Revitalizing Small Hydropower in Nepal

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ABSTRACT

Nepal is second richest country for hydropower. The potential energy may be used for national and regional benefits. But Nepal hoped for external assistance and did not develop new power projects in the last ten years for satisfying its own consumptive needs. It had to depend on imported diesel fuels for part of its own needs. The country suffered from load shading for nearly 6 hours in a day.

The large section of impoverished rural population, living in the sparsely populated hills needs power in lesser magnitudes for their immediate needs. For the people living under subsistence economy, such hydropower projects which serve the grid may not be accessible. But they have the resources for small hydropower. In the last five years, the government, the rural community as well as the private sector have attempted to build smaller projects for the consumptive need of the rural population. International supports are also reaching for such programs. The paper elaborates on developing smaller hydropower projects and its utilization and the changes it brought about in the economy. A few lines on Bhutan power are also added.

1 HYDROPOWER IN NEPAL

Nepal is located on the lap of the Himalayas between India and China. It has a population of around 25 million and an area of 147,181 sq. km. Due to mountainous and rugged terrain, accessibility is poor in most parts of the country. Nepal is rich in hydropower resources with an estimated potential of 83,000 MW and economically exploitable potential of 44,000 MW. In terms of the potential, it's the second largest in the world. There are six thousand rivers and rivulets within four big river systems fed with snow melt and monsoon water in Nepal with enormous hydropower potential. But as we have not developed our power potential, the supply is not able to meet our demands. Though the first hydropower plant was built back in 1911, Nepal so far, has developed only 650 MW of hydropower.

In Jan 28, 2007, the peak load was 640 megawatts (MW). Nepal's run-of-river projects, which have a total installed capacity of 458 MW, are only producing 190 MW at the moment. Even in the coming monsoon, when these projects run at full capacity, the country will still face massive power deficit, as the installed capacity is just over 600 MW, including 92 MW from the two storage-type Kulekhani projects and 55 MW from the country's thermal plants. Minus transmission leakage of 24 percent, the actual power availability, even in monsoon, is just around 450 MW. The annual rise of power demand in the country is about 8.4 percent, according to NEA's annual report. Nepal is importing 80 MW from India.

Estimates show that $69 billion (43,000 X $1.6 million per MW of generation cost) will be required to generate 43,000 MW of electricity. To meet the current demand of electricity, at least 50 MW needs to be added to the grid every year for some years to come. This translates into a financial commitment of $80.0 million per annum. So it presents tremendous opportunities for financial institutions. Nepal has seen some developments in the involvement of domestic financial institutions in the hydropower projects promoted by
the Independent Power Producers (IPP). Chilime, Khudi, Puwa Kholo are some of the projects which were locally financed.

Nepal laws designate less than 10 MW power plants as Small Hydro Power (SHP). Nepal’s northern neighbour, China has the exploitable SHP resources in China which amounts to 87,000MW, up to 23% of the exploitable hydropower resources in the whole nation, and ranks the first in the world. By the end of 2002, over 48,000 rural hydropower stations had been built, with the installed capacity of 31,040 MW and the annual output of 103.7 billion kWh in a total, which covers about 40% of the total hydropower capacity and 10% of the total electric power output respectively in China, and also takes world’s first place. In some provinces, the rural hydropower accounts for 20~30% of the total power generation. SHP is usually dispersed, easy to be exploited and integrated into local grids for power supply. As a favourable makeup to large grids, SHP can effectively meet the local power demand.

1.1. Benefits of SHP

The macro benefits of SHP are also evident, such as booming the economy of hilly areas, improving the rural energy structure, bettering the ecosystem, improving the living situation of rural people, promoting agriculture, creating more job opportunities and boosting tourism industry etc. Although these bring no direct economic profit to investors, the local government and people can benefit a lot, who in return, give strong support to station construction and its long-term operation, and ultimately brings out a huge invisible profit indirectly.

The investment return of SHP may not be very rich, but is relatively stable and reliable. The SHP seems to be a land of promise to private enterprises. Private financing SHP was initially started by the government but now-a-days, private funds have come from local investors.

Inside the arising tide of private funding SHP, some negative effects are also brought about, such as illegal campaign of “seizing river section” in which investors scramble for rights of river development. The rights are even transferred illegally in a few places and speculation and profiteering happened in disguised forms. There is a batch of so-called “4-withouts” illegal stations built without approval, design, acceptance test or normal management in some areas, which leads to a serious result and damage. For similar emergent measures, Chinese government has taken measures to weed out nearly 3,000 illegal stations. These negative effects are also adverse currents in the heated investment attributed to power shortage and chance of making money from SHP.

Based on the international practice, supervision on private power sector would be a very tough task. The off-take power quantity and tariff directly affect the enthusiasm of investors. A specific amount of financial subsidy still has to be used to stimulate private financing SHP in some countries. Responding the call for green energy in the globe, SHP, as the most practical green energy, can possibly be improved in its economic benefit with supports from various incentive policies.

Extension of national grid system for electrification to all district centres or district headquarters is quite difficult. District centres are considered as the development centres for the whole district. Hence, His Majesty’s Government /now, Government/ of Nepal in 1975 decided to establish a Small Hydel Development Board (SHDB) to electrify all remote laying district headquarters through isolated type small hydropower schemes, in the first place.

Sufficient energy is the key element for development process. Nepal, as a developing country, needs more and more new energy sources to meet the ever-increasing demand for socio-economic development and industrialization of the country. In this backdrop, hydropower is the only resource available abundantly in all hilly and mountainous parts of the country. It has the ability to reduce poverty and enhance the quality of life in the rural communities. Access to electricity promotes new economic activities, empowers women by reducing domestic drudgery in firewood collection, improves health and education services and provides a cleaner and healthier home environment. Apart from hydropower, other energy sources in economically exploitable scale are not available in Nepal.
2 ENERGY SUPPLY AND HYDROPOWER

Nepal’s per capita energy consumption is around 14 GJ, which is one of the lowest in the world. Traditional energy source in Nepal is fuel wood. It still accounts about 80% and is available free of cost in many rural areas of Nepal. Electricity in Nepal is generated from hydropower plants, diesel power plants and solar energy cells (photo voltaic system).

To date, only about 10% rural population has access to electricity. Its use is limited mainly for lighting purpose. Traditional water wheels (/Ghattas/) are in use throughout Nepal since early days. These primitive water wheels are being developed for mini-micro hydropower plants for agro-processing and lighting purposes. They are popular for the electrification of scattered and isolated settlements in hilly areas of Nepal. Number of agencies and institutions are supporting the implementation of mini-micro hydropower plants.

There are almost 4,000 Village Development Committees (VDCs) in Nepal. Almost 2,000 of them have been electrified by the end of 9th five-year plan. In its 10th Five-Year Plan (2002 – 2007), the Government of Nepal adopted poverty reduction strategy (PRS) as a major challenge, in which rural electrification is a prime component. An ambitious target to electrify 2,000 more VDCs has been envisaged. Out of them 1,000 VDCs will get electricity from the INPS and remaining 1,000 VDCs will be electrified from disintegrated micro-hydro and solar home systems. To boost participatory approach and involve grassroots people in development process, the plan also has envisaged formation of local cooperatives or user’s groups for rural electrification through grid extension as well as through the development of small-scale hydropower plants up to 500 kW.

Nepal Government used to provide subsidies up to 75% for electromechanical equipment through Agricultural Development Bank, Nepal (ADB/N). Now, Danish-funded Energy Support Assistance Programme (ESAP), Rural Energy Development Programme (REDP) of the UNDP and Remote Area Development Committee (RADP) are involved in implementing mini-micro hydropower schemes in the hilly areas of the country. Presently, there are hundreds of mini-micro hydropower schemes under process by these institutions. ADB/N financed more than 500 water turbines, mostly of the cross-flow type, ranged from 5 to 20 kW. These days, portable type “Peltric Sets” are also popular in remote areas for lighting and for other recreational purposes. Usually, they have capacities from few hundred watts to one kW.

Established in 1975, the Small Hydel Development Board was engaged in planning, survey, design, implementation and operation/maintenance of small hydropower plants throughout Nepal. Later in 1985, Nepal Electricity Authority (NEA), a public utility, was formed as per the policy of the Government of Nepal to look after all electricity-related works by merging of the Department of Electricity, Nepal Electricity Corporation and Small Hydel Development Board.

3 HYDROPOWER IN BHUTAN

Bhutan is very close neighbour of Nepal. It has potential of 16,000 MW and generates 350 MW. The demand in the country is 72 MW. 75% of its annual generation is exported to India. It contributes 50% of revenue generation. Hydro Power Master Plan (1990-2010) identified 91 potential sites, out of which 25 sites with 11,000 MW were techno-economically feasible. Out of 24 hydel plants, the 4 have the capacity over 1,000 KW. In 1967, the first hydro project was completed. Chukha Hydel Project (336 MW) was completed in 1988 under cooperation from India. The 20 KW Kekhar is the smallest MHP. The electricity demand was just 22 MW in 1991. Now it is 80 MW. About 40% of the population has access to electricity. The total energy requirement is 500 GWH. The projects recently completed are Kurichu (60 MW) and Tala (1,020 MW), Basochhu a(60 MW) and Kellingochhu (200 KW). These are run-of-the river projects. These are fully financed by India through grant and loan funding.

The Power Ministry of India argues that a similar umbrella agreement with Nepal should start with run-of-the river projects. A number of projects like West Seti (750 MW), Budhi Gandaki (600 MW), Arun 111 (400 MW), Upper Marshyanganjdi (121 MW) and Upper Karnali (300 MW) are outlined. Private sector Indian companies like Reliance, GMG and others are keen to develop these mega hydro projects in Nepal.
4 GOVERNMENT POLICY AND THE PRIVATE SECTOR

To develop hydropower, the only natural resource, and to electrify rural areas, Nepal set the priorities in subsequent five yearly development plans:

Electrification programs will be made extensive to augment the development and expansion of agriculture production and of cottage and small-scale industries in the mountainous and Terai (plain area bordering with India) regions of the country. For the implementation of these programs, small and mini hydropower plants will be developed where electrification can’t be provided through the Inter Connected Nepal’s Power System (INPS).

Electrification programs will be implemented in the district headquarters and other places of the country to maximize the utilization of limited resources on the basis of the following considerations: i) area with economic potentials, ii) area with possibility of underground and pump irrigation, and the development of cottage and small-scale industries, iii) adjoining areas where electrification works have already been completed, iv) area in proximity of hydropower plants and v) Development of hydropower plants through public and private sector participation by simplifying licensing process and providing incentives.

For these objectives Nepal promulgated new Hydropower Policy 1992, Electricity Act 1993 and Electricity Regulation 1994. As per the policy and act, no license is required for a hydropower project having capacity up to 1,000 kW and for the projects of more than 1,000 kW, the procedures have been simplified. The government promulgated, revised and updated “Hydropower Development Policy –2001”. Apart from NEA, there are several independent power producers (IPPs), some of which have already established hydropower plants including SHPs and selling electricity to NEA. They are: Himal Power Limited, Bhotekoshi Power Company, Chilime Power Company, National Hydropower Company and Arun Valley Hydropower Company. There are other hydropower companies also in Nepal, who have concluded PPA with NEA, and are in process of project implementation.

5 CHALLENGES AND ISSUES

Generation of affordable and cheaper electricity from hydropower projects and supply to rural areas is the main challenge of Nepal. Hydropower plants, though in smaller scale, are capital intensive. Due to the poor accessibility and rugged terrain, transportation of materials and equipment is quite expensive. Dispersed villages and settlements in hilly and mountain areas make electrification process costly. Due to the high electricity tariff and low affordability of the village people, electrification in rural Nepal is very slow despite high demand. But, load factor is very low due to weak economic activities. Electricity is used mainly for lighting purpose. Therefore, to date, only 5% of rural population has grid electricity, and around 5% has electricity supplied from isolated type mini-micro hydropower schemes and solar home systems. Management and harmonization of isolated type micro hydropower systems are becoming a big challenge for NEA as the national grid system approaches to these areas.

Most of the equipment and materials have to be imported from outside. It needs foreign currency. Ever weakening local currency and strict conditions for foreign currency make hydropower projects expensive. Additionally, power supply system loss in Nepal is around 24%, which is quite significant. It needs improvement.

Big variation of discharges during dry and monsoon season, high concentration of sediment during flood period and weak and fragile-geology in many areas of the country make hydropower projects challenging. Long-term hydrological data also are not available for many rivers. New gauging stations have to be set up to get reliable discharge data. High transmission line cost in hills and mountains to evacuate power from a hydropower plant located in far-flung area also is posing economic problem.

There is a remarkable disparity of economic level of the rural and urban people. Return on investment from hydropower generation and distribution is quite difficult in remote areas. Nepal Government is unable to undertake sustainable rural electrification process due to huge investment requirement. Private investors are
not attracted in rural areas due to low financial return. In addition to that, security and political stability are two major issues, which are seriously affecting in speedy implementation of development infrastructure in Nepal these days.

In April 2007, India said that it can give at most 35 MW of additional power to Nepal only with the existing transmission links. This is in addition to the 80 MW that Nepal has been importing from India in the dry season. During the dry season this year, Nepal had asked India for around 100 MW of additional power to deal with an acute power shortage that led to as much as 40 hours of power cuts per week per household. But power availability in the country has improved in the second seek of April 2007 the astonishing rise in water discharge in the country's rivers owing to melting of snow early this year. However, the constraint posed by transmission links is set to make Nepal suffer still greater shortages during dry seasons for at least two more years, even if the proposed high voltage transmission links enter construction immediately. At the Indian Prime Minister's direction, Bihar Electricity Board has agreed to provide this amount of power at the concessional rate of IRs 4 per unit. The spot price of electricity in the Indian market is IRs 7 per unit. (1 IRs=NRs 1.6)

To address the constraint posed by existing transmission links to Nepal-India power exchange, Nepal Electricity Authority and India's Infrastructure Leasing and Finance Company agreed to jointly build four high voltage transmission links across the border, each of which will cost around NRs 2.08 billion. India currently has a total installed capacity of 135,000 MW, of which 26 percent comes from hydropower. The projected demand for India for 2012 is 200,000 MW. This is estimated to jump to 500,000 MW by 2025.

Nepal's export oriented projects in the pipeline include the 750 MW West Seti, with which PTC has already initialed a Power Purchase Agreement at 4.795 cents (Rs 3.4) per unit, Tamakoshi II and III, which were recently awarded to SN Power, a Norwegian Company, and Arun III, Budhi Gandaki and Upper Karnali, which are in the process of being awarded to developers.

6 INTERNATIONAL SUPPORT

There are encouraging instances of power development. The World Bank approved a US$ 75.6 million credit to the government of Nepal to provide electricity facility to the majority of people, who have little or no access to the white gold. The fund was provided to support the government's efforts at expanding access by strengthening partnership with the private sector and local communities. The funds will be implemented through the Nepal Power Development Project (NPDP) that will increase access to electricity mainly in rural areas connecting around 47,000 households. After the Bank's refusal to invest in the Arun III project in 1995, NPDP is its first major investment in the hydropower sector. NPDP established a Power Development Fund (PDF) to help the private sector to undertake developments of small and medium sized hydro projects. PDF will support the private sector by providing resources for long term financing and guarantees for first time investors in the sector.

Power Development Project (PDP), seeks to provide long-term debt financing to develop small and medium-sized (10 to 30 MW) hydro projects. Other partners to the implementation of hydro-projects under the PDP include the Nepal and the Norwegian governments, USAID, United Nations Development Programme and the German Technical Cooperation (GTZ). While the Nepal government will finance a part of the PDP, Norwegian government and other agencies are to provide technical assistance in a number of areas. The implementing agencies for the activities under the PDP include the Ministry of Water Resources, Department of Electricity Development, NEA and Alternative Energy Promotion Centre (AEPC).

7 NEA FACILITATES

As in April 2007, 172 micro hydel projects (MHP) generate 236 KW and these projects benefit 386 families. In the second phase, 125 MHP will generate 451 KW and 5,000 families will benefit.
A district has been named Model Energy District. It has MHPs with 1,000 KW. In the south-west region, all the wards of Surkuwa and Paiyu VDCs, Rangkhami-6 and Damel-2 villages also are developed under Energy District.

In Kathmandu Valley itself, different rivers are used for MHPs. They are Theule (24 KW), Kaluni (22 KW), Upper Kalune (12 KW). Three MHPs have been developed in Urja Khola (rivulet), namely, Urja-1 (9 KW), Urja-2 (25 KW), Urja-3 (118 KW). Twelve Pico and Peltric sets generate 165 KW and benefit 1,762 families. 65 families enjoy solar energy. There is a plan to develop a mini-grid.

In the last five years, the government, the rural community as well as the private sector have attempted to build smaller projects for the consumptive need of the rural population. International supports are also reaching for such programs.

7.1 .**Rural Power Supply Licenses.**

Just 5% of the country's rural population and 18 percent of the total population enjoy electricity. But over 150 community organizations applied for the management of electricity distribution in rural areas.

Rural electrification has proved to be very challenging and expensive. Providing electricity to one household requires Rs 15,000 to 30,000. The NEA charges a subsidised rate of Rs 4 per unit from clients who consume less than 20 units per month. Currently, about 75 percent of its clients use less than 20 units.

The number of micro-hydro power stations currently stands at 94, with collective power generation put at 1,304 KW. They are spread over 15 districts. This has encouraged micro-enterprises, which would not have been possible in the absence of electrification. This is being hailed as a major achievement since only six per cent of the rural population have access to electricity through the national grid. NEA sold its less-than-5 MW small hydropower plants to the private sector, as the cost of operation was high compared to the revenue generated. It will continue to be responsible for the distribution of the electricity as the plants will be connected to the national grid. There are 40 such plants in the country.

The REDP facilitated the efforts of the local people to build a lot of micro-hydro projects since 1996. It has been extended to 10 additional districts, which are not expected to have access to electricity, at least until the next five years. However, the most notable aspect of the electrification through micro-hydro projects is that people have grouped, under co-operatives in some cases, and are known to mobilize nearly Rs 18.7 million as weekly savings, which is being further handed to borrowers to run micro-enterprises. Total investment adds up to Rs 35 million.

More than 90 years after the country's first electricity generation utility was commissioned in Kathmandu, around one and a half dozen VDCs of Lalitpur District had access to power. South Lalitpur Rural Electricity Co-operative Society in coordination with NEA undertook the distribution of electricity to the 19 VDCs in the southern part of Lalitpur district. The programme would be observed as the base for the national electricity distribution system in the country. The amount for the project came from the 19 VDCs and the government provided 230.8 million rupees. The co-operative society purchased electricity from NEA and started distribution and revenue collection.

7.2 **Power Purchase Agreements**

Many SHPs are in a position to sell surplus energy. NEA earlier set a limit of power purchase from Independent Power Producers (IPP). But there is no such limit for SHPs.

NEA and Sunakoshi Hydropower Company signed a power purchase agreement (PPA) for 4.5 MW Lower Indrawati Hydro Project. The agreement period is of 25 years. NEA will buy electricity at Rs 4.25 per unit for dry summer season and Rs 3 for the rainy season. The agreement also quotes 6% rise in the price every year. The project was completed in 2005. NEA has already bought 121 MW of electricity through PPA with private sector, including 5 MW Mailun Khola, 10 MW Langtang Khola, 2.6 MW Sunkoshi and 1 MW Barmachi.
7.3 Buying Electricity: No Limit

NEA cancelled its previous policy of buying up to 50 MW of electricity from private parties. It purchases all electricity produced by Nepalese companies now. NEA's average electricity tariff is Rs. 6.81, which is among the highest in the world. This is mainly because of high cost of construction and the high price of power purchased from Khimti and Bhotekoshi power projects, which has to be paid for in dollars. In contrast, the power from the 20 MW Chilime and 3 MW Piluwa Khola, both of which have been constructed by local investment, is much cheaper. NEA purchases power from Nepalese companies at Rs 3 per unit in the wet season and Rs 4.25 per unit in the dry season.

The list of projects, plants installed (MW), energy (GWh/y), date of operation are listed as under:

<table>
<thead>
<tr>
<th>Project</th>
<th>Installed (MW)</th>
<th>Energy (GWh/y)</th>
<th>Date of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharping*</td>
<td>0.50</td>
<td>3.29</td>
<td>1911</td>
</tr>
<tr>
<td>Panauti</td>
<td>2.40</td>
<td>9.37</td>
<td>1965</td>
</tr>
<tr>
<td>Trisuli</td>
<td>21.00</td>
<td>114.55</td>
<td>1968</td>
</tr>
<tr>
<td>Tinai</td>
<td>1.02</td>
<td>10.16</td>
<td>1974</td>
</tr>
<tr>
<td>Khulakhan I</td>
<td>60.00</td>
<td>154.7</td>
<td>1979</td>
</tr>
<tr>
<td>Khulakhan II</td>
<td>32.00</td>
<td>95.00</td>
<td>1982</td>
</tr>
<tr>
<td>Andhi Khola 5.10</td>
<td>38.00</td>
<td>1991</td>
<td></td>
</tr>
<tr>
<td>Puwakhol 6.20</td>
<td>41.00</td>
<td>1999</td>
<td></td>
</tr>
<tr>
<td>Modh Khola 14.00</td>
<td>87.00</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Kali Gandaki A</td>
<td>14.00</td>
<td>512.20</td>
<td>2001</td>
</tr>
<tr>
<td>Piluwa Khola 3.00</td>
<td>18.00</td>
<td>2001</td>
<td></td>
</tr>
<tr>
<td>Other Small Hydros</td>
<td>32.00</td>
<td>1975 - 2003</td>
<td></td>
</tr>
</tbody>
</table>

Total 566.80 MW

* Not in operation

Power plants of more than 10 MW are in shown in italics.

8 MHP IN HILLY DISTRICTS

Hilly districts are far away from the national grid. But they have enough resources for MHPs. Some cases are cited:

Myagdi & Parbat

The 30 KW Marang MHP was started in February 2003 in Myagdi District. Water from the Marang River was channelled through a 605-long canal system to harness electricity. It provides lightening to all the 7 Wards in the Marang VDC and has benefited 272 house-holds in the remote area. Rural Energy Development Project (REDP/UNDP) supported the Rs 4.3 million project with a grant of Rs 2.1 million. It received supports from local VDC, Myagdi District Development Committee (DDC), and labour contribution from the general populace. Minister Narayan Singh Pun, who is a pilot and runs an airline company, provided helicopter for the transportation of generator. A 100 KW micro hydro scheme received similar supports. The 6,000 people in six remote villages benefited.

The 13 KW Bhyakure Khola MHP at Bhimphokari in Kavrepalanchok (north of Kathmandu) started supplying electricity since 2002. The project was completed under the RHD Programme. The project was completed at a cost of Rs 1.86 million. It benefited about 70 families of three wards of the village. The electricity has been generated by dropping water from a canal from a height of 29 meters at a speed of 90 meters per second. Among 15 districts where the micro hydro project has been launched under RHDP, it is the first time where earthling system has been used to make in lightning proof.

Baglung

The 24 KW Gaundi Khola MHP of Dudilabhati VDC, Baglung, completed in 2002, benefits 250 households of 4 Wards. The work was accomplished with the joint effort of HMGN, REDP, (UNDP), DDC, VDC, ADB/N and the community people.
Pyuthan

A 16 KW MHP is completed by Rural Energy Development Programme under UNDP and Pyuthan DDC at Syauliwang VDC, the remote area of Pyuthan District. The electricity was distributed to 195 families of 4 Ward of the VDC.

8.1 Some Typical Cases

Water Pipe for Electricity:

The Nete VDC of Gulmi district has 750 watt electric power generated out of the water pipe that passes through the village. The 4-way tank and pen stock pipes were used for this purpose. It received Rs 68,000 from GARDEP Project and the rest from the villagers.

Tsho Rolpa: Highest place for MHP:

The 15 KW Tsho Rolpa MHP at Gaurishankar VDC in Dolakha District in central Nepal, is at 4,580 meters. It is the highest place for MHP in the world. It gets energy from the Chhoroipa glacier in the Rolwaling Valley. It was completed in October 2003. Earlier, a 20 KW project was built at Therangphedi at 4,500 meters. The Tsho Rolpa glacier lake, which is at an altitude of 4,580 metres, was identified by scientists as a potential threat for an outburst. The Department of Hydrology and Meteorology (DOHM) installed this plant for the workers living in the glacier lake area of Tsho Rolpa. The Government of The Netherlands funded the project.

The plant opened up potential tourism opportunities on the Tsho Rolpa lake trekking route. The 4-year project immediately reduced the water level sufficiently and also reduced the risk of breach forming in the natural moraine dam by the construction of an open channel. Lowered lake level increased the freeboard of the dam, decreased the hydrostatic pressure within the moraine and reduced the volume of water available to form a potential Glacier Lake Outburst Flood (GLOF) by 20 percent. The immediate risk from Tsho Rolpa was reduced.

Damages Corrected:

Equipment in the Jhankre Micro-hydro plant, benefiting 800 households, was destroyed in October 2002 by the Maoists. Operated under the co-operative concept, cost per unit of electricity generated by Jhankre micro-hydro is just Rs 1.70, almost four times cheaper than the cost of power supplied by NEA. The project has created employment opportunities and small industries such as rice mills have flourished. The Maoist rebels destroyed 9 small hydro plants, 5 substations and 5 transmission lines causing a loss of 2090 kW. It affected 8,996 families. They were reconstructed.

Similarly, one of the oldest plants at Panauti (2,400 KW), was set up under the Soviet assistance. One turbine of the Panauti Powerhouse closed for 8 months after the bombing by the Maoists attack, but was restarted in May 2003. Panauti is also used for irrigation.

9 CONCLUSION

There has been a marked rise in political consciousness. In the New Nepal, hydropower projects have been taken up after competitive biddings. Many small hydro power projects have been started by the Nepalis themselves and they have received support from international organisations. Dependence on imported power requirements may no longer be needed and we will be exporting hydropower after five years. Nepal may follow a faster pace of development, no lesser than Bhutan.

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