Power and people: aspects of micro-hydro

by Andrew Scott

The many potential benefits of micro-hydro can only be realized if all aspects of access, ownership and use are investigated beforehand.

FOR CENTURIES, water power has been harnessed for grain milling and other direct mechanical uses, and in some countries water power continues to be a major source of mechanical power. In Nepal for instance there are said to be thousands of traditional water-mills (*ghattas*) still in use. During the twentieth century water power began to be used for electricity generation, and now the majority of large and small modern installations are for electrical applications.

In remote hilly regions of the world, where supplies of grid electricity and diesel are subject to interruption if they exist at all, the decentralized generation of power by micro-hydro installations is an appropriate option. (Up to 100kW is the accepted definition of micro-hydro.) ITDG's micro-hydro programmes in Nepal, Sri Lanka, and Peru aim to establish local manufacturing capacities and install improved micro-hydro technology. Similar programmes can also be found in Pakistan, Colombia, Indonesia, China, Laos, Thailand, Ecuador, Rwanda, and Zaire.

Power from water can be direct (mechanical) or electrical, and the range of uses very wide. The principal end-uses of micro-hydro power in rural areas are grain milling in the case of direct power, and lighting in the case of electricity.

There are two kinds of micro-hydro installations, those providing a power source and an end-use, and those providing a power source only. The latter is usually only for electricity generation. The socio-economic appraisal and evaluation of both kinds of project needs to take account of the whole system, including both power source and end-uses. In undertaking such appraisals four aspects are especially important: the viability of micro-hydro, the management and ownership of schemes, water rights, and the benefits derived.

Micro-hydro power can be the most cost-effective source of energy in many situations, but the cost advantages are generally realized only over the longer term. While there is a high initial investment cost (US$1000 per kW installed for electrical schemes), the operating costs are very low. The investment cost of a diesel unit (which is the most common alternative) is lower, but operating (i.e. fuel) costs are high. When making the comparison therefore, it is necessary to consider the life-times of the alternatives. For micro-hydro this is often assumed to be a 20-year period, and for diesel a five-year period. The time horizon of private investors, however, is usually much shorter than the lifetime of a micro-hydro plant, and the costs of finance for the investment can make micro-hydro a poor financial option. The financial problem for the investor is repayment of the loan and interest. This is the case for both modern turbines and alternators or traditional water wheels, though the amount of the investment clearly differs. For this reason, micro-hydro installations need to have a substantial proportion of their available power consumed from the start (a high load factor), in order to be viable in the short and long term.

The availability of finance for schemes can also be a problem. In Nepal the spread of turbine mills, with over 600 installed in the last ten years including seventy with electrification, was only made possible by the availability of subsidized credit from the Agricultural Development Bank. In other countries a constraint on the dissemination of micro-hydro power is the lack of credit for such long-term investments. The prevalence of subsidies

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in the energy sector, whether for rural electrification via the grid or for domestic kerosene consumption, compounds this problem and can bias the viability and choice of the power source. ITDG is currently working on the development of technology which will lower the capital cost of micro-hydro installations by, for example, the use of induction generators and 'pico-hydro' turbines. Lower-cost options for micro-hydro installations will increase the opportunities for poorer communities to benefit from the use of water power.

Management/ownership

The high capital cost of micro-hydro also has implications for the ownership and management of installations, and for access to their benefits by the poor. For the poor to have some say in the management of micro-hydro schemes, the ownership and control of the scheme must be through a co-operative or community institution.

An evaluation of micro-hydro in Nepal found mill operations to be dominated by influential members of the community. The majority of water-powered grain mills in Nepal are owned by individuals, who are generally from affluent socio-economic backgrounds. Of seven schemes studied three were privately owned, four had elements of communal ownership, and three of the latter were tending towards private ownership. One community-owned mill was actually established by four partners, and is now owned by one of them. The evaluation concluded that 'Promoting community-owned mills without the prerequisite institutional and community development work may only lead to further exploitation of the weaker sections of society, with the community paying and a few benefiting in the name of the community'.[1]

The ownership and management of decentralized electricity generation installations such as micro-hydro by public utility corporations is often expensive and inefficient.[2] In Peru micro-hydro installations owned by the electricity corporation are more expensive, compared to those owned by local authorities, which has resulted in lower connection rates in the former.[3] In Nepal, locally resident mill owners were found to be more responsive and accountable to the communities they supplied.[1]

Managers of micro-hydro schemes must collect the revenues and maintain the installation. For direct-drive micro-hydro the revenue from service milling is easily collected by operators. In Nepal, milling charges are closely related to those of the diesel units with whom micro-hydro is competing. For the poorest, who have no access to cash, charges can be paid in kind, but these are greater in value than monetary payments.

Management of the load can be an important aspect of micro-hydro power installations, especially where the capacity of the unit is poorly matched with the load and where the load is unevenly spread during the day. This is primarily a problem for electrical installations, since direct-drive units are generally matched to the machines which they drive. In Sri Lanka, where tea estates use micro-hydro plants to supplement grid electricity and save costs, the training of operators and maintenance has been found necessary to enable the maximum benefits to be reaped. Good management of the load requires experience and training.

A tariff structure can be used to help maximize load factors and reduce the unit costs of power. Fixed-rate tariffs, for example a fixed amount per month per connection, are the easiest to collect. These can be set in different ways and 'given the right conditions under peak-demand tariff structure, consumers of lower economic means are able to consume at levels approaching those of their metered counterparts while paying less'.[5]

Water rights

A micro-hydro installation needs to be assured of its flow of water in order to succeed and be viable. Water is not consumed by a micro-hydro installation (except for losses in canals), and conflict over water use arises, therefore, from either the diversion of water to supply the turbine or from the consumption of water for irrigation by others upstream of the turbine. Potential conflicts can usually be identified and avoided by good design. The second case exists where there is a shortage of water for all demands.

In the Andean communities of Peru there can be strong competition for water between the power installations and farmers from the same community. It was found that 'the main limiting factor for building micro-hydro schemes is the evaluation of the best way to use water resources, in relation to irrigation-oriented agriculture and public services'.[3] The pre-installation survey needs to consider the water rights and uses of the whole catchment which supplies the turbine.

In another instance, at Turture bazaar in Nepal, the shortage of water led to investment in a diesel back-up for the micro-hydro plant. The installation of the micro-hydro unit coincided with the introduction of a new variety of rice upstream of Turture. The demand for irrigation water therefore increased, with the result that there was insufficient water to operate the mill during the dry season. This was compounded by excessive leakage as a result of poor civil engineering.

It is the benefits which micro-hydro brings that determine the value of programmes to support the introduction and dissemination of the technology. These benefits are not necessarily pecuniary in nature.

The major benefit from micro-hydro in Nepal has been the relief for women from the physical effort and drudgery inherent in the traditional labour-intensive agro-processing techniques.[1,4] An operation that can take almost 10 days of labour if executed traditionally within the home might take an hour in a turbine mill. These positive effects have not been confined to households of better socio-economic standing. In Nepal even relatively poor sections of village communities are using the mills.

The economic benefits of micro-hydro can include employment generation in the community and income to mill owners. In Peru, however, electrification through micro-hydro has not had the expected impact on job creation and incomes. Of six schemes covered by one study, only one had significant industrial use.[3] Similarly in Nepal, the employment generated through micro-hydro installations has been limited. The experience of micro-hydro tends to lend support to the conclusion that 'rather than rural electrification programmes causing increased wealth, economic dynamism, improved literacy and other aspects of development, it may be that it is precisely in areas with such characteristics [already] that programmes are likely to succeed'.[2]

The major demand for electricity in rural communities is for lighting. Many people in poor communities attach such great importance to access to an electricity supply that it often far outweighs the economic benefit to them. Apart from the obvious benefits of the availability of electricity, such as the ability to study and work during the hours of darkness and access to television and videos, there are other important socio-cultural benefits. These include the sense of security from lighting, status, and a general sense of improved quality of life.

References

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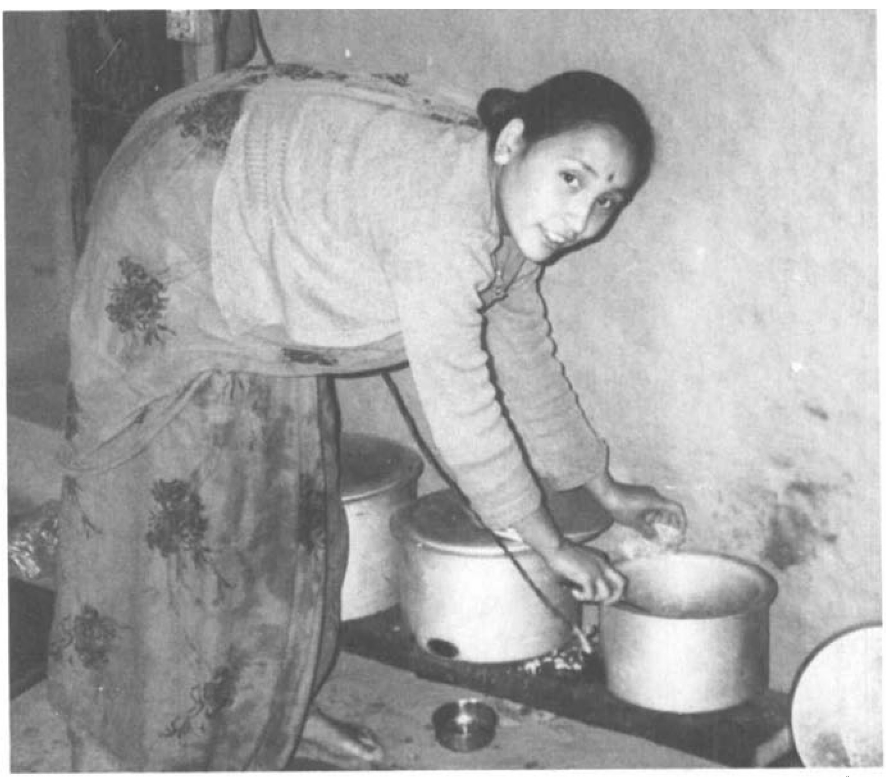

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