A Turgo runner is more difficult to make than a Pelton and the vanes of the runner are more fragile than Pelton buckets. At one time they were exclusively made by Gilbert, Gilkes and Gordon a UK
manufacturer who owned the patent rights, but they are now manufactured in several other countries.

1.7 WATER WHEEL TURBINE:

The water wheel turbine has been in use since time immemorial specially in Himalayan regions.

The Water Wheel is traditionally used in Nepal with a vertical axis. The water enters the waterwheel from top. The turbine is made out of wood to enable simple building and repair techniques to be used. A consequent of this design are low efficiency and power output (maximum 12 KW). Out of this traditional Water Wheels the improved Water Wheel was developed. The wooden waterwheels was improved and replaced later with a steel one with round buckets. This improved the momentum transfer of the water and doubled power output.

The multi-purpose Power Unit (MPPU) is the type of turbine in between the Water Wheel turbine and the improved Water Wheel turbine. The name multi-purpose refers to the construction of the MPPU which enables the connection of various machineries to it. The concept of the MPPU is basically the same as that of the improved Water Wheel turbine, a vertical axis with a fixed and a rotating grinding stone. Technical complexity, power output and price are in between those of the improved Water Wheel Turbine and crossflow turbines. All components are of steel instead of wood, water supply is improved and friction losses are reduced compared
to the improved Water Wheel Turbine. Design philosophy was to produce a device as cheap and simple as possible. Special attention was given to transportability.

1.8  LOW HEAD TURBINE:

Also called a Michell-Banki turbine a crossflow turbine has a drum-shaped runner consisting of two parallel discs connected together near their rims by a series of curved blades. A Low Head Crossflow turbine always has its runner shaft horizontal (unlike Pelton and Turgo turbines which can have either horizontal or vertical shaft orientation).

1.9 Working Principle Of Turbine:

In operation a rectangular nozzle directs the jet onto the full length of the runner. The water strikes the blades and imparts most of the kinetic energy. It then passes through the runner and strikes the blades again on exit, impacting a smaller amount of energy before leaving the turbine. Although strictly classed as an impulse turbine, hydrodynamic pressure forces are also involved in the operation of the turbine.

A high part-flow efficiency can be maintained at less than a quarter of full flow by the arrangement for flow portioning. At low flows, the water can be channeled through either two-thirds or one third of the runner, thereby sustaining a relatively high turbine efficiency.

1.10 Commercialisation of specialized turbines:
1.10 (a) FLOATING VERTICAL HYDRO TURBINES FOR USE IN RIVERS.

These turbines can be built as compact units ready to be dropped in a river with very little of excavating before placement. The floating Vertical Hydro Turbine must be tied up with a set of wires to withstand heavy floods in the river. Under normal operation the unit shall rest on the river bottom. The efficiency can be as high as 75% even with a head of only 1 m. This type of compact Floating Vertical Hydro Turbine is not suitable in rivers with drift ice during winter.

1.10(b) NAUTILUS TURBINE:

It is a specialized micro hydro systems designed particularly for low head and imported by Nautilus Water Turbine for the Renewable Energy Market. These small machines operate on heads from 2 ft. to 100 ft and are normally used on conjunction with energy storage and inverters to provide conventional 120 or 220 volt power at 50 or 60 cycles. The output of even the smallest ultra low head machines is sufficient to power a remote camp or homestead and he larger machines will easily power a conventional home when used with Battery Storage.

The low head turbine is basically an ultra low head reaction turbine built in different power rating using the best material possible. This is the most environmentally responsible approach to construction and promises very long life. The Nautilus has an expected life of over 50 years. This pico type hydro sets can harness very little power sufficient to light an individual household.

Laser cut stainless steel components will maintain smooth hydraulic surfaces for many years and never rust. Massive taper roller bearings and carbon/ceramic face seals will last 7 to 10 years between refits. Stainless steel construction with
good strength and abrasion resistance allows for very light weight design. The Nautilus can be disassembled with no component weighing over 95 lbs. (44 kgs). Total assembled weight without generator is under 230 lbs (105 kgs). It can be backpacked, transported by mule or light aircraft into the most remote areas.

The design of such turbine has no guide vanes. This simplifies the turbine-set-up - and almost eliminates clogging and loses of power. This factor is very vital in a small turbine. An inspection port facilitates runner inspection and occasional cleaning. The Nautilus turbine will provide power with only (1.2 m) of net head and with very little discharge as low as 1.2 lps. On ten feet head, it is capable to produce power of 2.5 kw and similarly it is capable to produce output power ranging from 0.5 kw to 3.5kw in the head range from 1.2m to 6.2m. The design is as such that it proves very versatile application in terms of delivering power to very small load centres or even individual households in remote villages which is otherwise isolated and inaccessible.

A small amount of electricity can make a dramatic change in the lifestyle of these people by providing lighting, refrigeration and access to television and radio programs. There are many social aspects to bringing power into a village. How will the lifestyle of the villagers change? What new uses for the power will they find? The size of the load can often change according to special accessions or holidays. Sometimes the total load in the village grows dramatically after the system has been installed. Therefore, before planning a village electrification project, a careful analysis has to be done regarding the village load profile keeping in view all the existing parameters of the said village.