Himalayan Small Hydropower Summit
(October 12-13, 2006), Dehradun

WOMEN & MICRO-HYDRO SYSTEMS

Lalita Balakrishnan
Member InCharge, Rural Energy Department, AIWC
New Delhi

OVERVIEW OF MICRO-HYDRO SYSTEMS

WATERWHEELS and vertical-shaft Norse wheels or bucket turbines had been in use in many parts of Europe and Asia for some centuries mostly for milling grain. Two distinct types of watermill were developed: the small, vertical-shaft Norse Mill evolved out of Scandinavia, while the horizontal shaft waterwheels originated in the Mediterranean civilizations. Subsequently, improved engineering and metallurgical skills, during the Eighteenth century, combined with the need to develop smaller-and higher-speed devices to be able to generate electricity without the need for large gear trains, led to the development of turbines which were first used to generate electricity for practical purposes.

Until the 1930s small turbines were increasingly used in Europe and North America. With the development of centralized electricity grids and the economies of scale achieved by large hydro plants, (and with the increasing penetration of subsidized electricity into remote rural areas) there was a steady trend away from small hydro from the 1930s until the 1970s. In fact micro-hydro installations that functioned earlier in the century were allowed to run down as grid connections, often linked to fossil-fuel power stations brought into remote regions. Manufacturers who had produced small hydro-turbines for decades either went out of business or switched their main production capacity to pump manufacturing or other such allied products, for which there was a steady market.

Early micro-hydro was often with DC (direct current) because of the crude level of speed-control on the turbine-generator set, compared with more modern AC (alternating current) generation. Thus another reason for the decline of micro-hydro was the increasing standardization towards AC 50Hz (sometimes 60Hz) of mains electricity. Most readily-available electrical appliances began to need good quality AC power with only small variations in voltage and frequency. The cost (and power) overheads associated with good quality control systems proved very high for small systems. A control system for a 10kW installation costs much the same as for a 100kW plant and often uses as much as 1kW to sustain itself; this is trivial for a 100kW system but is 10% of a 10kW output. As a result, the control system for micro-hydro of less than around 15-20 kW might cost more than the whole or the rest of the system.

A lot of work has been done to standardize and to develop modular construction like building blocks for small low-head turbines, so that low-head installations can be packaged by manufacturers in a way that reduces the complexity of designing and constructing the civil works. Low-head sites tend to be demanding in terms of design skills because no two sites can ever quite use the same arrangements for impounding the water and controlling the flow to the turbine. Numerous novel turbine types have appeared commercially in recent years, such as reversed pumps (an attempt at a cheap turbine by reversing the direction of a standard pump)

and various ‘bulb’ turbines in which the generator is packaged into the turbine hub and submerged in the flow so that the need for a powerhouse can be eliminated.

HIMALAYAN WATER MILLS

There are in India today nearly fifty thousand locations where water mills are serving - as they have done for centuries – a local need, mostly grain milling. **By applying affordable technology to most of these, it has been estimated that an energy equivalent of 15,000 KW can be generated and along with gainful employment for hundreds of youth.**

Water mills popularly known as ‘Gharats’ have been playing a vital role in the day-to-day life of people of Uttaranchal for the last several decades although in recent times – with the advent of new technologies – Gharats have been neglected a lot. But with the intervention of a few NGOs, Gharats in Uttaranchal are now being upgraded.

With growing awareness among water-millers and persistent effort by the well known NGO, HESCO around 150 water mills have been technically upgraded since 1989 in the Garhwal region of Uttaranchal. **If these water mills could be used to produce electricity with minor changes, not only the energy requirement of the region could be met but also a transformation can take place in the development of the Himalayan region.** Due to the repeated efforts of water millers and NGOs, the Ministry of Small Scale and Cottage Industry has recently announced the status of ‘cottage industry’ to the water mills.

Generally water millers in the Himalayan region had been ignored though they had been involved in the grinding of grains. Moreover, in the erstwhile UP hills – and now Uttaranchal – they have been paying Rs. 60 as taxes to the State government since pre-independence days but they were never included in district-level plans. In an attempt to empower water millers, the first ever National Convention of Water Millers was held in New Delhi two years ago. The millers in the convention demanded grant of soft loans for the upgradation of their units.

In Uttaranchal, many water millers are marketing flour produced from their upgraded water mills under the brand name ‘Gharat Flour’. Much to their surprise the flour is getting a good response from the local market! And this is known to grow!

MICRO HYDRO SYSTEMS

Micro hydropower is an indigenous and renewable source of energy for which the potential exists in almost the whole Hindu-Kush Himalayan Region, which includes Afghanistan, Bhutan, China, India, Myanmar, Nepal and Pakistan. Micro Hydro (MH) is generally defined as decentralized small-scale water power plant less that 100 kW. Micro hydro can provided electricity to rural communities which otherwise might take years to be served by national electricity services.

ADVANTAGES

- The components of MH can be locally manufactured and systems can be locally assembled.
- The adverse environmental effects are minimal.
- MH Plants are comparatively easy to manufacture and install indigenously, thus boosting employment, economic activity and the industrial base.
- MH systems can be locally managed, operated and maintained with some basic training input to the local people, particularly the youth, especially women. The organization and management costs are lower than for the other energy systems.

The various components of a micro hydro project need attention; as stated below: -

Civil Engineering Components: Structures designed to conduct water from source to the turbine for optimum energy generation. It has several sub-components described below.

Turbines: The turbine converts energy from the falling water into rotating shaft power.

Drive System: Transmits power from the turbine shaft to the generator shaft or the shaft powering other devices. It also has the function of changing the rotational speed from one shaft to another when the turbine speed differs from the required speed of the alternator or device.
Electrical Systems: Convert mechanical power into electric power. This consists of a generator and alternator.

The functional life of a micro hydro plant is considered to be 15 years. However, a lot depends on how the plant is maintained. Civil structures usually last for a long time, if they are not subject to natural calamities like floods & earthquakes. The life of electro-mechanical components depends on the quality of the products installed and on how they are maintained. Regular preventive maintenance generally increases the lifetime of the equipment.

Example of a Self-dependent Small Hydro Electricity Project based on Public Participation

Karmi Small Hydro Electricity Project located in district Bageshwar is one of the 24 small hydro electricity projects set up in Uttaranchal State for village electrification. This project is located on karmi Gad sub branch of river Sarua near Paiyatoli village on 8 km. Foot way from Phulwari on Bageshwar-Kapkot-Karmi road (under construction) in Kapkot development block of Bageshwar district. Total capacity of this project is 50 kW and a 50 kW cross flow trubine has been fitted there. This project was built in 1998-99 at a cost of Rs.52.9 lakh with financial assistance from Ministry of Non-conventional Energy Sources, Government of India. At present, this project is supplying electricity to 225 families of six villages, viz. Lora, Bhayat, Tani, Paiyatoli, Pairar and Karmi.

Technical details of the project:

Name of the project	Karmi – 1 Small Hydro Electricity Project
Capacity	50 KW
Type of turbine	Cross flow
Number of beneficiary families	225
Discharge	130 1/s
Head	70 m
Total transmission line	5 kms
Total distribution line	7 kms

With the installation of the project based on public participation, all the families in the villages have got light facility, and the villages are able to use power-operated electronic equipments. This has improved their living and economic standards. Most of the families in villages receive television and hence the villagers can easily receive up-to-date information about events in the country. With this facility, the level of learning and education of children has greatly improved and the villagers have also become conscious about general health and cleanliness at home as well as the environment.

Availability of electricity has specially benefited the women and the children for their study. After finishing their routine work during the day, now they earn extra income by doing work like knitting, weaving etc. and with the provision of light facility at nights, villagers are also able to execute their jobs during nights as well.

Spinning of wool and bamboo work is widely prevalent in this region, and electricity has facilitated the spinning of wool. Instead of spinning by hand, farmers new use small power-operated machines and get higher output in less time. This has improved the earning capacity of farmers.

The Energy Committee has appointed locally trained unemployed young men for operation of the project. Due to facility of electricity in the area, shops remain open till late in the night increasing the income of shopkeepers and providing facility to general public for late-night shopping. There is a noticeable rise in their economic & social status among residents, as well as living standards.

POSITIVE IMPLICATIONS OF MH PLANTS: -

MH plants have positive implications for all people, but especially for women in reducing their labour and the time spent in processing activities, as mentioned above. It has been observed that there has been a change in the gendered division of labour associated with the power mill located in the village. For instance, men now sometimes carry the grain to the nearest mill, which was rarely the case with the traditional water mill located far from the village. Similarly, the awareness programme, supported by the REDP, has brought about a positive change in women's and men's attitudes towards women's mobility and participation in development activities. This awareness has also enabled women to control the gambling

habits of men. Women's involvements in community organisations provide women with a voice for their social and economic independence.

Rural electrification will not be effective unless it addresses the diverse social and economic needs of local people, especially women who lag behind socially and politically. Although women are equally represented in Village Energy Committees, they are often silent or not taken seriously in these meetings. For example, a woman from Pokharichouri mentioned: "If we talk in the meetings, men do not listen. We agree with whatever they say."

Most of the time, women are the more frequent ones using the electricity at the household level and it is therefore, essential to train women in small repair and maintenance activities, for which they are eager to come forward. Electricity is not an end itself and it should be integrated with other social and economic activities, which enable local people, especially women, to enhance their socioeconomic status. For instance, adult literacy programs could be conducted at night in villages with micro-hydro electricity, and this would enable women to read and write and to become aware of gender, environment, and energy issues. Similarly, electricity from micro-hydrro systems could power small-scale cottage industries, such as handlooms, handicrafts, and bakeries, if it is integrated with credit, marketing, and extension services.

EXAMPLE FROM NEPAL

Taking Nepal's example Micro-hydro has proved to be a very successful form of rural electrification in that country & men and women in rural villages praise its benefits. Yet, the impact of micro-hydro could be greater if the focus of policy changes from supply to demand, if women are able to participate actively at all levels, and if rural electrification brings about social and economic change, especially for women.

The Rural Energy Development Program (REDP), supported by UNDP, has used a holistic approach to launch an alternative energy initiative in Nepal. The primary emphasis of the programme has been the promotion of micro-hydro plants, not only for providing electricity but also for improving the quality of life of the rural population (REDP, 1997). Women's empowerment is one of the six principles of the REDP through which women's participation is encouraged in village-level energy planning (REDP, 1997). REDP has implemented a rural energy programme in 15 districts of Nepal, and Kavre is one of the first districts located in the mid-hill region.

At the village level, there has been a concerted effort to involve local communities, but women's participation has been limited to mobilising savings funds and contributing labour in the construction process. They have had little input in decisions related to the project, such as the location of the power mills. This has a large impact on women's work since they carry the grain to the mill.

Access to micro-hydro mills has brought great relief for the women from drudgery. Women, who used to spend six to eight hours per week pounding and processing grain, now spend only half an hour, excluding travel time, on this task. In a focus group discussion, in

Pokharichouri village, a woman commented, “We have more leisure now and more time to chat with friends”. However, in most cases, the time saved is used for other household chores. With access to lights, they were able to do more work in the early morning and at night. The concept of sharing chores with male members and other women working outside the home is foreign to these women. Moreover, there are few income-earning opportunities available at the village level.

HANDS ON EXPERIENCE

“Run-of-the-river” scheme means no reservoir, no water-storage; Little or no impact to fish environment.

In the U.S., the province owns all surface water and stream beds up to high water mark, obtaining rights is not usually a problem. Unwritten policy of “not encouraging” small hydro projects ended approx. in 1985. During the month long training at Solar Energy International Colorado-U.S. in 1994, which I had attended, the participants were taken to a farm in Sweetwater, which was engaged in breeding Race horses. The practical training included inspection of existing system repair & maintenance. It was a run of the river system which produced enough electricity for the whole ranch; for lighting, Refrigerator & other appliances including a dishwasher capable of washing 100 plates per minute.

In this hands on training, after looking into the small turbine, we walked upto the weir and found that the filter at the beginning of the weir was clogged with leaves & twigs. Once this was cleaned the system started working! Installation of another filter was suggested with regular cleaning and this simple maintenance could be done by women very easily!

CONCLUSION

The main advantages of hydro power are:

- Power is usually continuously available on demand
- Given a reasonable head, it is a concentrated energy resource
- The energy available is predictable
- No fuel and only limited maintenance are required, so running costs are low (e.g. compared with diesel power) and in many cases imports are displaced to the benefit of the local economy
- It is a long-lasting and robust technology; systems can readily be engineered to last for 50 years or more without the need for major new investment

Against these advantages, the main shortcomings are:

- It is a site-specific technology, and sites that are well suited to the harnessing of water power and are also close to a location where the power can be economically exploited have to be selected & the process is difficult
- There is always a maximum useful power output available from a given hydro power site, which limits the level of expansion of activities which make use of the power

- River flows often vary considerable with the seasons, especially where they are subject to monsoons, and this can limit the firm power output to quite a small fraction of the possible peak output
- Lack of familiarity with the technology and how to apply it inhibits the exploitation of hydro resources in some areas; for example existing river control structures (e.g. weirs) and water supply reservoirs could be exploited to produce power as well, but are often left undeveloped.

It must be stated in conclusion, that whenever these schemes are set-up in villages, they should be properly handed over to a Voluntary Co-operative Group which should take them over & get properly educated for operation & maintenance as well as security for safe guarding the installation at all times. There is an urgent need for these systems today & it looks as if the Govt. of India will support them wholeheartedly.

REFERENCE

1. Training Manual – Solar Energy International Carbondale, Colarado, U.S.– 1994. On "Micro-Hydro & Solar Cooking" – Month long training programme.
2. A.K.Tyagi, Akshay Urja (Renewable Energy) (January-February 2005, Vol. 1, Issue-1 Uttaranchal Akshay Urja Vikas Abhikaran, Urja Park Parisar, Industrial Area, Patel Nagar, Dehradun
3. Ishara Mahat, Newsletter of the Network for Gender and Sustainable Energy – ENERGIA (Volume 7, Issue 1, December 2004), Expert, Gender & Development
4. SETs Manual – prepared by INSEDA – Asia Focal Point for INTERNATIONAL Networking for Sustainable Energy (INSEDA) 27, B, Zamrudpur Community Centre, New Delhi., E-mail: **ray.myles06@gmail.com**
5. Drawings: Courtesy Solar Energy International (Colarado, U.S.)