CHAPTER 1

INTRODUCTION

The improvement in quality of life and poverty alleviation of rural poor requires sustainable rural energy supply at reasonable cost. Even with subsidy, the majority of rural population can't afford the use of energy to improve the quality of life. World over it has been recognized that the energy for the basic needs is required for sustainable development of rural areas. However, taking conventional to these remote rural areas is not very techno economically viable. Thus there is a need for assessing, locally available renewable energy potential and developing, planning and implementing relevant technological options for rural development to cater to the needs of rural population. The program must simultaneously address the energy requirements for income generating activities and other needs such as energy for water supply, health facility, and domestic purposes as far as possible. These rural energy options can be various depending upon the location, availability and geographical conditions.

Energy, environment, economics & ecology of any part of world are interwoven with each other. Energy is basic need of household, industry, agriculture and transport sector. It is one of the prime requirements for socio economic transformation of rural areas in our country. It is a mission "Bringing India a prosperous future where energy is clean, abundant, reliable and affordable."

For a state like Uttarakhand which is predominantly hilly it is even more a challenge. As per national electricity policy, power to all is assured by end of 2012. In spite of claims of villages and hamlets having been electrified, it is a fact

that even today a large number of our population, most notably in the hinterland, lack access to electricity.

There are many reasons for this non electrification. Major causes are:

- Remoteness and low population density of the region, makes the grid electrification economically non viable.
- In case of Uttarakhand many habitations are situated at such remote locations that repair and maintenance of existing lines is always a problem. Therefore most of the time quality of electricity is very poor. It is either not available at all or available at very low voltage.
- State of Uttarakhand is covered with dense forests but these forests restrict the entry of power lines for small villages within the forests. There are many villages that are not far away from the grid but due to their situation inside the forest, these are deprived of grid electricity.
- In many cases main villages are electrified by the grid connectivity but many tonks associated with the villages are neglected because of their distance from the village.
- Installation and maintenance cost of grid lines at high altitude areas makes it a very expansive proposal.

The challenge is not just of providing electrical power, it is of energy. Electrical power is just one of the means to energy. Satisfying the energy needs, may be for essentials like cooking, lighting, irrigation, income generation through small or cottage industry, is the basic issue for livelihood in the rural areas. For which power can be one of the many alternatives.

1.1 EXISTING STATUS

Even after 60 years of independence a large portion of our population is deprived of power, which is one of the basic needs to generate livelihood at local level. The absence of which is causing youth to migrate from their native places to the urban areas in search of livelihood, causing socio - economic disturbance on one hand and let the natural resources of their native places go unutilized on other hand .

Extending the grids to rural and peri rural areas is not techno - economically viable. Accessibility to fossil fuels like Coal, Petroleum fuels and Natural Gas etc in such areas is also impractical. Moreover rising concern over global warming and climate change encourages tolook for local renewable energy solutions. Some of the renewable energy options in this region can be solar energy, biomass, geothermal, wind energy and hydro - energy etc.

Uttarakhand is endowed with rich hydrology and its rivers, streams and springs offer vast hydro power potential. For rural communities located in far off places, watermills or “Gharats” offer a sustainable, economical, reliable and renewable source of energy and livelihood. They are environmentally sustainable and claimed as Green and Clean Energy Mechanism.

The idea of using energy contained in water and converting it into useful energy was known to mankind since long. Traditional watermills for grinding grains are being used in the Himalayan region and approximately 2.5 lac watermills are still in use. In Uttarakhand alone its population is about 15000, however as per the reports of state nodal agency for renewable energy, UREDA, more than 50% of watermills are defunct [1].

1.2 TECHNOLOGY

A watermill is a machine constructed by connecting a water wheel to a mill stone or generator. A typical traditional water mill consists of a wooden turbine with straight wooden blades, fitted inclined to a thick vertical wooden shaft tapering at both ends. The water chute consists of an open channel either made from wooden planks or carved from a large tree trunk. The chute is narrowed down toward the lower end forming a nozzle. The wooden shaft of the turbine is supported on a stone pivot through a steel pin and held in the sliding bearing at the top. The sliding bearing is a wooden bush fixed in the lower stationary grinding stone. The top grinding wheel rests on the lower stone and is rotated by the turbine shaft through a straight slot coupling. The gap between the stone is adjusted by lifting the upper stone with the help of lift mechanism. These watermills are designed to deliver up to 5 KW electrical equivalent output.

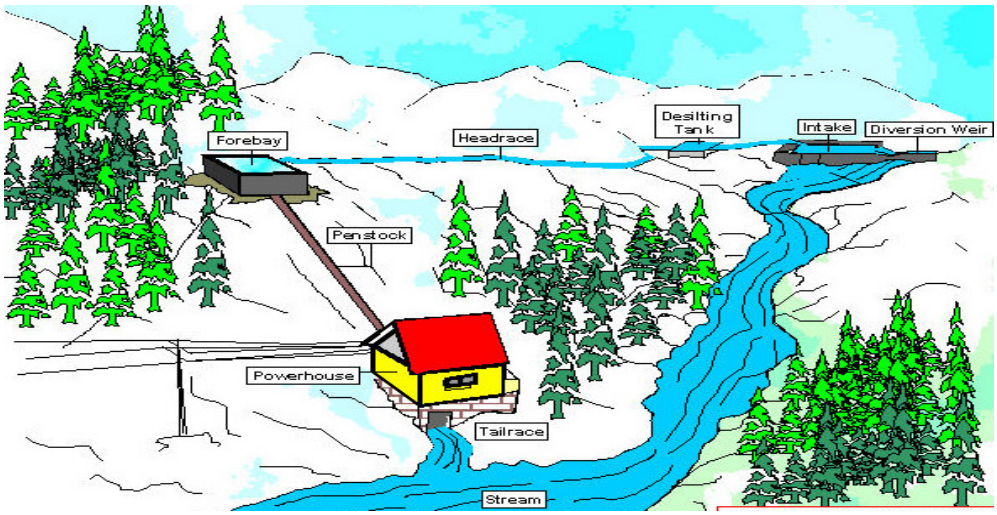
1.3 EXISTING STATUS OF WATERMILLS

Traditional watermills, made by village carpenters and blacksmiths from locally available materials, consist of a wooden turbine and wooden or iron blades that rotate when water flows over it. These turbines/ blades are heavy and un engineered. The shaft that connects the wheel to a rotating stone pivots on a stone. Water from a stream is diverted through an open wooden channel to fall from a height of about 3 - 7 meters on to the turbine, thereby activating the system. In order to stop the machine, the miller (operator) just changes the direction in which the water flows on to the blades.

(**Fig 1.1:** Traditional Wooden Watermill Installed at Katapathhar)

It is important to note the advantages inherent in the indigenous watermill technology, in particular it is:

- simple technology
- locally designed and built
- involving mainly local materials
- low cost



(**Fig 1.2:** General Site Layout for a Watermill)

1.4 OBJECTIVES OF RESEARCH

- Identifying the technical parameters which are of concern for proper functioning of watermills.
- Performance analysis of existing watermills on technical parameters.
- Identification of design improvement parameters in existing status/ system.
- Redesigning a model watermill incorporating suggested modifications, testing and comparing the results.

1.5 METHODOLOGY

The existing status of watermills in Uttarakhand is based on primary and secondary data collection as mentioned in following points.

Primary data for the research includes

- Location of watermill (distance from road, village, market etc.)
- Problems with existing watermills
- Willingness to own a watermill
- Possible utilization of energy
- No. of families getting benefited
- Energy assessment

Secondary data collected for the research includes:

- Village/household electrification status.
- Watermill population & their status.
- New initiatives/incentives for improvement & promotion of watermills in the state.
- Hydrological data (water head, availability of water throughout the year, flow etc.)
- Energy assessment

Secondary data was collected through survey covering entire length & breadth of the state i.e. all 13 districts of the state. Primary and secondary data is analyzed using pie charts & bar graphs etc.

On the basis of above analysis improvements are being suggested with respect to operation & maintenance practices, equipment selection and site selection, Design improvements are suggested based on review of different available designs.

Prototype of suggested modifications is developed and results are compared after experiments. The general engineering strategy for upgrading the mills is to establish the improved systems that can be coped up with by the mill-owners. The needs and capabilities of the person who is going to install and operate the equipment should have as much bearing on the overall design as the hydraulic and engineering criteria.

The research focus on two general approaches that can be applied successfully in the local context:

1. A simple upgrade that can be maintained locally, either by the miller himself, or a local craftsman.
2. A design that is still simple in concept, but is well-engineered and sophisticated enough to be maintenance-free for at least 10 years.

Methodology is presented in the following chapters:

- Renaissance of Watermills for Sustainable Development in Rural Uttarakhand
- Engineering Analysis & Assessment of Existing Watermills
- Engineering Re design & Prototype Development of Watermill System
- Good Operation & Maintenance Practices
- Conclusion & Future Research