Develop Micro (Small) Hydropower Greatly to Promote Bamboo and Rattan Industry in the Hilly Areas

Hangzhou Regional Center (Asian-Pacific) For Small Hydro Power

Ⅰ Foreword

In China small hydropower (SHP) refers to those SHP stations with installed capacity below 50 MW and power grids mainly with SHP. The classification of SHP is as follows: micro, mini and small hydro power. The micro hydropower refers to those stations below 100kW.The hydropower stations with installed capacity between 100 and 500 kW is called mini hydro power. The hydropower stations with installed capacity between 500 and 50000kW is called small hydro power.

There has been tremendous SHP development in China. The history has witnessed the use of pine resin for lighting to the present electric lighting at the rural electrification stage. In 1996, the electrification coverage ratio for township, village and household reached 96.6%，94.3% and 91.7% respectively, greatly increasing the living standards of the local people, protecting the environment and booming the local economy in the vast hilly areas.

By the end of 2000,altogether 49278 SHP stations have been built, the SHP installed capacity amounted to 24.85 GW, with annual power generation 79.98 bil kWh. There were 19545 MHP stations with installed capacity amounted to 696 MW, with annual power generation 1.68 bil kWh. Much has been also scored in R+D, planning, equipment manufacturing, operation and maintenance etc. According to the statistics, half of the total land, 1/3 of the Chinese counties (800 counties) and 1/4 of the Chinese population mainly depend on SHP. It has a special role to play in rural energy supply, environmental protection and poverty alleviation.

Currently, there are over 40 MHP equipment manufacturers widely adopting simplified, generalized and standardized principles. The units include tubular, impulse, Francis and axial types, heads range from 1 to 100 m. Not long ago, special research was conducted to the MHP of 3 kW, 5kW and 8kW. The equipment and technology have the trend of commercialization. Both the technology and product are easy to obtain, with the manuals easily to be mastered like electric appliance. The farmers may purchase, install and maintain by themselves. It is cheap in price and easy to use, welcome by the farmers.

II The policy and measures for SHP development in China

1. *Adopt the policy of "relying the locality for the main and supplemented by the state"*

The local people use the local funds, technology and material available to exploit SHP to serve the local economy. The State guides and supports in technology and finance. Years of practice show that the small amount of state financial support can mobilize the local forces to develop SHP, thus promoting the exploitation swiftly.

2. *Setting up the hydropower funds*

Two cents (RMB) are levied for per kWh in the rural SHP grids as the hydropower funds in the rural regions.

3. *Adopting "electricity generates electricity"*

The profit gained from SHP does not go to the local revenue but be used to redevelop SHP.

4. *Tax policy*

The new tax policy in 1994 imposes 6% for SHP as VAT in contrast with 17% for large hydro. In terms of income tax, half of the tax (33%) levied would return to the SHP stations as favorable policy in some of the provinces.

5. *Policy for electricity price*

The electricity of SHP belongs to the extra energy, participating the market adjustment. Its price can be set with cost, tax and proper profit.

6. *Loan policy*

From the State to the locality, several hundreds mil yuan was set aside for SHP construction. The return period was around 10 years.

7. *Self-collection of funds by farmers*

It was the common practice to invest by labor and funds by the farmers. Some counties set the policy that every labor force should commit itself to the hydropower and public projects, exceeding 8-10 working days every years. Other counties counted the working days of the farmers as the financial input during the construction of SHP stations and power grids.

8.Policy of protecting the SHP grids

The State has the regulation that large grids support the SHP grids. Large and small grids operate together at the areas where there is such condition, supplying and adjusting each other.

Ⅲ Develop micro hydro power to solve the lighting, food and bamboo processing for the villagers in Rongshui county of Guangxi Zhuang Minority Autonomous Region

Rongshui Miao Minority county of Guangxi Zhuang Minority Autonomous Region lies in the north of the Region and southern part of Yungui plateau. It is rich in forest and hydro power resources. There are many rivers and gullies with steep mountains, ideal and unique for developing small (micro) hydro power potential. According to statistics in 1977,apart from the Rongjiang River passing by, the total hydro power potential of the county reaches 318.7 thousand kW, of which the exploitable potential is 243.7 thousand kW with the annual power generation 712 mil kWh. The seventeen townships out of the 21 townships in the county are situated in the high hilly areas. The county has the total population of 460,000, of which people of Miao, Yao and Dong minorities represent 71% of the total, with an area 4663.8 km^2 and 85.5% being hilly. As the natural conditions are bad, more hills, cold, rugged and steep with poor transportation facilities. The county is one of the 300 counties which receive special government subsidy.

Since 1994, in accordance with the principle of "mainly micro, small, mainly relying local resources, self-reliance and benefit right in this year", Rongshui county has developed 1814 small hydro power stations with an installed capacity of 15195 kW, occupying 6.2% of the exploitable resources. The annual power generation was 38.4545 mil kWh. All the townships have been electrified. Of the 205 villages, 193 villages have access to electricity, representing 94%. The electricity coverage is 71%. The installed capacity increased from several kW to1600 kW,with 35 kV and 10 kV transmission lines.

1. Xiaoyangdong SHP Station

Xiaoyangdong SHP Station has an installed capacity of 1 × 75 kW and it lies at Xiaoyangdong village of Xingdong township, Sanfang town of Rongshui county, over 130 km away from the county center.

The main parameters of the Station

- ***Station type*** diversional
- ***Max head*** 27m
- ***Flow*** 0.17-0.381m^3/s
- ***Rated output*** 0.58-73.8 horse power
- ***Supply area*** 5districts, 465 households, 2550 peoples
- ***Electricity consumption*** domestic 45kW; Agr-processing 25 kW; Village run enterprises 5kW
- ***Completed in 1976***
- ***Investment*** Xiaoyangdong villagers
- ***Cost***

  Total cost: 124,000 yuan RMB (at that time), of which: the power house part:72000 yuan; Transmission line:52000 yuan. Per unit cost: 2480 yuan per kW cost.
- ***Source of funds*** Bank credit 70000 yuan; Self-mobilization 54000 yuan
- ***Management personnel*** 1; Wage 300 yuan per month
- ***Economic indices***

  In 1999, the actual annual power production: 72000 kWh; the actual annual utilization hours:3600; the electric price:0.45 yuan/kWh; the actual energy sale: 36000 kWh; the annual revenue: 16,200 yuan; expenditure: 5546 yuan, of which(1) wage: 3600 yuan, (2) Depreciation fee: 1100 yuan, (3) maintenance: 766 yuan, (4) operation & management: 30 yuan, (5) other fees: 50 yuan Profit: 10000 or so.

2.Tonglian SHP Station

Tonglian SHP Station has an installed capacity of 1× 55 kW and it lies at Shangtonglian village of Tonglian township, Wangtong town of Rongshui county, over 100 km away from the county center.

The main parameters of the Station

- ***Station type*** diversional
- ***Maximum water head*** 25m
- ***Discharge*** 0.17-0.38 m^3/s.
- ***Rated output*** 0.58-73.8 horse-power
- ***Operating mode*** isolated
- ***Power-supply area*** 202 households in 5 regions with population of 965
- ***Power-consumption area*** living 45kW; agricultural by-products processing 4.5kW; bamboo products processing factory 25kW
- ***Completed in 1979***
- ***Invested & owned by Tonglian Village***
- ***Total cost*** RMB 100000 yuan (the price at that time)
- ***Fund resource***

  Self-raised funds & loan from bank. In addition, RMB60,000 yuan subsidized from the government in 1996 was used for replacing the original generator of 35 kW with a new one of 75kW.
- ***Operating & maintenance Staff***

  4 staffs totally, managing three shifts day, and with one staff being on duty for one shift. Salary: 150-200yuan/person • month.
- ***Electricity price***

  lighting: 0.25-0.3 yuan/kWh; agricultural by-products processing:0.45 yuan/kWh; bamboo products processing factory:0.75 yuan/kWh.

Since this station was built 20 years ago, it has been making contribution to local people with a population of 965, for supplying power on lighting, broadcasting & television, cinema, culture & education (there's a middle school opposite the station, which also uses electricity from this station), health care and foodstuff processing. In addition, with electricity, the villagers can use it instead of firewood, such as using electrical cooker for dinner, and it could decrease the deforestation, and thus help to protect the local ecological environment.

In recent years, the station supplies power to a private-owned bamboo products processing factory, which is 100m far away from it. There are 9 sets bamboo products processing machines installed: 7sets × 3kW+2sets×1.5kW. The annual income totals 800,000yuan, while tax of 39600 yuan is levied annually, and over 20000 yuan is given to the station for the electricity consumption annually. This factory offers 30 job opportunities for local people, and purchases a great number of bamboos, say over 720000 pieces, from local people every year, which are difficult to be transported outside for sale. Before this factory was established, only score of cents for a piece of bamboo, however present,220 cents for one, and it helps to increase the income of local people. There’s a villager, who could make more than RMB2000yuan each year by selling bamboos; and his two children working in the bamboo factory, can each get a salary of 200yuan every month, therefore, the annual income of this household has an increase of over 5000yuan. There is a such saying among the villagers that: with electricity, it seems to have got a bright pearl; and with that bamboo factory, it seems to have got a treasure-box, then, the bamboos are changed to be costly and the living conditions could thus be improved. Meanwhile, the boss of the bamboo factory also wins great profits.

3. *SHP developing process in Rongshui County*

(1) Primary stage for MHP/SHP construction

At the National Working Conference on Rural Hydropower which was held in 1958, on the basis of carrying out “the National Outline on Agriculture Development”, the Chinese Ministry of Water Resource suggested to speed up SHP development in rural area to meet the constant increased demand on power. In 1964, the Department of Hydropower in Guangxi Autonomous Region made arrangement on River Planning, which was completed only half a year later, and then, the construction on MHP/SHP began. In Rongshui county, a working group on rural power was organized by the Burean of Hydro Power, with around 10 staffs attended, specialized designing, construction and installation services on SHP of the whole county. Moreover, a series of training courses was conducted, to make instructions on the working principles, structures, operation and installation of MHP/SHP. Firstly, a pilot micro hydropower station was set up in Sirong village in Rongshui county, for training the representatives from all the neighboring towns or villages, which includes lectures and site-study on the processes from dam construction to electro-mechanical installation. After being put into operation, it supplied electric power on lighting, agricultural by-products processing as well as the bamboo products processing for local people, who felt extremely delighted with it. Once a station completed, it was constantly visited by all the people from neighboring villages. By the end of the 1960’s, 48 SHP stations with 48 sets of units have been built already in the county. The total installation capacity amounted to 1800kW, ranging from several kW to hundred kW. Due to extreme shortage of electro-mechanical equipment, which was difficult purchase at that time, water pumps for lifting water or motors were thus re-installed to use as turbines and generators, meanwhile, without steel pipes, bamboos and wood pipes were used instead. This filled the blank in the history when there’s no MHP or SHP station in Rongshui county.

(2) Repid-developing period for MHP/SHP

The fact that only in several years of the 1960’s, 48MHP/SHP stations were built, has not only accumulated the experience and laid the technical foundation for the rapid development on SHP in 1970’s, but also opened up a new horizon for the minorities in mountainous areas. Abiding by the principles and policies on SHP, such as “self-construction, self-management and self-consumption”, “who constructs will be benefited and have the right to manage it”, “a SHP station has its own power supply area”, etc, the local government and local people were stimulated greatly to make contribution for SHP, which was developed swiftly, just like the spring bamboo-shoots after raining. The local people regarded the MHP/SHP construction as the most important things and honored to take part in this field or be supplied with power.10 years later, with great effort from governments of all levels and the local people, more than 247 stations of 251 units were built, with an increased installed capacity of 8023kW. In this period, the unit capacity of the main stations in the county or the towns was ranged from 100kW to 160kW, with transmission line of 35kV and 10 kV. The county power grid and local power grid were formed primarily, to offered power to local people for lighting and agricultural by-products processing, as well as to ensure stable and reliable power supply for industrial and agricultural development of the county.

(3)Stage for improvement

In the 1980's, with the economic development, the power grid was enlarged. Among the built stations, some aged were scrapped while some others were connected to the grid after technical rehabilitation, and the isolated stations became less and less gradually. Some of the villagers purchased the micro units of 0.2-3kW to install by themselves, which so far, have amounted for a great number in Rongshui county, being distributed here and there. According to the primary statistics such kind of units has reached over 2000 sets, with total installed capacity of 1590kW, and annual output of 1.7GWh. The successful achievement on MHP/SHP has promoted the development on other businesses, provided power to mountatinous areas, and gain remarkable economic and social benefits.

IV With full advantages of hilly resources, SHP is developed to push bamboo & rattan industry in Xinyi city, Guangdong province

Xinyi city is located in the southwest of Guangdong province, and to the north of Maoming city, with a total area of 3080.5km^2, a population of 1213000. There's a long history of bamboo & rattan industry in Xinyi. At present, with a large amount of output, it is the largest base for manufacturing, processing and exporting of bamboo & rattan wares in Guangdong province. Meanwhile, thanks to the abundant water resources in this city. Xinyi is also one of the primarily rural electrified counties (cities) in China, with the remarkable achievement on SHP development.

Back to previous years, Xinyi was known as a poverty- stricken mountainous area. The year of 1992 saw that the GDP of the city only reached RMB1150 million yuan, while the total agricultural & industrial output value 1620 million yuan and the financial income 88.7 million yuan. However, the Xinyi people fully took advantage of the rich resources of bamboos, rattan and hydro potential, to make great efforts on economic development as well as on other industries, and thus as a result, bring to an economic leap. In 1993, it removed itself from the name list of "poverty-stricken counties". In 2000, the GDP in this city reached RMB6 billion yuan (according to the pricing standard in 1990), with an average annual increase of 14.1% during the period from 1996 to 2000, the total agricultural & industrial output value was 10.63 billion yuan, which reached 132.4% over that in 1995, with an average annual increase of 13.5%; the financial income was 268 million yuan, with an average annual increase of 13.3%. The annual income for employee reached 8265 yuan, while 3575 yuan for peasant.

1. Programming on local economic acceleration with use of hilly resources

Owing to some natural, geological and historical disadvantages, in the mid 1980's, Xinyi city was still in a poor and under-developed status, and regarded as one of the poverty-stricken areas in Guangdong province, with characteristics of weak foundation, poor status, low income, less development, etc. As a typical hilly county, its area could be described as "80% of hills, 10% of water and the other 10% of cultivated land". Among the total area of 300000 ha., 200200 ha. is hilly, covered naturally with plants such as bamboo and rattan, which could be used to weave articles. By the end of 2000, the total foresting area reached over 2.54 million acres, with the coverage of 68.1% and the greening rate of 88.5%. Its forest resource is the third richest in Guangdong province, with the potential capacity of 9.6 million m^3. There's a very heavy precipitation in Xinyi, with an average annual rainfall of 1762mm. Among the large number of rivers and streams in this city, 12 with the catchment area of 100 km^2, 9 between 50-100km^2, 28 between 15-50km^2, and the potential hydro energy reached 209400kW, of which 178700kW is exploitable. Depending on the rich hilly, water and labor resources, plan on local economic acceleration is programmed as "to go up hills for planting bamboo & rattan, to go down hills for processing, and to go outside for marketing", to speed up the economic development by fully taking advantage of the abundant hilly resources. Meanwhile, much attention is paid to forestation, with a program of "forests for storing water, water for producing electricity, electricity for processing industry, and all for the improvement of people's living conditions", which means that with large forestation, water resources could be kept and increased, and small hydro power could be greatly developed with this kind of abundant energy, then, as a result, the bamboo & rattan industry would have a prosperous prospect.

2. Hydro potential in hilly regions tapped for setting up SHP stations

It's one of the backbone industries for hilly regions to greatly develop SHP by taking the advantage of the rich hydro potential. So far, in Xinyi city, 257 SHP stations have been built, with the installed capacity of more than 110MW, and the normal annual output of 350 million kWh, with which stood at the 13th place among all the national SHP counties.

(1)To construct SHP stations with multi-modes by fully taking the advantage of rich water resources.

257 SHP stations have been completed.

(2)To construct SHP stations with sorts of investments. For the SHP development in Xinyi, over RMB1 billion yuan is needed totally. So far, the total cost for the stations built has exceeded 700 million yuan, among which, some were invested by the government of the city, by towns or villages, while some with joint-investments from city and town, or town and village, and in addition, some others were share-holding or private stations.

(3) To develop SHP smoothly with multi-mode management. Taking the advantage of the electricity price with SHP, and absorbing possible investment to set up plants, to promote by- product industries, to improve the producing capability and reliability of the stations, to update the SHP technology, then, to win fruitful achievement on SHP development.

3. *The hydropower station for Zhonghuo Paper Plant*

The hydropower station for Zhonghuo Paper Plant is built on the Guizi River in Zhonghuo village, Guizi town, Xinyi city. The catchment area above the dam-site is $4km^2$.

The basic parameters of the station

- ***Station type*** diversion
- ***Water head*** 97m
- ***Discharge*** $0.15m^3/s$
- ***Operating mode*** isolated operation
- ***Power-supply area*** Zhonghuo Paper Plant
- ***Power consumed by*** Zhonghuo Paper Plant
- ***Completed in 1972***
- ***Economic indices***

In 1996, the annual generation of this station amounted to 221MWh, with the total revenue of RMB68 100 yuan. The annual production of paper plant reached 8000 tons paper with the total revenue of RMB20 million yuan, and there were totally 200 staffs and the profit at that time totaled RMB3 million yuan. The load for the paper plant was 800kW, and there were 100 sets of motors with the maximum power of 75kW, and every month the electric power consumption amounted to 300MWh. During high-water period, 100kW was provided from this hydropower station to the paper plant, other 700kW obtained from the large power grid, and during low-water period all the power generated from this station was conveyed to the paper plant, and the remains from the large power grid.

4. *The prosperity of bamboo & rattan industry accesses local farmers to the international markets*

The bamboo & rattan industry has already been the backbone industry in Xinyi City with its highest industrialization, best economic profit, largest economic scale and the function of gathering the most populous farmers.

(1) Bamboos are extensively planted as to meet the demands on this resources.

Local farmers are extensively advocated to plant bamboos as to meet the demands on this kind of resources, and now the plant areas amount to more than 40000 hectares and the bamboo planting is primarily arranged in a regionalized and large-scale base as to provide enough materials for this industry. Meanwhile, owing that the bamboos are intensively and finely processed, the bamboo price is continuously rising up, that is, now about one RMB yuan/kg risen from the previous scores of cents/piece, which is obviously increases the farmers' income.

(2) Industrialized management with a means of "corporation + household".

In order to upgrade the bamboo & rattan industry, the management mode of "a corporation combined with farmers" is adopted, that is, the bamboo & rattan corporation shall organize the local farmers to produce the wares after the received the order from the overseas customers, then this corporation shall purchase, refine and pack all these required products. By this means, thousands of households are well organized and likened to the international markets. Until now, there are totally 701 enterprises for processing or dealing bamboo products, which involve 42044 workers. With the business expansion, the materials for the bamboo industry extend from the bamboo to rattan, willow and other agricultural resources, and the combined weaving products such as, bamboo & rattan wares, bamboo & wooden wares, rattan & iron wares, bamboo & iron wares and other mix-weaving series become more and more popular. The amount of farmers (250000 farmers from more than 70000 households) involved in bamboo planting and bamboo & rattan processing industry accounts for about 30% of the total population, which covers 23 towns of this city. Therefore, the maximum annual per capita income amounts to over RMB15000 yuan, and the minimum is no less RMB4000 yuan, and now there are 41 bamboo-handicrafts companies with their total annual revenue of more than RMB5 million yuan, and among which 22 companies even exceed RMB10 million yuan. The businesses in dealing bamboo & rattan handicrafts have extended to Guangxi Autonomous Region, and Jiangxi, Fujian, Shangdong, Anhui, Hainan and other provinces or regions domestically, and the products are exported to the U.S.A, the U.K., Germany, France, Japan and other 30 countries and regions. In 2000 the total revenue concerned with the weaving of bamboo wares reached RMB1.6 billion yuan, and other US $200 million achieved from export.

5. ***Other concerned industries are promoted with the development of bamboo & rattan processing as to enhance the sustainable economic development in hilly areas***

SHP development stimulated the processing industries and promoted the local economy, which contributed a lot to improve the living standards in the locale. Large areas of bamboos are planted, the barely lands forested and the water resources are protected, thus finally achieves a benign circulation with "bamboo forests storing water, water generating power and the electric power moving the processing industries", which also gives a strong push to SHP development. On the other hand, thanks to the rapid SHP exploitation, there is a huge source of electric power in Xinyi city, and presently all the villages and all the households can be accessible to electric power with the coverage of power grids in the city.

V Conclusions

With advantages of convenient installation, low cost, easy maintenance, short-term construction and quick payback, there must be a huge market potential for micro hydropower development. On one hand, micro hydropower is very suitable for those remote hilly areas where population is dispersed and not accessed by the large power grids, and with the decentralized rural electrification, most developing countries are in urgent need of micro hydropower. On the other hand, with much more attention paid to the ecological environment, some developed countries also turn back to refurbish the previously discarded MHP stations or newly set up low-head micro stations with no negative impact to the surroundings, in the coverage areas of large power grids.

From the successful experiences in which local people of Rongshui and Xinyi was alleviated from the poverty and on a way to their prosperity, the poverty-relief mode can be concluded for the poverty-stricken remote and hilly areas, that is, to plant rattan and bamboo in mountains, build hydropower stations for electric power, and with generated electricity to process the bamboo and rattan into handicrafts, then push the produce to the market for profits, in order to enrich the local living standards as a result.

In remote hilly regions, the rich natural resources shall be fully tapped and the low-cost manpower used, so as to convert these natural advantages into economic advantages in these districts. Micro hydropower, as a sustainable environmentally sound energy, will pose no negative impact to the surrounding environment during its construction. On the contrary, it will perform multi functions such as flood-control, irrigation, water supply etc. in its small valley after the implementation. Meanwhile, in these areas with power supplied by SHP, the electricity replaces the firewood, which will protect the local forests, as well as better the surrounding ecological environment.

With mature technology, low investment risk, low operation cost, long lifespan, convenient maintenance and low construction expenses, the investment of micro hydropower station can be paid back during3-5 years. The construction term is very short, and as its completion, it can be operated for power generation with profits achieved, and its payback term can be allowed longer.

Where there is electricity, there is light. The electric power can speed up the modernization in the remote hilly regions, so that farmers can bid farewell to the conventional living mode of "work with sunrise and rest as sunset", which undoubtedly plays an invaluable role in spreading scientific & cultural knowledge, enhancing the spirit civilization of rural areas, improving the school enrollment of rural children, executing the family-planning policy, alleviating the poverty, shortening the gap between cities and villages, and social stability and economic development in rural areas.

The electric power from micro hydropower stations is adopted for lighting and processing the bamboo wares, and the added value of bamboo is improved, and domestic and international markets are exploited, even a piece of bamboo with the value of several yuan can be changed into beautiful handicrafts with value of scores of US dollars. Only by this means, can SHP and the bamboo & rattan industry be continuously prosperous, and the deep-rooted poverty in remote hilly areas can be alleviated completely.

It is expected that with the government's supports and farmers' efforts, SHP and the bamboo & rattan industry shall be combined together and promoted with each other, and in the future, rattan and bamboo shall be planted in mountains, hydropower stations built for electric power, and with generated electricity to process the bamboo and rattan into handicrafts, then push the produce to the market for profits, in order to enrich the local living standards as a result in other underdeveloped countries.

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ENROLMENT INFORMATION

2002 TCDC Training Course on Small Hydro Power

Sponsored by the UN and China, Hangzhou Regional Center for SHP (HRC) aims at promoting the SHP development in the world. China has most SHP stations and has gained much experience in SHP development. In order to disseminate SHP technology, HRC has already held with success 34 training workshops for 580 participants from 60 countries.

1.Objectives: To master the basic theory and principles of SHP development, feasibility study, operation, maintenance etc.

2.Date: From 9 Oct. to 16 Nov. 2002, Hangzhou, P.R. China.

3.Venue: Hangzhou Regional Center for SHP, Hagnzhou, China.

4.Course Contents: Procedures of SHP development, feasibility study, hydrological analysis, low-cost civil structure, turbo-generator, electric design, automation, economic evaluation, operation, maintenance.

5.Training Methods: Lectures, discussions, field trips & seminar.

6. Medium of Instruction: English

7.Source of Trainees:SHP technical personnel or officials from developing countries.

8.Methods for Evaluation: presenting country report on SHP.

9.Participant's Qualifications and Requirements for Admission: The applicants should be under 45 years old, graduated from technical schools with two years' SHP practice, be in good health with no infectious diseases and not handicapped, be proficient in English; prepare a review paper or report on SHP development of the participants' country, not to bring family members to the training course, to observe all the laws, rules and regulations of P.R. China and respect the Chinese customs.

10.Training Expenses: The expenses of training, boarding and lodging, local transportation, pocket money of RMB 30 Yuan per person per day during the training period in China will be borne by the Chinese government and distributed by HRC. The international travel costs including round trip tickets, transit fares, the expenses of medical care, insurance for the participants are covered by the participants themselves.

11.Application and Admission
Nominated by their respective governments, applicants are requested to fill up the Application Forms, which should be endorsed by the departments concerned of their respective governments, and submit with valid Health Certificates provided by authorized physicians or hospitals to the Economic and Commercial counsellor's Office of Chinese Embassy (ECCOCE) for endorsement; If endorsed, Admission Notices will be issued to the accepted participants by ECCOCE through the related government departments. With Admission Notices, participants should go through all necessary formalities with all the mentioned documents to China on the registration date.

12.Insurance: The training course organizer dose not hold any responsibility for such risks as loss of life, accidents, illness, loss of property incurred by the participants during the training period.

13.Liaison Address: Attn:Mr.D.Pan &Ms. Shen Xuequn

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HRC's Visit to Vietnam

As an implementation of the cooperative project named "Joint Research and Development on Small-sized Hydropower Units and Automation Control System", which was proposed on the Fourth Session of the Joint Committee on Science and Technology Cooperation between the Government of the People's Republic of China and the Government of Vietnam, a delegation from HRC, paid a visit to Vietnam from 7th to 14th, December 2001.

During the stay in Vietnam, HRC and its technical cooperative partner-HPC (Hydro Power Center, Vietnam) had several discussions in friendly, sincere, and warm atmosphere, with mutual understanding and targets on benefits to both sides, and at last, a Memorandum of Understanding as well as an Application Form for Joint Research and Development Project had been reached and finalized. It is expected that the two sides would be able to have fruitful cooperation in the field of SHP, especially on automatic control system for SHP stations.

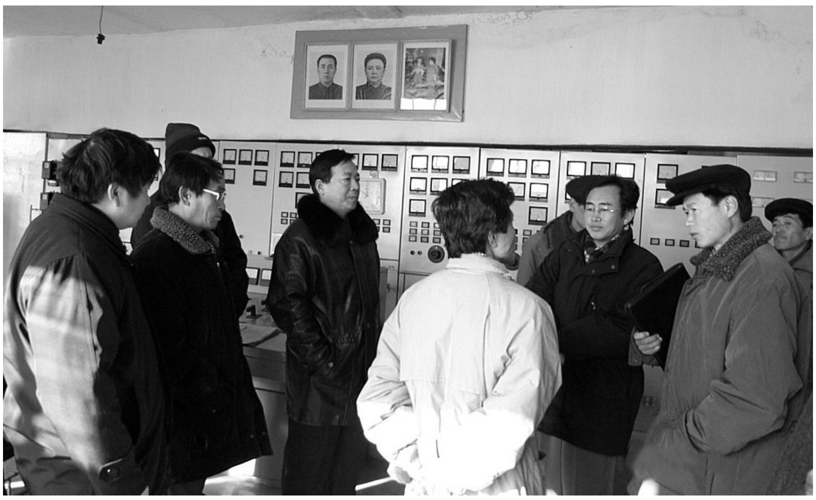
Meanwhile, HRC delegation also called upon respectively the Vietnam Institute for Water Resources (VIWRR), the Ministry of Science, Technology and Environment (MOSTE), and some other related organizations in Hanoi. The officials with these organizations all offered their high evaluations to the swift SHP development in China.

It is hoped that, with great supports from the two governments and joint efforts of the two sides, the cooperation on SHP units and automatic control system between the two countries would have brilliant prospects. ■

HRC's SHP Mission to DPR Korea

At the invitation of the Academy of Sciences of DPR of Korea, the mission of Hangzhou Regional (Asia-Pacific) Center for Small Hydro Power conducted the study tour to DPR of Korea between 18th Dec 2001 and 29th Dec 2001. The implementation o f the study tour for the key SHP development technology is one of the cooperative projects fixed by the 37th conference jointly held by the Chinese Ministry of Science & Technology and the Academy of Sciences DPR of Korea.

During the study tour, the Korean side made reception and proper arrangement. Dr . Pak Sung Chae, the Vice-President of Academy of Sciences, DPR of Korea, held dinner for the whole delegates. The original objectives set in the documents have been scored through a series of visits, presentations, exchanges of experience, technology and other activities concerned.



1.The total power installed capacity of DPR Korea is 4 mil kW, hydropower representing 60% and thermal power 40%. There is an urgent need for technical renovation for those hydropower stations set up in the 50's and 60's. Further more, there is severe shortage of funds, plus natural disasters including seaquakes in 2000. The whole nation suffered from the shortage of electricity. The potential of hydropower in DPR of Korea is 12389MW, 32% of the exploitable being tapped so far. In order to solve the energy problem, the DPR Korean government paid much attention to the development of medium and small hydropower in the recent years.

2.The classification of hydropower in DPR of Korea is as follows: hydropower stations bigger than 20MW is classified as big hydropower station; hydropower stations between 1MW and 20MW is classified as medium hydropower stations; hydropower stations between 100kW and 1MW is classified as small hydropower stations; hydropower stations smaller than 100kW is classified as micro hydropower stations.

The big hydropower stations are invested and constructed by the State. The medium and small hydropower stations are invested and constructed by the locals. Some tidal power stations are also being constructed.

3.Technical exchanges and cooperation of the HRC mission with Institute of Electricity and Hydraulic Institute under the Academy of Sciences of DPR Korea were conducted. The governor that the Institute of Electricity developed for isolated medium and small hydropower stations (Korean standards) had the characteris-

tics of being low in cost, advanced (real time computer control) and practical. The deveice had been applied in 4 hydropower stations for over one year and it appeared stable. Due to the financial difficulties in its dissemination, the Korean side expected to cooperation with HRC in promotion. The HRC mission welcome the recommendation and agreed to conduct further discussion on the cooperation in HRC earlier in 2002. The Hydraulic Institute showed keen interest in the rubber dam and slab facing rock-filled dam technology.

4.Institute of Electricity and Hydraulic Institute under the Academy of Sciences of DPR Korea expressed to send more participants for SHP training in HRC. The HRC mission welcome more participants from DPR of Korea to attend 2002 TCDC training workshops on small hydro power to be conducted in HRC. Report was given to t he Chinese Embassy in DPR of Korea by the HRC mission.

5.The HRC mission visited the West Sea Barrage at the outlet of Taedong River. This project consisted of three parts:8km long dyke, 3 spill gates and 3 ship locks, forming a fresh water reservoir of 2.9 bil m^3. The benefit to prevent the sea water flowing upwards to Pyongyang and to solve the rural irrigation and water supply for industrial use was salient, together with the benefit for fishery and navigation. The sea dyke has also the function of rail and highway transportation. The total investment was 4 bil USD. The project was started in 1981 and completed in 1986, unique of Korean features.

6.Study tour was made to the Songchon SHP station as arranged by the Korean side. The Station was handed over to the Academy of Sciences DPR Korea in 1994 and supplied its energy for the Academy. The Station is located at the left side of Songchon lock-gate at Taedong River. Four pits were designed for the turbine generator units. However, only one bulb type unit of 5200kW installed in 1990. The other three pits were so far unoccupied due to the design error, plus the changes of hydrology and the working condition at the river area in the past 10 years. The actual installed capacity is below 6000 kW for the station. The alrady installed unit is operating at a very low efficiency, i.e. only around 60%. The output is not adequated with all its backward auxiliary equipment, unable to meet the energy demand of the Academy. The Academy demanded urgently the technical refurbishment to the station, putting forward the simplest scheme: installing two tubular type units of each 1000 kW at the rest unoccupied pits. At the same time, the Academy asked HRC mission to help solve the equipment of the two units. The Korean side put forward 4 schemes to HRC mission: Credit from the Chinese side, donation from the Chinese side, adopting the unused or abandoned Chinese units and lastly supplying steel from the Chinese side or cash donation from 40,000 to 5 0,000 USD. Owing to the fact that the electricity price in DPR Korea was currently too low and thus it almost ruled out the possibility of using the credit from China. In regard with the other three requests, measures are being explored through the relevant Chinese ministries after the HRC mission was back. ■

Technical Mission from HRC to Mongolia for the UBPSPS Project

In accordance with the invitation from Morit Impex Co.Ltd in Mongolia, the technical mission from HRC arrived at Ulaan Baatar in the afternoon of 16 November 2001, for carrying out negotiation and consultation on the UBPSPS Project.

During the next three days, the HRC mission, accompanied by Morit Imprex, paid several study tours to the site of the UBPSPS project, which is 20km away from Ulaan Baatar. There, struggling to climb up the hills all covered by heavy snow, we made site-selection of the up-reservoir and undertook the geological reconnaissance. Meanwhile, the related information, for the lower reservoir as well as for the water source-Ulaan Baatar Sewage Treatment Works, was also collected after close investigation.

Furthermore, the HRC mission had exchanged views with Morit Imprex on the drafted scheme of the project, and the cooperation modes were confirmed as follows: (1) the project design will be implemented by HRC, among which, the feasibility study is to be completed with the cooperation of the two sides, i.e., the basic technical datum on topographical geological, hydrological as well as electrical condition will be offered by Morit Imprex, with which the two sides can make discussion on the scheme together. Once it is finalized, HRC will submit a feasibility study report. (2) HRC will be of assistance to financial issue of the project by recommending appropriate loan-based Chinese investors. (3) The electromechanical equipment made in China will be adopted in this project.

Negotiation was also held on the charge of designing. As a result, a general protocol on this project has been achieved, including 5 annexes.

(1) Brief report on HRC mission's activity in Ulann Baatar;

(2)Information required for the feasibility study of the UBPSPS project;

(3)Work plan for the feasibility study of the UBPSPS project;

(4)Outline for the programming of the feasibility study report;

(5)Agreement on the feasibility study of the UBPSPS project.

As one of the developing countries, the government of Mongolia pays much attention to the utilization and development of hydro power, however, with some shortages on technology, equipment and funds. In China, mature and competitive advantages are available in this field, and we would like to make continuously our devotion to the global SHP development. ■

A Chinese Magazine "Small Hydropower" by HRC

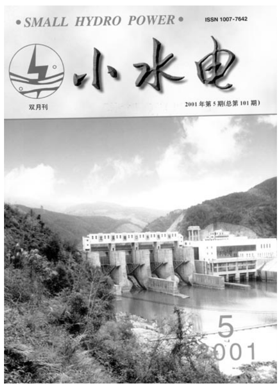
The Chinese "Small Hydropower", a magazine that National Research Institute for Rural Electrification (NRIRE) and Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power has edited and published for 102 issues (bimonthly), allocated with the International Standard Serial Number ISSN 0256-3118, and China Standard Serial Number CN33-1204/TV. It was published in Chinese and with English titles. Special features are technical experience of SHP development in China. Information of international SHP activities and important events in the field of SHP have also been widely included.

This magazine has carried news, views and articles on all aspects of small hydro power. It is useful to those who are intersted in technical experience of SHP development in China.

"Small Hydropower" is the only professional publication on small hydropower in China, which is issued domestically and abroad. It is widely circled in all corners of China concerning SHP, and getting more and more popular in over 600 rural counties which is primarily hydro-electrified, more than 2,300 counties with hydropower resources, more than 50,000 small-sized hydropower stations, thousands of colleges or universities, research institutes and other administrative authorities on SHP. Advertising is welcome for any equipment manufacturer to target Chinese market on SHP construction, equipment purchasing or other businesses.

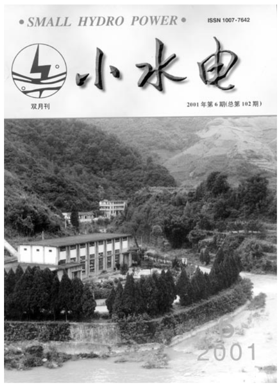
Subscription rates (1 year):USD40.00

The main contents of the 101th issue (2001 No 5) read as follow.



A Chinese Magazine "Small Hydropower" by HRC

The main contents of the 102th issue (2001 No 6) read as follow.



Working Research
Development of SHP in Chengde municipality area
Developing plan of water power and conservancy in Shangrao municipality area
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Power reliability management of county power network
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Strengthenng safety administration for improving benefits

Programme and Design
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Examination and treatment of cavitation in Shuangmiaohu power station
Analysis of follow current tubes breakdown in thyristor exciter

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High hopes for Indian Small hydro

India is taking the development of its small hydro resources very seriously. I M Sabai reports on one of the latest projects which aims to utilise hydro potential in the country's Himalayan regions

India has an estimated small hydro potential of 1015,000MW. By the end of 2000, only 1327MW (357 projects of capacities up to 25MW each) had been commissioned. Of this, 223.27MW was accounted for by 271 projects of 3MW capacities of less. Another 131 projects (131MW) were under construction. Consequently, only about 10% of the total small hydro potential in India has been exploited, even though small hydro is one of the best sources of energy for the country's hilly, remote and inaccessible areas.

In the last decade or so, the Indian government has initiated a series of steps to encourage the development of small hydro in a planned manner. The federal government set up a separate department, which was upgraded to the Ministry of Non-Conventional Energy Sources (MNES) in 1992, to oversee programmers of all renewables (including small hydro). Originally, small hydro of capacities up to 3MW came within the purview of MNES. In November 1999, the latter's mandate was enlarged to cover projects up to 25MW. A separate financial institution, the Indian Renewable Energy Development Agency (IREDA), was established under the administrative control of MNES to fund renewable projects.

The small hydro division of MNES has been co-ordinating action with the state governments to speed up small hydro development, under the policies laid down by the federal government and supplemented by the states. Undeterred by the slow progress so far, MNES has set itself a target of adding 2000MW from small hydro by 2012. For this purpose, the various state governments have also been asked to draw up their respective programmes to develop projects, both in grid-connected and local-distribution modes. The emphasis is on setting up commercial projects with private participation where possible. Dr P Saxena, director of small hydro at MNES, says there are over 150 small hydro power projects in the range 5kW to 3MW, in remote and inaccessible areas, aggregating to about 125MW. But this figure needs to be increased considerably.

The federal government, in conjunction with the states, is building up a database on small hydro which identifies prospective sites. This comprises field information gathered under a UNDP/GEF-funded project. By the end of 1999, about 3350 sites of capacities up to 3MW each (2852MW) and 662 sites up to 3-15MW (5520 MW) were identified.

MNES will now have to undertake a similar exercise for the projects in the region of 15-25MW. For micro schemes (up to 100kW), the government wants to encourage local initiative and has funded two types of demonstration schemes:

- Upgrading water-driven mills to produce electricity for domestic and local use.
- Installing portable, micro hydro sets (5-15kW) for local communities in remote and inaccessible areas. Fifty such sets have been installed in seven states and the local response has been heartening.

To develop mini (0.1-2MW) and small (2-25MW) projects, the government expects institutional efforts from the state utilities, non-governmental agencies and IPPs etc.

INTERESTING PROJECTS

An interesting small hydro project, currently under implementation in India, has been funded by the United Nations Development Programme (UNDP) along with the Global Environment Facility (GEF). Its aim is to optimise development of small hydro resources in the hilly regions of India. The sub-Himalayan areas of 13 Indian stares fall under its remit. The components of the project include.

- Setting up 20 small hydro projects at selected sites, each with a capacity of less than 2MW.
- Trying out different ownership, management and operational models.
- Selecting appropriate technology.
- Upgrading and developing 100 watermills to produce electricity for local consumtion.
- Developing low-wattage devices for domestic use in cooking and heating.
- Emphasising the localised distribution of energy, instead of putting it in the grid.
- Involving the local population and NGOs in the project.
- Developing a national strategy and masterplan for small hydro in India, involving the government, project developers, equipment manufacturers and consultants, among others.
- Training stakeholders and improving the capabilities of three selected technical institutions in the small hydro sector.

The project is not merely a scheme to construct small hydro power plants.

Small Hydro-Aspen Revisited

Only ten years after installing a new turbine system at their Maroon Creek hydro-electric facility in 1986, the City of Aspen, Colorado was faced once again with the decision as to which was the best turbine to select, after the original unit failed to meet expectations. HTS Inc. was asked to make recommendations and concluded that replacement with a new Ossberger Cross-Flow Turbine would remedy the operational problems experienced at this site with a healthy dose of reliability. What follows might serve as a guide on how to avoid costly mistakes by selecting suitable equipment the first time around, based on performance and reputation, rather than price alone.

The background

The City of Aspen, Colorado investigated the feasibility of power generation at their existing water supply line and, in 1985, developed specifications for a turbine/generator package, including commissioning and start-up. After extensive information exchange between the consulting engineering firm and Ossberger Turbines of Virginia, it was concluded that a cross-flow turbine was ideally suited for the variable flows that characterized this site. Flow to the Maroon Creek site is not only seasonably variable, but is also determined by the city's varying water consumption. Only water in excess of the demand for consumption could be diverted for power generation. Thus, with its high and flat efficiency curve, the Ossberger cross-flow design seemed a perfect match.

Unfortunately, when the project was sent out for bids in 1986, price was the determining factor in awarding the bid. Not Ossberger, but the lowest bidder-a local manufacturer who was affiliated with the consultant-was selected to build and install the turbine with associated equipment.

Its other components cover project planning, training, improving skills, and involving local citizens and NGOs etc. It also has strong environmental aspects. An environmental impact assessment of selected schemes will be undertaken, while any selected technology will also be environmentally friendly. While providing electricity to the locals for cooking and heating is expected to lead to a reduction in the use of wood, and thus in tree-felling.

The work done so far includes the preparation of master and zonal plans; training for selected office personal and those in the field; upgrading skills; selecting appropriate technologies; and developing 110 watermills. EIAs for some of the selected schemes have already been done. Construction at most of the 20 small hydro projects started in 2000 and is still in progress.

The US$15M small hydro project started in January 1995 and originally had a 30-month duration. It was given a first extension until December 1999, and then December 2000, as delays took place involving the installation of the 20 small hydro projects. The latter, significantly, were meant to have a 'demonstration' value, for replication in other areas. Because of delays, the project is now likely to be extended by one more year.

One of the main achievements of the project is the indirect emphasis it has placed on small hydro power development in India. The creation of a core of trained personnel, and research and development by selected technical institutions, will give a strong backing for the development of small hydro.

Although the project has been imaginatively conceived and is far-reaching, some feel that it is not realistic and seeks to achieve too much, particularly for what originally was intended to be a short term project. On the whole, however, there is a feeling in India that UNDP-GEF should initiate and finance one or more similar follow-up projects, learning from the experience gained from the current project.

SHARING EXPERIENCES

Some of India's experiences in carrying out small hydro power projects in remote areas are appropriate for replication in other countries. South Asia, Nepal, Pakistan, Bhutan, Bangladesh and Sri Lanka all have similar hilly and remote geographical areas, with small hydro resources which are largely unserved by power systems. Small schemes with localised distribution would not only meet power needs but also significantly improve the quality of life of the population.

The same is true of many countries outside this region. Projects could be devised to suit local conditions, and be funded by UNDP-GEF and other multilateral agencies. Trained personnel and upgraded institutions can also help to formulate and implement projects elsewhere.

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Source: International Power & Dam Construction

For the next ten years, site operation was unreliable and, even when in operation, the equipment under-performed. Broken turbine runners and shafts were repaired, but the repairs or replacements were short lived. Perhaps more importantly, the shortfall in electricity generation at full and partial flows, even when the unit was operational, ended up representing a significant economic loss which could no longer be overlooked. The city finally made the decision to remedy the situation or scrap the hydro scheme altogether and asked HTS Inc. for suggestions. A field trip by the author to the Maroon Creek hydro station led to a proposal to replace the broken turbine with an Ossberger unit. This proposal was accepted at the City Council Meeting in November of 1997 and HTS began immediately to provide the necessary services and machinery.

The challenge

The powerhouse is fairly small and located near several impressive residences occupied by the celebrated rich and famous of Aspen. Therefore, it was constructed as a log cabin in order to blend with its rustic, wooded surroundings. Besides budget limits, the biggest challenge was to use as much of the existing equipment as possible, without sacrificing reliability, and without making major changes to the powerhouse or civil structure. Complicating the challenge was the existence of a long penstock which carries flows at high velocities and pressures, and creates the possibility of extreme overspeed conditions during emergency shut-downs. The water supply line for the City of Aspen is buried beneath a site access road and consists of a 2 mile (3.2km) long, 39 inch (1 metre) concrete pipe which bifurcates and is reduced to a 30 inch (76cm) steel pipe that extends to the hydro plant.

HTS Inc. supplied an Ossberger Cross-Flow Turbine with a maximum flow rating identical to the original specification-43 cubic feet/sec (1220 litres/sec) at 156 feet (47.5 metres) of head-but we made use of the existing 450kW induction generator. The existing switchgear, head level controller and hydraulic power unit, and the pressurized pipe with bypass line and pressure-reducing valve were all left in place and reused. However, the existing butterfly/shut-off valve had to be replaced by a new gate valve designed to maintain a uniform flow pattern. Likewise, a new speed increaser with flexible couplings was needed to step-up the turbine speed to match the 1200 rpm generator speed. In order to fit the new turbine and discharge tube in the existing floor opening, it was also necessary to design and install a transition piece to connect the existing round pipe flange with the rectangular turbine intake flange.

The execution

After the equipment was delivered to the site in the fall of 1998, installation was carried out by the City's Water Department under the supervision of HTS Inc. The butterfly valve was replaced with a knife-type valve, to fit inside the powerhouse. The Ossberger Cross-Flow Turbine design, which is remarkabl for its efficient use of widely varying flows, is equipped with two individual guide vanes, which permit effective utilization of flows varying between 16% and 100% of rated flow. Regulation of these guide vanes is accomplished by two hydraulic cylinders with counterweights mounted onto each guide vane arm to effect fail-safe shut-down in case of load rejection or emergency shutdown. In addition, the parallel shaft, single-stage gearbox is equipped with a water-cooling coil, embedded in the sump.

Installation was quite simple, only requiring field welding of the transition piece counter flange, and moving the generator back a few inches to fit. Start-up and commissioning procedures went according to plan, except for required modifications to the existing hydraulic power unit, including larger hoses and control valves to achieve the oil flow necessary for faster turbine shut-down. Due to the 2 mile (3.2 km) length of the water supply line, and the high flow velocities experienced during the high flow season, it took some time to adjust the pressure release by-pass valve settings, in order to limit penstock pressure rise and generator runaway speeds during load rejection tests.

The results

The refurbished Maroon Creek Hydro station has now been in continuous operation for over a year. The new installation has been very reliable and output has increased as maintenance requirements have declined. Even a famous neighbour by the name of Jack Nicholson, whose home is near the powerhouse, appears to be pleased, since he has had no more complaints about excessive noise levels after the new turbine went on line.

The following table shows the dramatic increase in output and proves that it is wiser not to select equipment by price only-to have a successful hydro project it is necessary also to pay attention to product quality and the reputation of the manufacturer.

Table 1. Summary of generator output increase at various flows

Flow (cubic feet/sec)	Before (kW)	After (kW)	Increase (%)
43	370	465	25
21.5	150	300	100
11.3	50	150	200

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Source: Renewable Energy World

Low head pico hydro

recent developments in Nepal

by Jonathan Cox

Introduction

In Nepal, the indigenous development and implementation of pico sized equipment for low head sites has not attracted a great deal of attention, (unlike 'Peltric' sets and small crossflow turbines). However, low head Pico hydro has been successfully implemented in Vietnam for a number of years now. There are many low head sites in Nepal suitable for pico and micro hydro schemes. This can be readily appreciated when one considers the hundreds of 'ghatta' (traditional wooden mills) sites across Nepal. Many of these sites have the potential for pico hydro, using propeller turbines. These sites do not lend themselves to Peltric or crossflow type turbines. Another potential advantage of small propeller turbine schemes is the possibility of reducing civil costs to a very small proportion of the overall implementation cost.

NHE is an indigenous Nepali manufacturer of electro mechanical equipment for the hydropower industry that has experience of crossflow turbine development and manufacture. For the last four years it has been developing a series of 'pico' hydro sized propeller turbine models with a view to producing commercially viable, standard units, which can be made in batch production. In parallel with this, NHE has been able to develop a laboratory for simple hydraulic testing and bench testing of electricial prime movers and controllers.

This article will describe the development achieved so far and point to challenges for the future.

Design requirements and other specifications

After a preliminary survey, it was realised that the predominant market for such equipment would be the farming hill communities where grid supply has not extended. Many of these communities inhabit remote regions of Nepal where the way of life is subsistence farming with little in the way of income generation. Any hardware needs to be cheap, simple to install and operate, and needs to run reliably. In the community, power will be used primarily for lighting, TV and electric rice cookers. Income generating applications such as battery charging agro-processing become more important for larger units.

It was decided to develop a range of discrete units of increasing capacity and sophistication with specific users and applications in mind. In this way, a series of standard units made in batch production on a purpose built assembly area could be facilitated. The resulting economies of scale in the manufacture and supply of parts would help minimise the cost of the electromechanical package. Additionally, the hydraulic, electric and control modules could be generically similar if not the same. Of course, there is no reason why one-off designs could not be engineered suitable for larger, micro hydro sites.

So work has concentrated on three standard units; 200W, 1kW unit and 5kW. The former aimed at individual farmers or families in the community and the latter two for agro-processing end uses as well as domestic lighting for small 'hamlets'. The 5kW size is still under development.

Method of development

Initial work centred on finding a suitable hydraulic design to use/adapt. Originally, it was hoped that a permanent magnet generator could be used but due to supply problems, this idea was dropped in favour of using an induction motor as generator (IMAG) with exciter capacitors in a conventional C/2C arrangement. In parallel with the hydraulic testing, a very low cost, proprietary, electronic load controller was developed which allows the turbine to run under 'load control' with rejected load being diverted to ballast. In this configuration, the head and flow are effectively fixed. Additional development work was needed to incorporate other control functions such as overload protection, short circuit protection and protection for the IMAG to eliminate the possibility of demagnetisation of the stator iron core during service. All of these requirements were subsequently met.

Because the head and flow requirements (2 meters and 30 l/s) of the first model were so modest, simple hydraulic laboratory testing has been possible in an 'open flume' configuration identical to the actual site installation. Simple yet effective instrumentation was developed for measuring flow and shaft torque, (head and shaft speed being fairly easy to measure). For flow, a rectangular notch weir was calibrated. An in-line torque sensor measures shaft torque which allows the hydraulic efficiency to be determined.

A basic analysis of the hydraulic behaviour of the model was made possible by using a special housing made of Perspex for flow visualisation in conjunction with a 'yaw meter'. The yaw meter comprises a Pitot tube connected to an apparatus that allows the tube to i) be rotated about its own axis and ii) traverse a section of the turbine tube. The Pitot tube is connected to a differential, water filled manometer. Making use of the classicial theory of flow around a circular section together with calibration data, the meter was used to analyse the water velocity (magnitude and direction), across a section of the flow down stream of the runner. This yielded valuable information about the nature of hydraulic losses in the turbine. Supplementing the laboratory work, and providing very valuable 'user' experience, two engineering field test sites were commissioned in October 1999 and have been running on and off for the last 2 years.

Two quite differnet sites were selected. The first site is in the Mid Western region of Nepal in a district called Jumla. This area is remote. Although there is an airstrip near the administrative centre, it takes several days to walk in from the better-connected plains of Nepal. Because of this, any material (such as cement), flown or portered into the region is typically three times the cost that it would be in urban Nepal. For this reason the civil construction was made totally of locally grown pinewood. The rivers and streams in the Jumla valleys are typically glacier fed so that flow variations are much less seasonal than in other regions of Nepal. Winter temperatures are sub zero and so valuable 'cold climate' test data would be generated.

The second development site was set up about seven kilometers away from the NHE factory for convenience of monitoring service activity. In contrast, this site is just 300m above sea level (although in the foothills), in light jungle. This site has been subject to a high load of vegetable debris in the diversion channel. Although a trash rack screens most of this out, the turbine's ability to operate when leaves, twigs (and even seedpods) are ingested through the runner has been tested. Flow at this site is highly seasonal and in flood conditions the sand and debris load in the diversion channel increases significantly. Another regional factor affecting the site is the high content of limestone in the surrounding hills. This has manifested itself by the build up of significant deposits of calcium carbonate on various parts of the turbine.

Despite the above units being very much 'prototypes', site operation has proved that the basic concept in conditions typical of normal service environments is satisfactory. A number of areas of detail improvement were identified which have been incorporated into the design of units manufactured for demonstrator purposes.

The demonstrator programme

NHE is primarily a manufacturer, so has signed an agreement with the Centre for Rural Technology (CRTN), for the implementation of four 200W demonstration sites, two of which are already in service. NHE has just started a programme with Development & Consulting Services (DCS), for a further three sites two of which will be 1kW units. Again, these will be implemented over the next few months.

Conclusions & plans for the future

The development of the 200W system has moved to a point where it is ready to be implemented in production although the production facilities are not complete. Technically, the control system can be operated safely and simply. Safely-meaning that the system is short circuit protected, overload protected and the generator cannot be de-magnetised in normal operation. Simply-meaning there is a single 'on/off' switch and a reset switch on the box face plate. Hydraulic changes have resulted in the output of this unit being increased to 210 Watts at 210V ac at 49 to 50 Hz under full load.

Laboratory testing of the 1kW unit has already shown that it will produce the power. The process of proving the design in the field is part of the demonstrator programme. The 200W complete electro-mechanical package will sell for the local equivalent of round about US$200. Obviously, implementers of the technology will be more interested in the total cost including the civil cost, the transmission line costs and the 'implementation' cost. Based on field sites implemented so far, assuming a transmission line of no more that 60 meters and a cement or wooden civil construction, the total cost will be $250 to $300. The 1kW unit, both in terms of electro-mechanical equipment and total cost, is likely to be 2 to 3 times that of the 200W unit.

NHE is keen to incorporate a number of improvements into the design of the 5kW unit in order to increase the hydraulic efficiency of this unit and so work is ongoing. If this can be successfully done, then the resulting machine will be smaller and therefore cheaper to manufacture as well as allowing the option of feeding the water into the turbine via a very short penstock pipe. NHE will have a very good platform for scaling the 5kW design up to power outputs of 25kW and above, (well into micro hydro territory). One off sites could be considered where the customer specifies the head and flow conditions and NHE provides an electo-mechanical package to suit.

In closing, the challenge for NHE now is to continue development of the existing and larger units. How committed it is to doing this will depend in part on how enthusiastically the community, government and non-government organisations embrace the technology. The "jury is out' on the demonstrator sites and it will be interesting to see how successfully these sites perform in the actual service environment and on a long-term basis. ■

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Source:pico hydro

Presidential inauguration for Chasma

The president of Pakistan, Rafiq Tarat,has inaugurated the 183MW Chasma hydroelectric power project which cost around US$0.3B and took 11 years to construct.

The project comprises 8 × 23MW bulb type turbines, two of which have already been commissioned with the remaining six to be commissioned in July 2001, according to sources at the Water & Power Development Authority (WAPDA). Chasma is a run-of-river project which has been built on the right bank of the river Indus. With a total installed capacity of 184MW its turbines can generate an average of 1081M kWh of electricity, worth US$0.03B each year.

The project has been designed and supervised by Chasma Group of Consultants comprising Sogreah and CNR of France and ACE, NESPAK and MAES of Pakistan. Construction has been carried out by three contracting firms: a joint venture of Hyundai of Korea, Hakas of Pakistan for the civil works, Marubeni of Japan for mechanical works and Alstom of France for the electricial works.

The international portion of this US$ 30.3B project has been financed by the Asian Development Bank, the French Credit and Citibank of Japan. WAPDA is contributing 60% of the project cost through its own resources.

The president also announced at the inauguration ceremony that Pakistan has the potential to produce 40,000MW of hydro power but only 12% of this can be utilised. Through WAPDA's Vision 2025 programme, the president said that 23,000MW of hydro power and around 80,000M m^3 of water storage sites have been identified and that WAPDA is expected to identify and construct hydro projects in the public and private sectors.

The president is reported to have asked WAPDA to select power projects which are environmentally friendly and have a direct impact on alleviating poverty. He has also invited donor agencies and multinational companies to come forward and help contribute to WAPDA's Vision 2025 programme. ■

Company develops second small plant in Scotland

Innogy plc is developing a 590kW hydroelectric generating station in Scotland, in the United Kingdom, as part of the company's plans to increase production from renewable energy.

The Auchtertyre Project, south of Tyndrum in Perthshire, is expected to enter operation by the end of 2000. Construction began in April 2000 on the station, which will cost approximately £ 1 million (US$ 1.6 million) to complete.

Caledonian Energy, a local contractor, managed project construction. Hydro Contracting, a unit of Southern Electric Contracting of the U.K., installed the power plant, and Mulcair Ltd. of the U.K. built the water pipeline and performed other civil works. Hydrocink, Czech Republic, supplied the turbine.

Innogy, which was formed to handle National Power's business in the United Kingdom, will supply electricity produced at the new power plant to the local electricity network. The utility holds a contract to sell power from the project, which was selected in the government's Scottish Renewables (SRO) Program to encourage the development of renewable energy projects. ■

Source:HRW

Pakistani projects fail to attract interest

Pakistan's North Western Frontier Province (NWFP) has received no response to its request for prequalification of tenderers for four hydo power projects. Owing to the poor response, NWFP has extended the deadline for submitting proposals to 16 February 2000. The four projects, which were offered to the private sector as build, own, operate and transfer schemes, include the 72MW Khan Kawar in Swat district; the 35MW Daral Khawar and the 106MW Golen Gol in Ghitral district; and the 28MW Summer Gah in Kohistan district. ■

Modemising Germanplant for 2000

A hydro power plant in Saxony, Germany has been modernized as part of Expo 2000, a German industrial trade show. The project is called 'Ostritz-St Marienthal; model town for ecological energy'.

Built nearly a centruy ago to serve the famous 700-year-old St Marienthal monastery, the piant was first linked to the public network in the 1960s. Installation of a new 104kW turbine was a key part of the DM2M (US$870,000) project which aims to highlight the benefits or renewable energy. All supplies to Ostritz, on the German-Polish border, are from renewable sources with any spare capacity fed into the regional network. ■

Source;International Water & Dam Construction

India's NHPC nets higher profits

India's national hydroelectric Power Corporation (NHPC) has earned net profits of US$95M during the fiscal year 2000-2001, up 10.4% from the preceding year. The sales turnover also moved up marginally to US$265M, meaning profit figures are the highest since federal owned NHPC was set up 25 years ago.

The company is however still owed US$560M by the state utilities to which it has sold power in previous years.

Apart from major projects, this fiscal year will see NHPC taking up certain selected small hydro projects. It has already been entrusted with the development of the 30MW Nimmo Bazgo and 18MW Chutak in the state of Jammu and Kashmir. It is also undertaking investigation work of three small hydro projects in the Maharashtra state. Bav-1, Bav-2 and Deoil, have a total estimated potential of 81MW. ■

World's first for Cornwall

The world's first glass and stainless steel waterwheel, measuring 7m in diameter, is nearing completion ready for the July 2001 opening of the Gaia Energy Centre in North Cornwall, UK.

The wheel will be one of the key working exhibits in the interactive Gaia SWEB Renewable Energy Exhibition to show the public how renewable energy can be harnessed for domestic and commercial use.

Designed and manufactured at Hydra in Indian Queens, North Cornwall, the 2.8t wheel has taken over 600 hours to assemble. Constructed from rolled pipe and laser cut stainless steel, the mirror-like finish comes from hours of cleaning and polishing.

Twenty-four buckets, made entirely from special toughened and heat soaked glass will be attached to the stainless steel structure. Each one contains 130 litres of water to drive the wheel.

'We have never had a commission quite like this one, even though we are an engineering company specialising in stainless steel,' said Mike Foote, director of Hydra. 'If we can help promote the importance of a healthy and sustainable environment, then we will have achieved something.' ■

Brazil restrictions to be eased

The brazilian government has announced that its power rationing plan is working successfully and is likely to allow an easing of restrictions in 2002.

In response to a drought that depleted the country's hydro power reserves, the government ordered residential and corporate consumers in June 2001 to cut consumption by 15-25%. According to a government official, consumption had fallen by 23.5% in the northeast and 25.3% in the remaining affected areas.

At the end of August 2001, water levels at hydro reservoirs, which account for 93% of the country's energy supply, were also said to be 2.72% above expected levels. This means that even in a worst-case scenario, assuming rainfall of 61% of its usual level, rationing in 2002 would not exceed 5% of consumption, said the government.

- Brazil and Venezuela have inaugurated a 680km long high voltage power line connection between the two countries. The US$400M intertie will supply cheap hydroelectricity from Venezuela to energy-starved northern Brazil. ■

Source:International water power & dam construction

News in Brief

- A 300W micro hydro project has begun operating in a hamlet in India's Narmada valley where the Sardar Sarovar dam has faced fierce opposition from NBA. However, the lobbying group is supporting the micro hydro scheme.

  An energy conference held in Kamchatka in Russia's Far East heard that the region has good potential for the construction of small hydro power plants, according to the RIA Novosti news agency. One speaker said that this is because Kamchatka is not connected to the national electricity supply network, and has topography conducive to hydro power plant construction.

- Su-Is Muhendislik has been awarded a contract to conduct consultancy services relating to the feasibility study for the construction of the 50MW Altiparmak hydroelectric power plant on the Coruh river in Turkey, according to an EBA Report. Su-Is bid approximately US$152M. The plant will generate 152GWh of electricity each year, and will have a 63m high dam.

- Vietnam could import small hydro power plants from the Czech Republic after officials from the two countries agreed in Hanoi to boost bilateral trade, according to the Vietnam News Agency. At least one Czech bank has said it will offer Vietnamese importers credits for use in importing commodities and equipment form the Czech Republic.

- Canadian Hydro Developers, through its wholly owned subsidiary Glacier Power, is progressing well with its 40MW 'green' hydro power project located on the Peace river in Canada. The run-of-river plant will have a series of turbines on the Peace river. A novel modular hydro concept is planned which is said to have a low impact and cause minimal flooding.

Micro–hydro from Toshiba

Japanese company Toshiba has developed a standard micro hydropower unit that can generate power from a head as low as 2m. The system can utilise river or irrigation water and is aimed at remote communities.

Hydro turbines are normally designed for a specific site but this can prove expensive for mini and micro hydro projects where standardised units make more economic sense. The new unit is designed to operate with a head of 2-15m and the power output is from 5 kW to 100 kW.

The turbine has been designed within a pipe in a 'through' configuration which can be inserted into a flow system and then requires no more than bolting to a concrete foundation. Power generation can commence within a day.

A 50 kW package weighs around one tonne and can be transported by compact truck. Toshiba claims that it requires only half the space of more conventional counterparts and that it costs only half as much as these units. It can be utilised for both rural and commercial generation, the company suggests. ■

Source: Modern Power Systems

Hydro dam proposal draws fire in Quebec

Environmental, tourism and recreational group are accusing the provincial government and Canadian utility Hydro Quebec, of sacrificing some of Quebec's most pristine rivers and wilderness areas to score political points while generating small amounts of electricity.

The utility has proposed that small private energy producers build and operate 36 hydro dams on 24 of the province's rivers. The developers will then sell the generated power to Hydro-Quebec, which in turn, would market it locally or across the border to New England in the US. If all the developments go ahead, it is anticipated that up to 425MW of hydro power will be generated.

A coalition of 25 environmental and tourism groups has submitted a position paper asserting that at least six of the proposed dam sites are on rivers in which Atlantic salmon spawn. Many others host hundreds of canoeists, kayakers, rafters and hikers. Aventure Ecotourisme Quebec has pointed out that artificial barriers have never before impeded many of the rivers targeted for damming. It is claimed that by damming the rivers, Quebec is damaging its natural heritage and tourism industry, which has much better potential for job creation than small hydro production.

If the plan proceeds, the small projects will begin coming on line in 2005. At least ten companies are expected to offer bids on the sites when bidding opens later this year. ■

Source: International water power & Dam Construction

Small hydro plant

- Ontario power generation (OPG) of Canada has announced plans to build a 12MW hydroelectric plant on the English river in northwestern Ontario. OPG was granted environmental assessment approval to proceed with the project by the Ontario Ministry of Environment in July 2001. Construction is expected to be completed by the end of 2003.

- Meghalaya state electricity board of India is to build an 84MW hydroelectric plant at Jalntia Hills, near Jowai. The run-of-river scheme is expected to cost US$76.4M, over a construction period of six years.

- **(1) Rajwakti**

The 3600 kW Rajwakti Small Hydropower project in Chamoli district of Uttaranchal (Northern state of India) is expected to be commissiond by the end of February 2002. Developed by Himurja Pvt. Ltd. On Nandakini river this is the first private sector Small Hydropower project in Uttaranchal. The project will generate 24 million kWh per year in 75% dependable year. The generated power shall be fed into 66 kV grid & shall be purchased by Uttaranchal Power Corporation, a Government company @ 2.50 per kWh ($ .05/kWh). Himurja Pvt. Ltd. is also developing 9000 kW vanala & 10000kW Dewali Small Hydropower project on Nandakini river.

- (2) **Aleo**

The 3000kW ALEO Small Hydropower project near Manali in Kullu district of Himachal Pradesh India is being developed in private sector by Aleo-Manali Hydropower Pvt. Ltd. on Alaini Nala in Beas Basin. The project has been approved by Himachal Pradesh Government at a cost of Rs. 150 million ($ 3.1million). The project shall have 2-pelton unit of 1500kW each operating at a net head of 273.70M. The project is targeted to be commissioned by the end of 2003. A lcoal consultancy firm, Small Hydro Engineers Consultants Pvt. Ltd. has been appointed as consultanted fo the scheme.

Compiled by :A.K.Goel Advisor, Small Hydro Engineers Consultants Pvt. Ltd. India

Araks hydropower scheme

The Armenian government has announced that it intends to start construction of a hydropower plant on the Araks river, bordering Iran, this year. The country is holding negotiations with its neighbour covering joint use of the river's energy potential.

The plant will have a capacity of 79MW and will generate an annual output of 469 GWh. The project, which is expected to take more than five years to complete, will cost $56 m.

The project forms the core of a programme of Armenian hydro development. Two more schemes are planned in the northeast of the country, one with a capacity of 60MW and a second with a capacity of 75MW. The programme also involves the construction of around 325 small hydropower schemes. Aggregate capacity is 270 MW.

Source:*Modern Power Systems*

California looks at revisiting small hydro

As a result of the energy crisis, Kings River Conservation District of central California, US, has announced it is investigation ways to develop its hydro power potential. The District is updating a 1985 study on 11 small hydroelectric projects along the Kings River. The decision comes after the district's US$215,000 investment in May 2001 to update the 1980s Bechtel Corporation study on a controversial hydroelectric project on Dinkey Creek. Dinkey Creek and Rodgers Crossing projects were abandoned in the 1980s after fierce opposition from environmentalists.

The Californian electricity crisis has inspired similar investigations into shelved hydroelectric projects in other parts of the Sierra.

Summerville project commissioned

Gauley river power partners (GRPP) has announced that the 80MW Summersville hydroelectric facility has started commercial operations. The hydro plant, located adjacent to a US Army Corps of Engineers' dam on the Gauley river, is owned by the City of Summersville, West Virginia, US, but was constructed and is to be operated by GRPP.

The first of the project's 2×40MW IMPASA turbine generators was synchronised to the grid on 27 June 2001.

GRPP is owned by Catamount Energy Corporation, a subsidiary of Central Vermont Public Service Corporation, and TJH Investments. The project was initially developed by the Noah Corporation and financed by New York Life Insurance Company. Black and Veatch provided engineering procurement construction services.

Hydro proposal for Tuttle dam

Symbiotics of idaho, US, has filed an application with the Federal Energy Regulatory Commission (FERC) for a preliminary permit that would allow the study of the potential at the Tuttle Creek dam for a hydroelectric power plant.

The preliminary permit application reports that the project would consist of four components: a 15.24m long, 6.1m diameter steel penstock; a power house containing two 6.5MW operating units; a 1.6km, 25kV transmission line; and appurtenant facilities. The project would have an average annual generation of 51GWh.

Source: International water power & dam construction

News in Brief

- During the financial year 1999-2000 (which ended in March), India's total installed hydro power capacity increased by 1371.5MW, making it the largest annual addition in recent years. The country's total hydro capacity is now 23,500MW, about a quarter of the country's total installed generation capacity.

- The 86MW Malana hydro project is expected to be commissioned by the middle of 2001. Developed by the Bhilwara group of India, the project is located in the Kullu district in the state of Himachal Pradesh. Bulgaria's Privatisation Agency is offering 11 small hydro power plants as part of an effort to liberalise the country's energy market. Several foreign companies have expressed an interest in some of the plants. Bulgaria plans to sell more than 600 small hydro power stations. According to the RIA Novosti news agency, Russia has opened a new trade and business centre in Quito, the capital of Ecuador, with the aim of Ecuador, with the aim of increasing Russian exports, such as hydro power generating units, to the Latin American market. This is Russia's first permanent trade centre in Latin America.

- Electricity of Vietnam (EVN) has submitted a proposal to the government to construct a 70MW hydro power plant in the Rao Quan Valley in Quang Tri province, according to the Vietnam News Agency. The plant is capable of generating 260M kWh of electricity each year and will require an investment of US$140M. Construction work is expected to last five years and the first generating unit is scheduled to start operation in 2006.

Wavegen secures funding

Scottish-based renewable energy specialist Wavegen has secured a major funding boost for its wave power generation technology.

In conjunction with Ernst & Young, the company secured the required US$7.2M funding for the further development and commercialisation of its wave power technology. This round of finance was led by Merrill Lynch New Energy Technology and includes further backing from existing shareholders, including Unotec Holding, AGIP Oil & Gas and 3i.

Wavegen's marine power generation technologies take advantage of the vast natural energy potential found in the waves of the world's oceans.

In December 2000, a demonstration Limpet plant was commissioned on the island of Islay and currently generates power under a 15 year power purchase contract with Scottish & Southern Energy and Scottish Power. This latest fundraising will allow the company to accelerate the development of its products.

Small generators get help to link up

The UK Government has announced the creation of a new body to help small, environmentally friendly power generators link to local distribution networks rather than the main grid.

The Embedded Generation Coordinating Group, under the joint chairmanship of the Department of Trade and Industry and Office of Gas and Electricity Markets, will co-ordinate work into how small generators, connected to distribution networks, can contribute to overall power needs; how they are charged for using the network; and how to make local operators' information about connection more transparent.

The government specifically included small hydro in its examples of generators it hopes will be connected to the system in greater numbers in the future.

Fushi hydro plant commissioned

Meiya power company (MPC) of Hong Kong, China, has announced that its Fushi hydro power plant commenced full commercial operation on 28 June 2001. The power generated by the 54MW plant, which is located on the Rongjiang river, will supply the needs of the Guangxi region. MPC has 70% ownership interest in the project. The first and second units became operational in April and October 2000 respectively.

MPC was formed in late 1995 and is owned by PSEG Global of the US, the Asian Infrastructure Fund (AIF) and Hydro-Quebec International of Canada(HQI).

India encourages private hydro

India's Hydro Industry has suggested a new set of measures to encourage private participation and growth in the hydro power sector. The measures are related specifically to competitive bidding, environment clearance, tariffs, financing and royalty issues.

The Chamber of Commerce has suggested that the limit of 100MW for allocation of a project to the private sector should be abolished and that there should not be any limit on capacity if private sector participation is to be encouraged.

Under the current Hydro Power Development Policy 1998, all projects greater than 100MW are allocated through a competitive bidding route which has not worked in the hydro sector.

Source: International water power & dam construction

News in Brief

- Nepal's 60MW Khimti plant in the Himalayan Kingom has been officially opened. The plant is the biggest private hydro plant in the country and began generating in July 2000, increasing Nepal's total installed hydro power generating capacity to 348MW, just below the demand of 351MW. Khimti is located on the Khimti Khola river at Kirne, 170km northeast of Kathmandu. The plant cost US$ 140M and was developed by Himal Power Limited.
- Cambodia's National Assembly has agreed a contract for a 12MW hydro power plant, which will be constructed with US$20M of Chinese aid. Construction of the plant will begin in early 2001 and is due to be completed by early 2003.
- The national Electric Power Authority (NEPA) of Nigeria will be constructing 16 new power plants, including hydro plants, within the next ten years as part of an effort to ensure a steady supply of electricity in the country. NEPA's president, Olugsegun Obasanjo, has set a target date of December 2001 for uninterrupted supply of electricity in Nigeria.
- Israel's Betaman company recently started building a 3.5MW hydroelectric plant in Ordubad district in the Nakhichevan Autonomous Region of Azerbaijan, according to the Turan news agency. The plant will start generating electricity in December and three more plants will be built inNAR.
- China has started work on the Longtan hydro project in the Guangxi region. The project is expected to take eight years to reach completion, with first generation expected in 2007.
- The Brazilian--Development Bank is considering more than 60 requests for development funding for small hydro facilities. Thirty of these projects will be evaluated by late 2001, and another 30 in 2002.