State-of-the-Art Technologies Appropriate for MMHP

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Introduction

Micro- and mini-hydro plants represent an 'intermediate technology' appropriate for the rural areas of Nepal. There is a broad spectrum of competing MMHP technologies. In addition to the basic requirements that technologies be reliable, locally-manufactured, and maintainable, an additional requirement is that the technology be properly suited to the needs and capabilities of the target communities.

Variety of MMHP Technologies

There is a variety of technologies already available or being developed which come under the MMHP category. The question for many remote districts in the country is not so much whether MMHP has a role to play in the district's sustainable development, but what kinds of MMHP technology are most suitable at the district's present stage of development and what policies should be followed to best implement MMHP.

The 'Improved Ghatta'

The 'Improved *Ghatta*' is an innovation on the traditional *ghatta*[16] which uses a metal runner to increase efficiency. The 'improved *ghatta*' has an average grinding capacity 2.7 times higher than that of a traditional *ghatta*. It also has the additional advantage of allowing power take off with a pulley for rice hulling and electricity generation.

The situations in which the 'improved *ghatta*' may be suitable are as follow.

1. The 'improved ghatta' is appropriate for densely-populated communities where the existing *ghatta* does not process quickly enough and where there is no convenient site in the vicinity to put a second or third *ghatta*.
2. The 'improved *ghatta*' can be used where there is a demand for rice hulling and a small amount of power.

The situations in which the 'improved *ghatta*' would not be appropriate are as follow.

1. In cases where additional traditional *ghatta*(s) can be installed, an 'improved *ghatta*' would not be justified simply on account of the improved speed of processing.

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16 A traditional water mill which uses a timber runner. The capacity of the *ghatta* is around 0.5kW.

2. The existing *ghatta* can be built and maintained with no metal parts and this is an advantage in an area where the closest welding shop is a faraway town many days walk from the mill.
3. The 'improved *ghatta*' would not be suitable in cases where there is demand for an oil expeller, a saw mill or for electricity beyond half a kilowatt.

Turbines for Milling

Turbine-run milling schemes account for over 80 per cent of the existing micro-hydro schemes in Nepal at present. These schemes generally range from 5 to 15kW and are used to run a range of agro-processing machines, such as grinders, rice hullers, oil expellers, *chiura* beaters, saw mills, and so on.

The situations in which a turbine mill would be suitable are as follow.

1. The turbine mill is suitable for a region that grows a lot of mustard seed or other oil producing seeds or grows large amounts of paddy.
2. It is also suitable when the flow of water is too small to run a *ghatta* but where a large drop is present.
3. If there is interest in the community for add-on electric lighting, a turbine is appropriate.

The situations in which a turbine mill would not be suitable are as follow.

1. If the amount of grain grown in the area is small or if there is already another turbine mill in the area, an 'improved *ghatta*' is the better choice for an entrepreneur.
2. If the need of the community is for a large stand-alone electric scheme, a turbine mill is not suitable.

Add-on Electrification

A small generator can be added to an existing turbine mill to provide electric lighting in the evening to the community situated close to the powerhouse.

The Peltric Unit

A Peltric unit consists of an induction generator with the runner of a Pelton turbine hanging from its shaft. The standard unit manufactured by Kathmandu Metal Industries is designed to operate under a head of 50 m, and its outputs are as follow.

Head	Flow	Power Output	Number of Houses Served
50m	2 lps[17]	500W	5 to 10
	4 lps	1000W	10 to 20
	8 lps	2000W	20 to 40

17 Litres per second

The peltric unit is suitable for providing a few houses with electric lighting. In an area where grinding needs are adequately met by the *ghatta* and where oil processing is not needed, a peltric unit can provide cost-effective electricity to a community that can afford it. The Peltric cannot be used to run an oil expeller, a rice huller, a grinder or a saw mill. Hence, if there is a strong likelihood of interest in the community for these services in the future, the option of a turbine mill should be considered.

Stand-Alone Electricity

A turbine installation which is established primarily to produce electricity and to serve agro-processing activities only as a secondary function is called a stand-alone MMHP. In this system, it is normal for the agro-processing or saw-milling equipment to be situated away from the powerhouse and for it to be run by a motor powered by the electricity produced from the power plant. Where there is a large community that needs to be serviced by an MMHP for electrification in the range of 25kW or more, a stand-alone system can be installed. The stand-alone system would not be appropriate if the community is poor, there are no promising end uses, and the community has no prior experience with electricity.

Technology Bottlenecks

Even though the MMHP industry is relatively mature in Nepal, a number of problem areas remain in terms of technology development.

Civil Works

The area that has received the least research and development interest so far is the civil works aspect of MMHP. ITDG is at present working on Civil Works' Guidelines. The main areas of activity will be intakes, silt control, channels/spillways, slope stabilisation/retaining structures, crossings, penstock/corrosion protection, anchor and support blocks, and powerhouse construction. The project will also be identifying appropriate materials for civil construction, such as concrete/ferro cement, cement, masonry, pipes, and timber.

Pelton Turbines

After the cross-flow turbine, Peltons are the turbines that are most easily available and which are especially suitable for the generation of electricity. However, the locally-built runners suffer from low efficiency. A lot of work is needed to increase the efficiency of and local casting capability for Peltons.

Synchronous Alternators

The majority of synchronous alternators used in MMHP in Nepal are imported from India or Britain. The large alternators available in India have problems with the Automatic Voltage Regulators (AVR). They have been found to be unreliable and often produce oscillating voltages when used with an Electronic Load Controller. Work is being carried out by DCS and Nepal Power Producer to develop both static wound and electronic AVR which can be used for a wide range of alternators.

Induction Generator Controller (IGC)

The IGC was first developed for Nepal, and over a dozen of these controllers are being used with single phase induction generators in the country. However, the technology has yet to acquire the reputation for reliability which the ELC enjoys.

Current Cut-outs

Positive Thermal Coefficient Thermistors (PTC) have been found to be cost-effective with a current cut-out of up to 100W. For higher capacities, both the miniature circuit breakers (MCB) and the locally-designed and built Electronic Current Cut-outs (ECC) are being used. The reliability of the ECC also needs to be improved.

Grid Connection Technology

With the willingness (in principle) of the national grid to purchase energy from small producers, there is now a need to develop the technology for connecting MMHP schemes to the grid.

Appropriateness of the Technology

MMHP for Extremely Remote Communities

The study on 'Micro Hydropower in Humla with Special Reference to the Yangar Project' arrived at the following conclusions for MMHP adaption in remote districts such as Humla.

1. An appropriate choice of size and kind of MMHP technologies should be made in keeping with the needs and capabilities of the communities.
2. MMHP plants installed to provide lighting are not economically sustainable or affordable for most communities, even with a large subsidy.
3. MMHP plants installed for agro-processing, especially oil expelling, can make a positive contribution by saving labour, especially of women, and increasing income.
4. The current financial support provided to MMHP by HMG/N, via ADB/N, in extremely remote districts, such as Humla, is insufficient for them to be financially viable.
5. Community organisation is inadequate and there is a scarcity of skilled technical and managerial personnel in the communities in Humla for organising MMHP on their own. The schemes are unlikely to succeed without technical back-stopping and managerial support.
6. The role of motivating and organising the community should be carried out by an organisation such as the Karnali Local Development Project/Trail Bridge Building

Project, as it is in a position to develop a close relationship with the community, and not by the ADB/N or DCS which are not suited to fulfill this role.

Conclusions

A range of MMHP technologies exist for the entrepreneur or rural community to choose from. From the 'improved *ghatta*' to the grid-connected MMHP systems, there exists a broad spectrum of technologies developed to various levels. The challenge for manufacturers and technology development organisations is to achieve further reliability and better efficiency. At the same time, for rural development organisations, the challenge lies in selecting the proper MMHP technologies to meet their development goals and the needs and capabilities of the community.