Renewable Energy World, March – April 2008, Volume 11, No. 2

10 April 2008, available at: http://online.qmags.com/REW0308/# pages 118 – 123

A mountain to climb? How pico-hydro helps rural development in the Himalayas

by Alex Zahnd and Kimber McKay

A pico-hydro power plant for elementary lighting in a remote and impoverished Himalayan village in Nepal shows just what can be achieved with rural electrification using renewables. Alex Zahnd and Kimber McKay explore one of the four pillars of rural development.

Nepal, with a population of 28.5 million, is a developing country that the UN Development Programme (UNDP) ranks 138th of 177 countries using the Human Development Index. Some 80% of the population live in rural areas that are difficult to access and, with an estimated US $1500 annual GDP per capita, Nepal ranks among the lowest of the word's economies at 197th out of 225.

Urban Nepalis earn many times more than people in rural areas, and there is minimal cohesion between them. In the context of this diversity of living standards, at a rural electrification project in Humla in north-west Nepal, per capita GDP stands out at just $72 annually.

In terms of energy, traditional biomass fuel consumption in Nepal represents 93% of total usage nationwide, and 100% in remote mountain areas such as Humla, some 17 days walk away from the nearest road. With an average annual per capita electricity consumption of only 91 kWh, accessible only to about 25% of the nation's population, Nepal ranks very low globally in terms of the population's articulation with the grid. Furthermore, compared to developed nations infant mortality is high, ranging from 86 to 53 per 1000 live births for the poorest and richest 20% respectively. Humla district is known as a permanent food shortage area and surveys estimate that 65% of Humla's children under five are malnourished.

A holistic approach to development

A Holistic Community Development (HCD) approach for the people and communities living in the remote, impoverished Karnali region of Humla has been developed.

The conceptual basis of HCD projects is that various needs, as identified by the target population, cannot be addressed simply using a single approach. Rather, primary health and resource-dependent needs have to be addressed in a comprehensive, multi-pronged approach. Villagers articulate their primary needs and help to design projects that efficiently, sustainably and holistically address them.

For instance, installing small scale electricity projects benefit health through the reduction of indoor atmospheric pollution from open fire cooking, heating and lighting. They also benefit education, with light for non-formal-education evening classes for mothers and out-of school children, and the environment through the reduction of usage of biomass. However, by only attending to one piece of the overall picture, other critical needs can be neglected, such as a lack of a human waste removal system, and contaminated drinking water. In such an eventuality, the installation of lights will be of marginal benefit and the potential health benefits resulting from the new lighting system could not be clearly demonstrated.

The Family of four

Community development experience of over a decade shows that villagers define their most urgent, regular household needs as: minimal electric light inside the home, a smokeless stove for cooking and heating, a toilet nearby, and clean drinking water accessible in the village for every person. These four demands evolved into the ‘The family of four’ concept. The ‘family’ is a set of innovations that are installed, as a group, into each home in a target village, and includes a smokeless metal stove, solar lighting, a pit latrine, and access to a safe drinking water system. Common and easily treated conditions prevail in the target communities, and render life in this already challenging biophysical environment utterly miserable for many villagers. Scabies and other skin conditions due to unhygienic living conditions, chronic and often severe upper and lower respiratory chest infections primarily due to indoor air pollution from cooking over open fires, gastro-intestinal worms and other parasites due to a lack human waste disposal systems, and dysenteries and giardia infections from polluted drinking water are some of the primary conditions affecting people in these remote mountain communities.

To address only one of these problems with a technical solution might be attractive to a donor with a limited mandate, time-frame, or budget. While recognizing that limitations such as these are a reality for many donors, experience shows that a single-pronged approach is neither sustainable nor beneficial in the long-term. The lure of the single-pronged approach – its simplicity, the possibility of completing the project within a single fiscal year for results to be reported back to the donor, and so on – must be resisted. The ‘family of four’ HCD approach addresses the key features of village life which are responsible for primary health problems. The synergetic benefits of the components are consequently many times more powerful than individual projects, such as ‘just’ light, or ‘just’ clean water, or ‘just’ better sanitary conditions when implemented alone.

Electricity, one of the family of Four

Any rural village electrification, in order to be relevant and sustainable, needs to be embedded in a long-term holistic community development project, as electricity is ‘just’ one of the four pillars of the ‘family’ concept.

With no grid connection in sight, the communities in Humla need to tap their locally available renewable energy resources. In the target village for this project, water flowing year-round in a nearby stream, plus an average of 5–6 kWh/m2 per day of sunshine, provide significant potential renewable resources suitable for remote area power supply purposes, in this case providing minimal indoor lighting services. In order to understand the local population’s need for indoor lighting, it is important to understand how homes were lit previously and what activities occurred in homes after dark.

In Humla, all families traditionally use jharro – a resin-rich wooden stick from high altitudes – to light indoor living spaces. Burning jharro provides very smoky and minimal indoor lighting. Keeping this history in mind, it would be inappropriate to plan and design an electrification system for this context using the conventional approach. Despite the fact that typical systems supplying 100 W power consumption per family and using incandescent light bulbs are conventionally pursued in Nepal and elsewhere, such a project, for a remote and impoverished area like Humla, cannot be sustainable.The sheer amount of equipment and machinery that would need to be air lifted into the village makes such a project difficult. Additionally, initial project costs and the ongoing maintenance costs would be far beyond the local community's economic capacity, making this approach infeasible in the long-term.

Example after example of development projects worldwide have shown that local people have to grow into technological and subsequent behavioural changes slowly, for the simple, and perhaps obvious – but rarely admitted – fact that traditions and cultures change much more slowly than new technologies can be introduced. Project planners, in collaboration with local people, have to understand and openly discuss the local cultural milieu, attitudes toward change and the various factors that may predict the ability of each householder to accept and integrate new technologies into their daily lives.

The first time that an electrification system is introduced into a community, a step-by-step approach needs to be taken, starting with minimal, low-level energy services, initially providing indoor lighting only.

Such an approach cuts down on equipment size and weight, saves on infrastructure and transport costs, and increases the chance that local people's participation will be effective and sustainable. Because the step-by-step approach begins small, it also means that misuse of the system has a relatively small and easily addressed set of consequences. It is much easier to teach people who are not familiar with the basic concepts behind the electrification technology how to use, maintain, and trouble-shoot simple, small systems than large, complex ones. Futhermore, through the participatory planning, building and installation of the rural electricification system with local people, villagers learn new skills and competencies, and develop a strong sense of ownership for the new technology. That allows a more seamless transfer of the project to the local community, which is considerably better prepared and able to run and maintain the system.

Starting small – pico-hydro

The basic village electrification system is a small, embedded power generation unit just sufficient for minimal lighting purposes, utilizing and converting the locally available, renewable energy resources. A typical project is a pico-hydro power plant installed in the village of Kholsi in December 2006. This machine generates 1.1 kW at a maximal water flow of 83 litres/s, with a negative head and a conical draft tube of 2.7 metres long. Working in the pico range means that the chosen lighting technology's energy demand must be small. Therefore, the ISIS/RIDS-Nepal project, in collaboration with the local Nepali company Pico Power Nepal (PPN), developed white light emitting diode (WLED) lamps, each lamp holding 12 diodes (Nichia NSPW510CSE), with the unit consuming just over 1 W. These lamps are almost unbreakable, and last more than 50,000 hours, some 20 years if used for 7 hours a day.

The entire hydro power plant infrastructure, including the power house and the water canals, are built with locally available materials such as stones and wood, provided by villagers as part of their voluntary contribution to the project. In addition to providing these materials, individuals from every household in the village contributed labour and skilled assistance to the building and installation process.

Buy-in, participation and local sense of ownership were prioritized and openly acknowledged by project participants. While these issues are not a guarantee for long-term sustainability, they are important steps in the direction of a new paradigm of development.

At the completion of the project, villagers were proud of their achievement and described a strong sense of ownership in the entire endeavour. This stood in stark contrast to a hydro scheme several villages to the north, which was conceived of, designed by and implemented by foreign aid workers. Few, if any, local people were involved in a buy-in to the system that could have been achieved by contributing materials or labour of their own accord, nor, according to villagers in that region, were any local people trained on the maintenance of the system. It quickly fell into disrepair.

Kholsi village has 67 homes and one school, each house now has three WLED lamps, while schoolchildren in class read under an additional nine. A total of 210 WLED lamps are supplied.

The generator’s 225 V AC output is transformed to 615 V AC, travels via an armoured underground copper cable to the village, and is again transformed to 225V AC. Upon realizing that householders’ usage of the system for lights consumes a maximum of only 250 W at any time, the system was modified so that 850 W or more can be diverted full-time by a specially developed electronic load controller (ELC) to a water heater. This heats water in a 500 litre plastic tank that is insulated with pine needles and nestles within a larger, 1000 litre plastic tank.

The warm/hot water generated by this system is used for showering, improving hygienic conditions. It can also be used to prepare meals, reducing firewood consumption even more than already reduced by use of efficient smokeless metal stoves also installed in each family home as part of the ‘Family of four’ HCD approach.

From small acorns, mighty oaks

Experience in the field shows that in the context of remote and impoverished mountain villages in Nepal, small power generation systems are on a locally comprehensible, locally sustainable scale, and are therefore highly suitable for such communities, at least as a first step in a rural village electrification process.

It is crucial to include all the stakeholders in projects such as this, from the initial concept/design stage through to its official hand-over to the local end-users. The commitment of the project partners beyond the implementation phase is compulsory, to continue to support end-users on the use and maintenance of their new power system. This may demand a commitment to provide local, on-the-ground staff, who remain in the community for some defined period beyond the implementation phase. Although this demand is rarely heeded in development efforts that are occurring in other settings around the globe, it is certainly worth the investment.

Furthermore, unless there is a paradigm shift toward retooling development efforts in the direction of many small scale, bottom-up, grassroots-involved, holistic community developments, there is little hope for reaching noble – but so-far unobtainable – millennium development goals.

Even so, while there is no silver bullet solution to the challenges of international development, the ‘family of four’ concept, integrated in a long-term HCD approach, has been shown to be a significant step in the right direction for new development, at least in the context of such remote and inaccessible areas as Humla in Nepal. With time, both sides of the development divide – those offering assistance and those receiving it – will see and experience the practical and mutually beneficial, synergetic benefits that an HCD approach is able to bring forth. However, this process will not occur in a year or two, but will most likely unfold over the course of two generations of intensive living and working with the people who are being helped to escape the vicious circle of poverty and hopelessness. This is the cost of dignified and respectful development.

Kimber McKay is Associate Professor at the Department of Anthropology, University of Montana, USA and The ISIS Foundation Nepal Humla Project. Alex Zahnd is Assistant Professor at the Department of Mechanical Engineering for Kathmandu University, Nepal and co-founder and Project Director of RIDS-Nepal (www.rids-nepal.org).

You can contact Kimber McKay at Kimber.mckay@mso.umt.edu or Alex Zahnd at azahnd@wlink.com.np

Image Gallery (5)