SHP-based Rural Electrification in China

Hangzhou Regional Center(Asia-Pacific) for Small Hydropower

1 Progress of rural electrification

Since 1980 when the contract system of responsibility was widely adopted in China's rural areas, the economic situation there has changed remarkably. With the development of the economy, improvement in living standards and the emergence of township enterprises, the demand for electricity has increased greatly, and the imbalance between power supply and demand is becoming much more serious day by day, which ultimately hinders the development of the rural economy. In order to meet the power demand of rural mountainous areas, China's central government has decided to quicken the pace of rural electrification, and include it in the two key strategies of agricultural modernization and national energy construction.

In order to achieve rural electrification, where should the electricity come from? It is unrealistic and uneconomical to meet the power demand of vast mountainous areas and realize electrification by the national power grid.

One way for sustainable development would be to fully utilize local resources to provide rural electricity. In south China's Guangdong, Sichuan, Fujian and other provinces, a lot of experience has been gained in relieving power shortages through building SHP stations. For instance, in Yongchun County, Fujian, 252 small hydropower stations had been built up to 1992 relying on local efforts, and about 90% of the households thus had access to electricity. At the end of 1982, China's central government proposed to first build 100 pilot rural electrification counties rich in SHP resources with distinct Chinese characteristics, based on the experience and achievements made in rural SHP development at that time. At the beginning of 1983, the Ministry of Water Resources and Electric Power (MWREP) dispatched an investigation group to Yongchun in Fujian, Cili in Hunan, Longmen in Guangdong and Dayi in Sichuan province respectively to study the feasibility of realizing primary electrification on the basis of SHP promotion. During March of the same year, an outline for the pilot rural electrification counties and the primary electrification standards were worked out, and the name list of the pilot counties fixed as well. In October 1983, MWREP organized a "Forum on Pilot Counties for Rural Electrification from Six Provinces and Ten Counties" in Beijing, attended by directors from the provincial planning commissions, departments of water resources and electric power, and county governments, at which the policies and measures for setting up the pilot rural electrification counties were determined. On 12 December 1983, the State Council promulgated a government document No. [1983] 190, which approved the "Report of MWREP on Actively Developing SHP to Build Pilot Rural Electrification Counties with Chinese Style", as well as the name list of the 100 pilot rural electrification counties in the whole of China. In this document, the State Council emphatically pointed out that rural electrification is one of the major issues for 800 million peasants, and while setting up large and medium-scale power stations, local people and governments should mainly rely on their own efforts to actively realize the electrification of rural counties rich in hydropower resources.

In selecting the 100 pilot counties, consideration was mainly given to mountainous areas with rich hydropower resources, and underdeveloped revolutionary, ethnic, remote and poor regions. By setting up these pilot counties, the impact of rural electrification on the economic development of those backward areas could be better understood. According to statistics, among those 100 counties, 36 belong to the central and provincial level key counties for poverty alleviation, 25 are old revolutionary-base areas, 85 are mountainous counties, 2 counties are in pastoral areas, 25 counties have ethnic minorities and 7 are border counties. In these counties, the economic base was relatively weak, and the per capita net income was 199.18 Yuan (RMB) in 1982, and even 62.2 Yuan in some counties; power facilities were poor too, and the per capita annual power consumption was only 81kWh, and in some counties lower than 30kWh; the rural electricity usage rate was lower than 30% in some counties. All of these values were lower than a half of the average national level.

According to planning, the 100 counties had a total population of 33, 690,000, arable land of 2,559,333 hectares, and 11,370 MW exploitable SHP resources. It was estimated that by 1990 there would be a need for the installation of 3,040 MW and annual generated energy of 11 billion kWh if all were to reach the primary rural electrification standard. Furthermore, 342, 000 km transmission lines would be

Table 1 Main indices for planning of the 100 pilot electrification counties

Item	Unit	Before planning	After planning	Net increase
Population	10^3	33,690	35,420	1,730
Number of households	10^3	7,030	7,400	370
Area	10^3 hectare	36,623	36,623	
The installed capacity of exploitable SHP	MW	11,380	11,380	
Annual exploitable generation	10^6kWh	43,500	43,500	
Household electricity usage rate	%	60.6	90.8	30.2
Annual power use per capita	kWh/person/yr	81.8	210	128.2
Installed capacity	MW	1,460	3,040	1,580
Annual generation	10^6kWh/yr	3,650	11,100	7,450
Number of households using electricity for cooking	10^3 households		1,590	1,590
Ratio of households using electricity for cooking	%		21.4	21.4
Power consumed for domestic use per household	kWh/household	59	308	249
Length of transmission line	10^3km	193	330	137
Transformer capacity for power supply & distribution	10^3kVA	3,910	7,920	4,010
Planned investment	10^6 Yuan		3500	3500

erected, as well as 7.92 million kVA of supply and distribution transformers, as shown in Table 1:

After setting up pilot projects, counties with a better foundation for hydropower development successively reached the primary electrification standard ahead of schedule. Five counties in total reached the primary electrification standard in 1985, and Premier Li Peng personally issued certificates of competency and medals.

Based on the success of the first 109 (actually completed versus planned 100 counties) pilot primary rural electrification counties, the Ministry of Water Resources (MWR) finished the second 209 (200 in plan) and the third 335 (300 in plan) primary rural electrification counties between 1990-1995 and 1996-2000, with the relevant parameters shown in Tables 2 and 3. These three batches of 653 hydro-based primary rural electrification counties in total cover a population of 252 million, and an area of 2, 710,000 km^2, with more than 82% distributed in central and west regions, and more than 80% are in the former revolutionary, ethnic, remote or poor districts.

Up to 69.2 billion Yuan was put aside for the construction of these three batches of hydro-based primary rural electrification counties, of which 4% came from central government subsidies. New installed capacity of 11,359.8 MW was built and put into operation, of which 10,181 MW was hydro; 533 substations with 110kV voltage or above were set up, with total capacity of 16,470,000 kVA. 1, 932 substations of 35 (63) kV, with capacity of 12,470,000 kVA and 12,679

Table 2 Electrification of the second batch of 209 counties (1990-1995)

No.	Item	Before electrification	After electrification	Annual increase rate (%)
1	Installed capacity (MW)	3,132	5,502	12.0
2	Annual generation (10^6kWh/yr)	9,397	18,264	14.7
3	Proportion of households using electricity (%)	72.3	96.5	6.0
4	Total production value from generation (10^6 RMB Yuan)	10,624	25,896	19.3
5	Total production value of generation from local power industry (10^6 RMB Yuan)	363	1,083	20.0
6	Income of the local county and town (10^6 RMB Yuan)	5,395	11,869	17.0
7	Per capita income (RMB Yuan)	548	1,150	16.0

Table 3 Electrification of the third batch of 335 counties (1996-2000)

No.	Item	Before electrification	After electrification
1	Installed capacity (MW)	3,650	5,650
2	Annual generation (10^6kWh)	14,800	18,000
3	Per capita power use (kWh)	143	208
4	Domestic production value (10^6 RMB Yuan)	234,500	477,800
5	Financial revenue of counties (10^6 RMB Yuan)	15,000	25,500
6	Annual mean net income of farmers (RMB Yuan)	1,082	1,914

km of transmission lines with 110kV voltage or above were newly set up, together with 42,036 km of 35 (63kV) transmission lines and 225,000 km of 10 kV distribution lines.

By the end of 2000, there was a total installed power capacity of 20, 265MW in the 653 hydro-based primary rural electrification counties, of which the hydro installed capacity amounted to 17,697 MW. The generation in 2000 reached 68,250 GWh, and 59,770 GWh came from hydropower. There were 822 substations of 110 kV and above, with a capacity of 23,440,000 kVA, and 4,280 of 35 (63) kV substations with a capacity of 21,380,000 kVA. Furthermore, there were 30,059 km of transmission lines of 110 kV and above, 95,253 km of 35 (63) kV, and 694,100 km of 10 kV distribution lines.

After completing the third batch of primary electrification counties during the "9th Five-year Plan" (1996-2000) period, the per capita annual net income of farmers rose from 1,082 Yuan to 1,914 Yuan. During the "10th Five-year Plan" (2001-2005) period, China is going to invest over 70 billion Yuan to build another 400 hydro-based rural electrification counties, so as to promote the development of the rural economy. 80% of these 400 counties will be in the central and west regions, and 85% belong to the former revolutionary, ethnic, remote and poverty-stricken districts, involving 24 provinces or cities, nearly 200 million people, and an area of about 2 million km^2.

2 Principles and policies of rural electrification

In order to effectively promote the development of the pilot rural electrification counties, the State Council issued a special document, which defined the policies that the government would adopt for electrification of the pilot rural counties.

(1) Policies for the first batch of 100 pilot rural electrification counties

On December 12, 1983, the State Council promulgated the [1983] 190 Document, which clarified various questions about relevant policies and management systems.

◆ In order to help SHP develop continuously and steadily, SHP construction carried out at the county level and above shall be listed in the local capital construction plan in the future, so as to ensure the supply of essential goods, materials or equipment. The investment for all SHP stations which are collectively owned or which are self-built, self-managed and with self-consumption by the farmers themselves do not need to be in the State plan in order to avoid dampening their enthusiasm.

◆ Construction funds for SHP stations should mainly rely on local financing, with the central government offering support as necessary. From 1985, it is proposed to allocate 100 million Yuan every year from the power infrastructure investment budget to support some county-run small power stations. If these stations are really profitable, a certain proportion of profit should be collected to support SHP construction in other places.

◆ Implement the policy of "Electricity supports electricity". The profit of newly built SHP stations and the wholesale profit from power grid sales to counties should not be included in the local financial budget. All income, except production costs (including salary, materials, depreciation of fixed assets and major repair costs) and planned loan repayments, should be used for developing SHP stations and local small power grids.

◆ Continuously implement the low-interest loan policy for SHP development. From January 1984, the agricultural loan interest rate was adjusted to 0.6% per month on average, and a new monthly interest rate band was set ranging from 0.36% to 0.72%. In order to motivate production teams and rural households to develop SHP, it is proposed to grant loans for procuring equipment for newly built SHP stations at the low end of the band, i.e. a monthly interest rate of 0.36%. Meanwhile, the loan repayment time was extended from the originally stipulated 3-5 years to 10 years in case of necessity. The profits should be firstly used to repay loans according to contract, and the rest can then be used for "supporting electricity with electricity".

◆ Regarding SHP management, those SHP stations, thermal power plants, power grids, wind-power stations, geothermal power plants and other rural power projects which are built by local production teams should be run and managed by the local people. In those counties with electricity supplied by SHP stations, water conservancy can be combined with electric power, and a unified county-level management entity integrating "power generation, supply and use" set up to be responsible overall for electrification. The provincial departments of water resources and electric power should provide technical, financial and material support, with relevant sectors to take responsibility according to the concrete conditions of the province.

County-level small power grids and power-supply areas mainly relying on SHP should be under the unified management of the county government.

(2) Supplementary policies for the second batch of primary rural electrification counties

On March 22, 1991, the State Council promulgated the [1991] 17 Document, agreeing to the proposal from the Ministry of Water Resources to build the 2nd batch of hydropower-based primary rural electrification counties.

◆ China should continuously enforce the relevant policies supporting SHP development and management stipulated in the [1983] 190 Document.

◆ Construction funding for SHP stations should mainly rely on local financing, with the central government offering support as necessary. During the "8th Five-year Plan" period, the state shall allocate 200 million Yuan of loans every year to support SHP development. Work provided as a form of poverty-relief, and funds for poverty-alleviation and others can also be used in the construction of rural hydro and other local power grids.

◆The electricity price of SHP should continue to be determined according to the stipulation that surplus electric power after planned production can be regulated by the market, and be set at the local level.

◆ Areas with electricity supplied by rural hydropower can use the same policies as those offered to large power grids, that is, 0.02 Yuan per kWh can be collected in addition to the normal rate for the power construction fund, which will be used as development funds for rural hydro together with the funds from "electricity supports electricity" and special funds for SHP construction accumulated over the years, so as to implement paid utilization and rolling development.

◆ In order to adapt to rural economic development, and further arouse local enthusiasm for SHP promotion, under an unified plan, the provincial, prefecture and county governments can build medium-sized hydropower stations with a capacity of more than 25 MW and transmission and transformer projects with voltage level higher than 35 kV, thereby implementing the policy of "who builds and manages shall also get the benefit".

◆ Local economic development should be properly combined with comprehensive river conservancy and development, and the construction of power grids and power sources should be well planned. During hydropower construction, medium-sized stations should be combined with small stations, and priority should be given to build those stations with superior overall profits, or with regulating functions. The seasonal electricity produced during the wet season should be actively adopted to develop the local economy. If feasible, inter-county power grids are encouraged to be set up, and also integrated with large power grids, so that electric power can be supplied and sold from the county-level power grid to the large grid.

◆ Rural hydropower should be actively developed to realize primary electrification. For those governments at all levels with a heavy workload, the leadership for these tasks should be strengthened.

3 Impact of rural electrification

Through successively constructing the three batches of hydropower-based primary rural electrification counties during the "7th Five-year Plan", the "8th Five-year Plan" and the "9th Five-year Plan" periods, many achievements have been made, as well as remarkable economic, social and ecological benefits. The impact of hydropower-based rural primary electrification is mainly embodied in the following eight aspects:

(1) An important pillar of economic development in hilly areas, an important source of a county's fiscal revenues, and an important way for local people to shake off poverty and set out on a road to prosperity

The hydropower enterprises in the 653 primary electrification counties realized about 5 billion Yuan of taxes and profits annually, and the taxes turned over accounted for 8.8% of the fiscal revenues of the counties. In Guangdong province the 33 primary electrification counties turned over 660 million Yuan in taxes from rural hydropower in 1999, accounting for 22% of their total fiscal revenue, with the proportion reaching the highest figure of 68% in Ruyuan County. There were 7 primary electrification counties among the 8 counties of Tibetan Autonomous Prefecture of Gannan, Gansu province, and the taxes collected from rural hydropower and those high energy-consumption enterprises accounted for 30% of the fiscal revenue of the whole autonomous prefecture, of which taxes accounted for over 70% of fiscal revenues in Zhouqu County and Zhuoni County. The tax revenue collected from rural hydropower in Yi Autonomous County of Ebian in Sichuan Province accounted for 35.5% of the fiscal revenue of the whole county, and together with the tax collected from those hydropower–related industries, all the taxes accounted for 81.5% of the total fiscal revenues.

After constructing the three batches of electrification counties during the past 15 years, the gross domestic product (GDP), the fiscal revenue, the per capita income of peasants, and the per capita power consumption doubled in 5 years and tripled in 10 years, which fully demonstrates the intrinsic link between the construction of electrification counties and the economic growth of mountainous areas, and how it is an irreplaceable driving force.

(2) It promotes structural readjustment of the economy, which is beneficial in resolving deep-rooted structural contradictions, which constrain the economic development of poverty-stricken areas

Before the first batch of electrification counties, the proportion of industrial output value in the typically agricultural counties accounted for 36.6% in the gross output value of industry and agriculture; this rose to 60% in 5 years through the construction of electrification counties, and rose to 77.5% in 2000, improving by 40.9 percentage points in 15 years. During the 5 years of constructing the second batch of electrification counties, the ratio of industrial output value in the gross output value of industry and agriculture rose from 56% to 69%, further rising to 77% in 2000, with an increase of 21 percentage points in 10 years. The ratio of industrial output value in the third batch of electrification counties improved by 9 percentage points after 5 years. In the country as a whole, the proportion of industrial output value in the gross national output value of industry and agriculture accounted for 72.8% in 1985, 81.9% in 1995, and 83.7% in 1999, with an increase of 10.9 percentage points in 14 years. By comparison, in the three batches of electrification counties, the increase was basically 10 percentage points in 5 years.

The change of industrial structure brings about a corresponding change of employment structure. According to incomplete statistics, during the 15 years of constructing primary electrification counties, rural laborers were used, and local people were moved out and resettled, pushing the development of township enterprises and related industries, as well as promoting small town construction, with a total of over 30 million surplus rural labor force transferred to the second and the tertiary industries. With development of these two industries, construction of small towns was advanced again, promoting industrialization and urbanization, resolving the deep-rooted structural contradictions, which constrain the economic development of poverty-stricken areas, and guaranteeing continued rapid economic growth in mountainous areas. This is the basic reason why the economy of hydropower-based primary rural electrification counties can still keep growing steadily after electrification, and it is also the basic reason why the construction of electrification counties has become a permanent cure for poverty.

(3) SHP improves agriculture and rural production conditions, and brings about advances in agriculture

Most of these primary rural electrification counties are located in remote hilly areas, where it is hard for large power grids to reach and the power demand of these rural areas has not been met for a long time. Through construction of electrification counties, electricity for domestic use and agriculture production purposes can be provided, and the reservoirs of hydropower stations and their channels also help to supply field irrigation and drinking water, which advances agricultural development. During the past 15 years of constructing electrification counties, up to 120 million people have gained access to electricity; the electrification counties achieved a net increase in irrigated area of 1,686,700 hectares, and an increase in grain yield of 30 billion kg; and 64,255,000 people could get clean water for drinking.

(4) It promotes the comprehensive utilization of water resources, and accelerates the conservancy of medium & small rivers

In the construction of electrification counties, the authorities insisted on the principle of combining water conservancy with power generation, and have built up a group of multipurpose water control projects, with an increase of 50 billion m^3 reservoir capacity in total. Thousands of medium and small rivers have been basically developed and managed, with improvements in flood prevention and drought mitigation. In the 27 primary electrification counties of Hubei Province, 1,209 small-scale reservoirs have been built for setting up SHP stations, and 468 medium and small-sized rivers have been regulated basically. During the construction of 21 primary electrification counties in Chongqing municipality, reservoir capacity has been increased by 2,730 million m^3, and this played a positive role in retaining the local surface flow, silt, and alleviating silt deposition and flood devastation in the reservoir area of the "Three Gorges Project". The construction of electrification counties in Jiangxi Province promoted the comprehensive development and conservancy of medium & small rivers, and in the 45 primary electrification counties an accumulated reservoir capacity of 1,620 million m^3 was created, and a total soil-erosion area of 13,400 km^2 was conserved. In the electrification of Yunnan Province, the principle of combining medium & small-sized hydropower development with comprehensive administration of medium and small basins was observed, thereby moving away from the run-of-the-river type towards basin, cascade, rolling and comprehensive development. 40 medium and small rivers have been developed by the cascade mode, with an installed capacity of 510 MW, and there are a further 12 rivers being cascade-developed, with an installed capacity of 310 MW, which play an important function in realizing the targets of "the upstream of a river is to be used for building reservoirs, the middle reaches are for power generation, and downstream for irrigation" and "developing water & soil resources in river valleys" in Yunnan Province.

(5) SHP promotes ecological construction, environmental protection and sustainable development

Most of the electrification counties are situated on the upper reaches of rivers, so the cutting down of natural forests can be avoided, and soil erosion is therefore prevented if the policy of "substituting energy with electricity" is actively pursued. According to statistics, the forest coverage rate in the primary rural electrification counties increased at an annual average rate of 9.88 percentage points in the past 15 years, 5.4% quicker than that of the whole country. In Keshiketeng Banner of Inner Mongolia Autonomous Region, nearly 40% of the households living on agriculture and animal husbandry use electricity to cook meals after electrification, and timber consumption has reduced by 250,000m^3 in one year, thus preventing desertification of the land in this area.

Many medium and small hydropower stations and their reservoir areas have become local ecological tourist destinations. For instance, in Shanxi Province, there are 2 reservoir-based power stations built by 3 electrification counties Zezhou, Yangcheng and Pingshun. One of the water areas is as long as 9.5 km, and the other has a 2.5 km long backwater, thus forming beautiful scenery in the arid northern China. Those villages near power stations from where residents moved away because of the abominable living conditions in the past have now become tourist attractions of this province or bordering provinces with beautiful mountains, rivers, woods and grassland scenic areas.

(6) SHP promotes prosperity, stability and national unity of ethnic minority areas and border areas

250 hydropower-based primary rural electrification counties are located in ethnic minority areas, and more than 100 counties are in the borderland provinces. The population of these counties accounts for 40% of the national ethnic minority. The construction of primary electrification counties has quickly pushed economic development of these areas. During the period of constructing the third batch of electrification counties, the gross domestic product (GDP) increased by 18% every year, twice as fast as the national growth rate. In borderland counties of the second batch of electrification counties, such as Changbai, Aihui, Daxin, Huma, Ruili, Jinghong, Pingbian, Wensu, Fuyun and Bole, the gross output value of industry and agriculture rose to 4,950 million Yuan from 2,140 million Yuan during the "8th Five-year Plan" period, fiscal revenue rose to 350 million Yuan from 190 million Yuan, the peasants' per capita net income rose to 1,103 Yuan from 710 Yuan, and the grain yield rose to 920 million kg from 670 million kg. In Qinghai Province there are 10 hydropower-based primary rural electrification counties, which are all located in minority-concentrated communities. Through electrification the economy developed rapidly, and the per capita net income of farmers and herdsmen has quadrupled in 15 years. After electrification of the reclamation districts by the Xinjiang Production & Construction Corps, the area irrigated by pumped water wells & drip irrigation developed to 16,700 hectares, which has increased the agricultural gross output value 6.7 times in 10 years, and at the same time, provided clean drinking water for 175,000 people, accounting for three quarters of the total Corps population. The infrastructure facilities and living conditions have improved remarkably, which strengthens the confidence and resolution of ordinary soldiers to reclaim the wasteland and guard the frontiers, hence stabilizing the border region as well. During electrification construction, the border counties of Yunnan expanded their opening up to the outside world, and ranked the first in China's national power industry in providing electric power from SHP to neighbouring countries. This has consolidated the friendly rela-

tionships with neighbours, and stabilized the borders as well.

(7) SHP promotes spiritual civilization and social progress

In the already-built primary electrification counties, the TV coverage rate exceeds 90%, and the school attendance rate of school-aged children is generally above 95%. Audio-visual teaching methods are adopted in the primary and middle schools in mountainous areas, and all kinds of cultural, educational, hygiene and sport entities are developing. This has improved the scientific & cultural qualities of the local people as well as their physical conditions, so this build up of a spiritual civilization has achieved remarkable results. Ganluo county, Liangshan Yi Autonomous Prefecture of Sichuan, was one of the poorest counties in this prefecture before 1986, living on the resale of national grain. After electrification, cheap and abundant electricity attracted large amounts of investment locally or from other provinces, and factories were set up in this county to exploit the lead-zinc ore deposits which had lain idle for tens of millions of years. The value of industrial output of the whole county increased 77 times during electrification, fiscal revenue increased 16.9 times, and every social activity developed at full speed, thereby making the county one of the richest in the whole autonomous prefecture. It was the first to become an advanced county with good sports facilities in the three autonomous prefectures of Sichuan. People of all nationalities, especially those in the former revolutionary bases have benefited directly in developing rural electrification, use modern facilities for production and daily life, have increased their incomes, and have improved their quality of life.

4 Experience of rural electrification

(1) Policy support from the central government, and much attention paid by local governments basically leads to successful rural hydropower electrification

With the support of State policy, local governments at all levels issued a series of preferential policies to promote the development of SHP according to local economic conditions. For instance, the swift development of SHP in Guangdong benefited a lot from a series of preferential policies. In this province, SHP stations can enjoy a one-time subsidy of 500 Yuan per kW when put into operation, no matter whether the station is state-run, collectively-owned, a shareholding company or individual invested, and 1,300 Yuan per kilowatt for ethnic minorities and poor counties. With the support of preferential policies for SHP, the whole province has seen an increasing upswing in the setting up of small hydropower stations.

(2) Rural electrification is in accordance with China's conditions, as well as the existing national productivity development level

Why has SHP developed so fast with only a small amount of financial input from the government and no dedicated policy loans given during later stages? The installed capacity of SHP stations newly put into operation exceeded 1,500 MW in 1998, and exceeded 2 million kW in 1999. This shows that its development meets the urgent needs of economic and social development in the vast mountainous areas, and shows the strong desire of the local people to shake off poverty and march towards a relatively well-off standard of living.

(3) SHP should be closely combined with local realities, and a practical overall plan for electrification should be made

The planning for electrification is neither a brief plan made for power sources, nor a simple plan for power grids, but an overall planning of rural electrification organically combining various fields, such as power sources, grid, load, science & technology, management, investment, fund-raising, leadership, policy and measures. Planning should conform to the realities of the counties and their social development, and should be easy to put into practice.

(4) SHP has been driven by reform, and the need to break through the production relations that constrain the development of productivity, thus promoting the liberalization and development of rural social productivity

To implement the policy of "Electricity supports electricity" is to set up a benign cycle from input to output, and a mechanism of rolling development.

(5) Scientific and technological progress should be advanced, and management should be strengthened

The water administrative authorities at all levels have issued a series of SHP regulations, norms, standards and rules, which widely cover all the issues from exploration, surveying, planning, design, construction and management, and which suit the actual conditions of the SHP sector.

Table 4 summarises the achievements of the three batches of primary electrification counties in recent years.

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Table 4 Development of Hydropower-based primary rural electrification counties in China

Item		Year 1998			Year 1999			Year 2000		
		The first batch	The second batch	The third batch	The first batch	The second batch	The third batch	The first batch	The second batch	The third batch
Irrigated area (km^2)		305,957	827,032	2,033,307	305,955	795,834	2,017,823	298,310	793,307	1,981,649
Irrigated arable land (km^2)		21,099	59,322	88,793	20,816	55,771	94,206	20,420	56,870	101,710
Drainage & irrigation area with electricity (km^2)		2,106	7,260	7,484	2,007	7,475	7,908	1,931	6,085	9,740
Total population in irrigated area (10^3)		33,652	74,533	118,236	33,797	76,791	119,291	33,589	74,988	137,359
Counties supplied with electricity	Number	1,898	3,972	6,170	1,907	3,951	6,179	1,892	3,968	7,253
	Proportion with electricity %	100.0	100.0	98.9	100.0	99.9	99.1	99.9	99.9	99.9
Villages supplied with electricity	Number	29,305	58,493	86,758	29,578	58,003	79,865	29,201	57,966	89,833
	Proportion with electricity %	99.8	98.9	94.9	99.9	99.2	97.8	99.9	99.5	99.3
Families supplied with electricity	Number	9,715,912	18,968,844	27,494,577	8,888,125	18,584,317	28,821,436	8,943,955	19,718,902	34,331,472
	Proportion with electricity %	98.4	97.3	92.6	98.8	94.6	95.6	98.7	98.0	97.6
Year-end installed capacity	Total (kW)	4,563,084	6,636,496	5,496,724	5,115,144	7,000,075	6,063,075	5,531,768	7,266,322	7,467,178
	Hydro (kW)	4,240,501	5,746,442	4,501,787	4,788,187	6,024,290	4,894,135	5,195,278	6,411,890	6,090,234
Newly installed capacity in the year	Total (kW)	449,365	537,935	475,624	468,657	568,593	576,661	641,921	361,705	614,286
	Hydro (kW)	408,355	476,495	392,213	465,957	422,289	437,214	641,921	347,368	556,670
Installed capacity under construction	Total (kW)	990,915	985,353	1,110,682	817,820	910,511	1,047,173	863,830	1,092,970	1,235,950
	Hydro (kW)	990,915	940,353	1,030,482	817,820	818,151	984,973	863,830	1,056,970	1,235,950
Accumulated investment (10^3 Yuan)		15,104,650	22,931,450	14,556,380	18,648,460	25,877,980	21,200,140	22,424,820	31,426,610	33,005,390

Cont'd

Item		Year 1998			Year 1999			Year 2000		
		The first batch	The second batch	The third batch	The first batch	The second batch	The third batch	The first batch	The second batch	The third batch
Investment of the current year (10^3 Yuan)	Total	2,933,470	3,446,150	4,434,200	3,219,510	3,125,200	5,237,010	4,741,040	5,448,010	8,965,930
	From central government	27,940	36,710	271,800	42,800	188,530	402,130	351,150	503,680	784,650
	From local	337,200	238,720	482,350	314,580	337,270	603,770	651,680	941,940	1,196,990
	Domestic loan	1,310,800	1,414,140	1,838,510	1,399,450	1,421,490	2,159,950	2,737,090	2,452,250	3,936,450
	County Financing	1,257,530	1,756,580	1,841,540	1,462,680	1,177,910	2,071,160	1,001,120	1,550,140	3,047,840
Total reservoir capacity (10^6m^3)		37,506	65,123	43,843	21,194	90,645	61,069	30,238	81,101	62,931
Annual generation (MWh)	Total	15,435,260	21,915,140	17,865,040	16,248,030	21,818,030	19,300,570	18,682,780	24,163,450	25,403,600
	Hydro	14,756,350	19,252,940	14,530,690	15,501,710	19,419,670	15,291,670	17,734,020	21,677,180	20,358,490
Yearly power consu-mption	Total (MWh)	14,293,510	24,384,550	24,856,610	15,872,320	25,798,140	27,717,610	17,040,090	28,899,950	37,231,880
	Per capita power consumption (kWh)	428	332	213	474	341	236	513	389	298
	Domestic consumption (MWh)	2,942,870	6,252,060	6,946,260	3,177,010	6,444,630	7,848,570	3,353,090	7,170,490	10,465,680
	Domestic consumption per household (kWh)	332	321	234	353	328	260	370	356	298
	Electricity consumed by industry (MWh)	8,913,580	13,863,620	12,393,890	9,933,660	14,842,290	13,693,150	10,947,090	16,903,160	19,575,270
	Consumed by agriculture (MWh)	1,381,880	2,394,570	3,231,610	1,392,160	2,588,480	3,755,330	1,538,600	2,778,520	4,504,740
	Drainage & irrigation (MWh)	295,930	583,900	843,440	297,860	69728	897,890	299,850	671,680	1,021,920
	Others (MWh)	1,001,180	1,874,300	2,284,850	1,369,490	1,922,740	2,420,560	1,201,330	2,047,780	2,686,190

Discussion on SHP cascade development in small river basin

Liu weidong

I. General description

Following the startup of an ecological protection project of "substituting SHP (small hydropower) for fuel", a new round of SHP construction is going to reach its climax. China has numerous rivers, and statistics shows there are more than 50,000 each with a drainage area of over 100km^2, among them only 1,580 rivers each more than 1,000km^2. There are abundant SHP resources in those uncountable small basins each with drainage area of less than 500km^2. In China, the exploitable SHP is nearly 87, 000MW, and until now only 1/3 developed. In small basins, cascade development becomes one of the main approaches for hydropower exploitation. Rivers in most part of China are mainly fed with rainwater, and river flows fluctuate along with rainfall volume. The distribution of river flow depends in a great extent on that of precipitation. For small basins, due to short converging time, rivers rise and fall rapidly with the precipitation, which causes relative small river flow ordinarily. The annual flow of the river varies remarkably and there is a great disparity between rainy and dry seasons. The variations among years are also considerable.

II. Advantages of cascade development

At present, hydropower in most small river basins is developed through scattered approaches without overall planning, in which, more attention is usually paid to the current benefit only, and is apt to waste hydropower resources. However, the cascade development is oriented on the integral benefit of the whole basin, and fully utilizes the limited hydropower resources in this basin to create greatest economic & social benefits. Xiaojinhe cascade project in Guangdong Province is a successful case among the earlier hydropower development in small basins. Xiaojinhe is a tributary of Dongjiang River, with a drainage area of 33km^2, and is developed into 7 cascades with a total installed capacity of 9, 750kW and an annual mean generation of 41 million kWh. There are totally 7 reservoirs on the main stream and its tributaries, with a total storage of 10 million m^3. This cascade development has the following advantages:

◎ Thanks to a comprehensive planning and arrangement, hydro potential there is fully utilized, which favors a rational layout of the project and reduction of the engineering cost.

◎ The cascade development can be carried out successively. The scale of each station is small, and its cost relatively low, which is conducive to attracting investments from medium & small enterprises, and to the fund mobilization as well.

◎ Owing to the small size of project structure, the geological requirement is not so strict, which would ease the site selection.

◎ It benefits to unify the management of stations, centralize their maintenances and overhaul all stations for reducing the operation and maintenance expenses.

◎ Construction of the project caused less ecological disruption to the basin, which could easily be restored. It used less land, which minimized the difficulty of policy treatment and its corresponding expenses.

III. Cascade planning

1)Principle

Planning for hydropower cascade development in small basin shall be unified and accorded with the planning requirement of the main stream to which the small basin belongs. In drafting a cascade development scheme, consideration should be paid to the development of the hydro potential of the whole basin. The location of each hydropower station should be decided in line with the geological and topographical conditions, inundation loss, immigration and transportation, to ensure a maximum firm power, power production and benefit of comprehensive utilization with a minimum investment.

2) Runoff calculation

Since there is commonly lack in a long series of hydrological data at station site, runoff modulus was usually adopted to estimate the generation volume in the past. This kind of method often leads to a relatively big error in calculating generation volume for a hydropower station with regulation function, so that the production capability of the station cannot be accurately reflected. In China, hydrological gauging stations have been set up sequentially on medium & small rivers since 1960s, and presently over 20 years' data on flow and precipitation have been collected. In calculation of design annual runoff, the runoff data from the reference gage stations in adjacent basins can be applied, and then using the regional synthesis method, the runoff flow can be calculated according to the regional distribution rule of the runoff data and its correlation.

The distribution of runoff flow in a year can be determined by typical-year method. The daily runoff data of typical years at the reference gage station can be used to calculate the average daily flow of design typical wet, mean and dry years for the designed station site. Usually the year with a frequency of 10%-20% in the annual runoff series is selected as the wet year, that of a frequency 50% as the mean-water year and that with a frequency 90%-80% as the dry year.

3) The "dragon head" hydropower station

Among cascade hydropower stations, one with a relative large reservoir at top upstream is called a "dragon head" station, which is usually of monthly or quarterly regulated. This "dragon head" station not only utilizes water head at its own stage, but also makes full use of the hydro potential by increasing the generation volume through regulating the flow to all the downstream stations. Due to storage and regulation of the reservoir, the ratio of water utilization is increased, and in the mean time, the quality of electric energy can also be improved. For those provinces where the electricity tariff is different for peak-hour & off-peak-hour, the increase of average electricity price selling to the grid can be achieved by more peak and less off-peak generations. Taking Fengling stream in Zhejiang province for instance, its drainage area covers 95km^2, all cascade stations share a head of 210m and a "dragon head" station using 19.6km^2 drainage area, with a reservoir of normal volume of 1,780,000m^3 is constructed. Another example called Xilugang River project, in which the drainage area amounts to 138km^2, totally the used head is 183m for cascade development, and a "dragon head" reservoir is built with a normal storage of 1,960,000m^3.

To select the normal water level of a "dragon head" station, consideration should be given to the energy benefit from compensating regulation of the cascades, which shall be determined by means of technical & economic comparisons. A "dragon head" station generally adopts dam type or mixed type. In site selection, those sites capable of building a large reservoir should preferably be adopted. Wherever communications condition allows, priority should be given to develop the "dragon head" station.

4) Linkup between water levels

In the cascade planning, the tail water level of upper cascade is usually linked up with the normal water level of the lower cascade to fully use the head of river course. Should there be any large area of arable land, residential community, culture relic or historic site at the linkup, a part of head drop utilization can also be given up after verification.

IV. Conclusions

1) Development cost

According to funding available, all cascades can either be exploited in a lump or by rolling development. As the investment for each cascade is relatively small, it is especially suitable for medium & small enterprises to manage by a shareholding company, so that the fund shortage for SHP development can be alleviated. The idea of SHP development is also changing, from an aim of simply meeting the power demand to a sustainable development mode of assets management. According to statistics, in recent years the average capital cost per kW for a single station is about RMB5,500-8,000yuan (US$670-970), but in a cascade mode, the total construction cost can be reduced by 5% and even more. This would bring about more economic return to investors, stimulate their enthusiasms and promote the local economic development as well.

2) Rational utilization

Through SHP development, backward economy in hilly areas can be improved and rural energy be restructured, and furthermore, achievements of the "grain for green" campaign can be solidified to prevent soil & water erosion and protect ecological environment. However, we have also seen the destruction of ecological environment arising from project construction quite often. The irrational development of hydropower in small basins would be easily result in the flow cut-off in a partial river section with a phenomenon of "blank shoal". Therefore, necessary down flow discharge should be reserved during the cascade development of small basins, in order to maintain an ecological balance of the river course. Certain amount of power may be sacrificed rather than a flow cut-off in the river.

Though the exploitable SHP potential is large in China, but hydro resources can be easily wasted in any blind development, which would cause project sites deficient. The cascade development is an effective way, in which hydro potential can be fully used, total cost can be deduced and resources allocation optimized as well, so much importance should be attached to this. ■

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Treatments on the Abnormalities following Capacity Expansion

Liang Sun

After capacity expansion of some hydro turbines, such abnormalities as high temperature of the bearing, vibration of units, friction noise and so on, could be solved by qualified installation, removing the diversion cross added at the draft tube, and use of new runner, etc.

Summary

Capacity expansion of hydro turbine is an effective and profitable way to explore hydro potential. In the past few years, rich experience has been accumulated in refurbishing the turbines by much practice. A power station in a forestry farm, however, when we refurbished two different turbines with the same drawing, one hydro turbine appeared with higher bearing temperature, vibration, friction noise, while the other operated regularly as expected.

Survey

Basic data

The front and rear head covers, guide blades and runners of two HL110-WJ-42 turbines, built in early 1980s, were replaced. The tail diverting cross in draft tube was mounted according to request. Turbine A was installed under the guidance of Luoding Turbine Plant whereas Turbine B by plant's workers independently.

On-site testing

Turbine A operated well after refurbishing with pressure 6.1kg/cm2, maximum output 285kW which was only 220kW previously. Turbine B's pressure was 5.8kg/c m2 and maximum output was 265kW (previously 210kW). But when turbine B's output reached 160kW, the turbine started vibration. The larger output it became, the more vibration the turbine had, so that observers could hear friction noise from the machine clearly. Eventually observers could feel the strong vibration even from 3 m away and have an eye view of main axis in oscillation back and forth. And bearing 's temperature reached 56℃ and tended to increase, after just half an hour since the operation had started.

Check out the hydraulic turbine B

Dismounting Turbine B and checking it out, observers gained findings as follows:

(1) Loosening of the runner cone.
(2) Uneven clearance between runner and runner chamber, the runner mounted deviated, with bright spots in the inner side of runner chamber. Spoiled spots appeared at runner crown and runner band as well as inner side of runner band.
(3) Bright spots on end face of guide vane.
(4) Bright spots on inner hole and end surface of sealing ring of face head cover.
(5) Asymmetric guide vane opening with max.deviation of 5mm.
(6) A clearance of 1.2 mm between thrust bearing liner and thrust plate (too wide).
(7) 17 runner blades (the previous number was 16).

Analysis and Settlement

According to observed results and relevant experience, we concluded following main factors leading to the bearing temperature increase, abnormal sound and vibration:

(1) Inappropriate installation including eccentric runner, improper-placed runner axis and uneveness opening of guide blades.
(2) More than enough clearance between thrust tile and thrust panel, caused by excessive use of turbines.
(3) Unsuitable design factors including adding diverting cross at the draft tube and change of runner blade numbers.

Measure 1:

(1) Mount a shim and keep the clearance between thrust tile and thrust panel to 0.25mm to 0.55mm as standard.
(2) Refine axial bush to 3 or 4 contact points/cm^2.
(3) Rectify front head cover by adding a shim.
(4) Regulate guide vane opening.
(5) Adjust the main axis to make clearance between runner and runner chamber even.

Measure 2:

Remove the diverting cross at the draft tube. The cross which could decrease output swing and damp pulsation was installed as requested

Table 1: Results comparison before and after the measures taken

	Before Adjustment	After Adjustment
Bearing's temperature	64℃	58℃
Noise	Vibration noise, intermittent friction and clash noise	Vibration noise, no friction and clash noise
Vibration	Vibration starts at 160kW and increases with load increment	Vibration starts at 200kW and increases with load increment

by the client. However, there's no such design in this type of turbine. After removed of the cross, the user was effective that vibration obviously became slighter and the maximum output reached 265 kW. In spite of this, slight vibration still badly impact turbine's operation that runner cone became loose after one hour's operation. Further measure seemed necessary.

Measure 3:

Considering similarities between Turbine A and B and after adopting the second measure, we exchanged two machine's runner. The result was that turbine A operated normally, but turbine B operated with vibration. Then we tried to run Turbine B with previous runner (with16 blades), which resulted in no vibration but with lower output (220kW). The whole things came to obvious that with specialized hydraulic head, the vortex alternation, caused by rotational flow which streamed from outlet side when guide blades reached certain opening, came into regular frequency of lateral alternating stress on blades as well as periodic vibration involved with blades' boundary ply and velocity of flow. The same frequency of periodic vibration and guide blade's vibration led to the resonance. That was what we called Karman Vortex Street. As the old runner of 16 blades could hardly reach the aim of capacity expansion, we redesigned and selected after comparison HL120 runner blade type as the new runner. Turbine vibration, then in the test operation with new runner, disappeared and bearing temperature had fallen to 51℃. It was important that the maximal output mounted to 280kW, an increase by 33%. The client was quite satisfied.

Conclusion

From above efforts and experience, we may conclude that:

(1) The runner is the linchpin in capacity expansion.

(2) Another main cause to abnormalities may be inappropriate installation.

(3) Adding diversion cross at the draft tube without the design may lead just the opposite to what one wishes. ■

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Briefings

China's power sector growth rates 1998-2004

Indicator	1998	1999	2000	2001	2002	2003	2004*
Consumption(% y/y)	2.7	5.9	9.5	8.2	10.4	15.4	12.0
Generation(% y/y)	2.0	6.5	10.9	8.8	10.5	15.3	15.7**
Installed capacity(% y/y)	9.0	7.9	7.0	6.0	4.6	7.8	9.0
GDP(% y/y)	7.8	7.1	8.0	7.5	8.5	9.1	8.7
Power sector investment/ total infra. invest.(% share)	10.4	10.4	7.22	6.94	7.17	n/a	n/a

* forecast except generation ** Jan-Mar 2004 actual

Peak power by regional network for 21 months, April 2002-December 2003

Network	Provinces	*Trend(GW)	% change in period	Min-Max in period (GW)	% gain
Dongbei	Heiliongjiang Jinlin, Liaoning	20-12.5	7.5	20-27	35.0
Huabei	Nei Mongol, Shanxi Hebei, Beijing	32-35	9.4	32-40	25.0
Shandong	Shandong	13.5-14.8	9.6	13.5-17.6	30.4
Sichuan	Sichuan	6.7-7.8	16.4	6.7-10.5	56.7
Nanfang	Yunnan, Guizhou Guangxi, Guandong	29-34	17.2	29-40	37.9
Xibei	Qinghai, Gansu, Shanxi, Ningxia	11-13	18.2	11-16	45.5
Huazhong	Henan, Hubei, Huanan, Jiangxi	22-26	18.2	22-35	59.1
Fujian	Fujian	6.5-8.0	23.1	6.5-9.2	41.5
Huadong	Jiangsu, Shanghai Zhejiang	38-48	26.3	38-57	50.0
Chongqing	Chongqing	2.2-3.0	36.4	2.2-4.4	100.0

* Not shown:Xingjiang, Tibet, Anhui, Tianjin, Hongkong.

(Source:Power Engineering International)

Small Hydropower in Southeast Asia

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Introduction

SHP has been applied in Southeast Asia (SEA) for three decades now. There is a number of existing SHP installations, both of mini and micro scale. However, comparing the current installed capacity to the potential capacity, SEA has yet to fully reap the benefits of SHP.

Hydro Resources in SEA

Countries of mainland SEA have high hydropower potential for they are drained by five major river systems: the Irrawady, Salween, Chao Phraya, Mekong, and Red River. Except for Vietnam, countries of mainland SEA only have aggregate estimates of hydropower potential—potential undivided among the different scales of hydro technology. Thailand has an estimated theoretical potential of 1,770 TWh/ year of hydropower. Cambodia's hydropower potential, although under evaluation, is estimated at 83,000 GWh/ year. Laos has a theoretical hydroelectric potential of about 26,500 MW excluding mainstream Mekong. Of this, about 18,000 MW is technically exploitable, with 12,500 MW found in the major Mekong subbasins and the remainder in minor Mekong or non-Mekong basins. Myanmar has a technically feasible hydropower potential of 37,000 MW, the largest in SEA. Meanwhile, Vietnam, which has more than 2,200 rivers with lengths of more than 10 km, has an estimated SHP potential between 1,500 and 2,000 MW—7% to 10% of the total economic hydropower potential.

Though separated by seas and not having common major river systems, the countries of insular SEA—Indonesia, Malaysia and Philippines—also have high potential for hydropower. Indonesia has a total hydropower potential of approximately 75 GW from 1,315 possible locations of different sizes and utilization schemes. Of this potential, around 50% could be exploited by large-scale hydro, and 493 MW by micro-hydro. To date, the country has installed a total of 21 MW of micro-hydro capacity, which represent only 4% of the total micro-hydro power potential. On the other hand, the Philippines, which has 421 principal rivers with watershed areas ranging from 40 to 25,000 sq km, has a minihydro potential of 1,286.776 MW, according to the Philippine Department of Energy estimates. So far, only 89.07 MW has been exploited. Malaysia's technically feasible potential of hydropower is around 123,000 GWh/ year; however, small hydro potential is very low.

Status of SHP in SEA

Indonesia has a number of SHP installations and more are being planned. The micro-hydro project of the Government of Indonesia (GOI) and the GTZ developed standardized hydro and electricity schemes with nominal capacities of 10-100 kW and installed 28 micro-hydro power plants between 1992-1999. Plans to continue the project will focus on implementing standardized technologies for off-grid decentralized village hydro schemes with nominal capacities less than 100 kW and replacing diesel by installing on-grid schemes with nominal capacities greater than 25 kW. The PLN (electric utility of Indonesia), under the East Indonesia Renewable Energy Development (EIRED) Program, identified SHP plants at 15 sites in Sulawesi, Papua Barat (former Irian Jaya), and Flores with a total capacity of around 25 MW.

Currently, the Philippines has 68 micro-hydro systems, generating an aggregate capacity of 233 kW and benefiting some 6,000 households. The Philippines has 51 existing minihydropower facilities with a total installed capacity of 82.07 MW. These mini-hydro plants contribute around 200 GWh or 0.34 million barrels of fuel oil equivalent (BFOE) every year. The total installed capacity of mini-hydro will increase to 89.07 MW as a 7-MW plant in Bukidnon nears completion. By 2009, aggregate mini-hydropower capacity will reach 151.29 MW with the development of additional 12 mini-hydropower sites.

In Thailand, the Department of Alternative Energy Development and Efficiency (DEDE), formerly known as the Department of Energy Development and Promotion (DEDP), and the Provincial Electricity Authority (PEA) are some of the institutions involved with mini and micro-hydro. The DEDP installed 23 mini hydropower plants with capacities ranging from 200 kW to 6 MW for a total of 128 MW. Aside from mini hydro, the DEDP has also built many village-level micro-hydro power plants. Meanwhile, the PEA operates three small hydro generation stations with a total capacity of 3.8 MW. It plans to implement five more small hydro generation stations to increase the total capacity of its small hydro to 18 MW.

Among the countries of SEA, Vietnam is the most active in hydro technology. In 1998, around 500 small hydropower plants were constructed with a total capacity of 75 MW. Aside from having many installations, Vietnam also manufactures mini and microhydro components. Locally manufactured components include various types of turbines—Francis, Kaplan, Pelton, Crossflow, and Propeller type—and associated equipment for installations of up to 2.1 MW. Two mini-hydro installations programs are currently on going. The first program concentrates on the China-Vietnam border region, while the second focuses on the Central Highland provinces that border Laos and Cambodia.

Barriers to SHP

Some major issues hampering the commercialization of SHP in SEA include high investment cost, lack of knowledge in SHP development, lack of government policies, socio-economic concerns, environmental concerns.

The high initial capital cost of SHP schemes acts as a major impediment to SHP development in SEA where funding problems are most acute. The issue of distance between the hydro energy resource and the load centers, as in the case of Thailand and the Philippines, poses difficulties for SHP development. Project costing varies with the site, the size and the type of application. The specific investment cost per kW of SHP project also varies greatly from country to country, ragning from US$600/kW to US$4,000-6,000/kW. Further, the preinvestment work—site survey and feasibility study—is higher for SHP in percentage of the ultimate investment than large hydro. Usually, the cost of pre-investment work for SHP could be higher than the acceptable 10-15% of total investment, even if they are supported by government or foreign aid.

Attention has been paid to the training and technology transfer in some SEA countries during the last two decades, which enables them to master a great portion of work in SHP development. Although several countries have set up their own capabilities in SHP development, including pre-investment studies, engineering design, construction and operation, some other countries need to rely to a great extent on technical support from abroad. This fact, added to the costs of importing foreign expertise, materials and equipment, even if subsidized, has greatly impeded the faster development and more widespread introduction of SHP projects.

As these SHP are commonly produced for consumptive (i.e., residential) use, financial resources for the necessary O&M are frequently insufficient to warrant sustained operation. It is common that the existing SHP plants would be dismissed and replaced by the grid once the grid is extended to the area (e. g., Vietnam). Also, the economic feasibility of many SHP projects is not clear especially if and when compared with large-scale hydro and thermal power generation.

The socio-economic merits of electricity and of local resources exploitations are well established, but their quantification is still in infancy. In consequence, they do not usually enter into the evaluation of economic merits and projects, which could bring considerable advantages to the local population, and are in danger of being discarded by conventional economic analysis.

In some SEA countries, hydro developments are located in mountainous areas, commonly on land belonging to cultural minorities. In such cases the right of way to a project site, or the actual acquisition of ancestral lands may be problematic. Furthermore, there could be objections to water diversion if there are larger water users downstream for irrigation or drinking water supply.

In addition, there could be some environmental concerns although the environmental impact of run-of-river type developments is usually quite limited.

Policy Instruments Supporting SHP

In SEA, there exist policies supporting the use of SHP. Though more policies still need to be developed, existing policies signify the interest of SEA in SHP. In Indonesia, the decree on Small Power Purchase Tariffs (SPPT) opens the energy generation market to private entrepreneurs and cooperatives. The decree aims to regulate the selling of privately produced electricity to PLN, with one of its priorities being the electricity production from non-conventional energy sources (NRES) such as wind, solar and mini-hydro. PLN, according to the small power project agreement (SPPA) and the SPPT, will purchase NRES-based electricity generated and fed into the PLN grid by private companies. All SPPAs are long-term agreements with PLN to safeguard the interest of the private investor.

Meanwhile, the Philippine Department of Energy’s Renewable Energy Power Program (REPP) allocates US$30 million as a financial facility for private sector participation in NRE projects with capacities ranging from 200 kW to 25 MW. Project proponents are free to negotiate the financial terms with the conduit bank but the proposed interest rate, 12% for the funding source plus a 4-6% spread for the conduit, seems unattractive. To stimulate mini-hydro development, the Philippine government enacted Republic Act 7156, or the Mini-hydro Law. The law stipulates special incentives and privileges, such as tax and duty-free imports, lower sales tax, 10% VAT exemption, and seven-year income tax holiday.

To initiate private participation in power sector development and to promote the use of indigenous by-product energy sources and renewable energies for electricity generation, Thailand introduced the Small Power Producer (SPP) scheme in March 1992. At the end of 1996, there were 17 SPP contracts, three firm and 14 non-firm, with a total installed capacity of 910 MW; about 370 MW were sold to the national grid. The Thai government has embarked on a comprehensive Energy Conservation (ENCON) Program, adopting the Energy Conservation and Promotion Act of 1992. As one of its main objectives, the ENCON Program aims to promote the development and use of renewable energy sources, through Voluntary Programs. The program offers two types of financial support: support for the project implementing organization for the operational cost for management, administration incentives to individuals.

The energy master plan of Vietnam recommends the establishment of a Small Hydropower Development Authority (SHPDA). Since investments in the sector have been stagnant for years, the objective of the SHPDA would be to stimulate small hydro development by building local capacity to prepare a “bankable” pipeline of isolated and grid-connected small hydro projects that could lead to investments in this least cost remote power source on the order of US$20 million over a five-year period.

■

Mini and Small Hydropower in Europe

—Development and Market Potential

by Joachim Leckscheidt and Tjarinto S. Tjaroko
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For centuries, Small Hydro Power (SHP) has been an important source of energy in all European countries possessing water potentials. With the invention of more sophisticated turbines in the twentieth century, mini and small hydro plants were used for electricity generation and became the main source of electric energy. Townships in the mountains harnessed water resources to generate electricity. Water powered mills or factories were fitted with turbines and generators and the electric power was used for productive end use.

The Decline of SHP Development

This development continued till about 1950/1960, when the national grid was extended and reached the so far isolated SHP plants. In many cases grid supply turned only to be cheaper than operation, repair and maintenance of the SHP. In addition, stringent water management regulations and safety provisions for civil and electrical installations contributed to the early closure of many minihydro plants which, from a technical point, were still perfectly operational. In many areas the utility companies managed to enforce closure even when the supply from the grid was more costly for the user than from his minihydro plant. If production and feed-in was tolerated at all, prices paid by the utilities were so low that only the existing plants remained economical and this only, as long as no major repairs became necessary.

This situation was prevailing in most countries even after the 1974 oil shock. One would have expected that the oil crisis as well as protests against nuclear power would have opened the market for small and mini hydro. But it took more than twenty years of development and lobbying to bring about legislation and tariffs in favor or MHP.

New Momentum by the European Union

In 1997 the European Union issued the White Paper on Renewable Sources of Energy (26/11/97) outlining the future of Renewable Energy in the European Union. It covers competitiveness, environmental protection, security of supply and the promotion of energy efficiency and renewables. The paper defines a strategy and an action plan to promote renewable energy sources (RES). The target is a 12% share in total energy supply by 2010, compared to an estimated 6% in 1996.

One important feature of the Action Plan was a thorough situation analysis for Small Hydro in Europe. This "Strategic Study for the Development of Small Hydro Power in the European Union" was prepared on behalf of the European Small Hydropower Association (ESHA) under the ALTENER II project of the European Union and published in 2001* . It contains a comprehensive survey of present small hydro production, analyses the constraints to further development and recommends action by European legislators and the industry.

Present situation of SHP in Europe

Hydropower (large and small) contributes 17%** to production of electrical energy in Europe, ranging from 99% in Norway, 76% in Switzerland, 65% in Austria, 51% in Sweden, down to 23% in France, 12% Czech Republic, 6% Poland, 4% Germany, 3% and less in the UK and some other countries.

Small hydropower accounts for approximately 7% of total hydro generation in Europe. The present capacity and production for 30 European countries are shown in Table 1. The total installed SHP capacity stands at 12.600 MW and production is estimated at 50.000 GWh. Leading countries are Italy, France, Germany, Spain, Sweden, Norway, Austria and Switzerland which combine 86% of SHP capacity and production.

The SHP production consists of around 17.500 individual power plants with an average capacity of 0,7 MW and a production of 2.9 GWh per year. Average capacity varies widely between countries, from over 4 MW per plant in Romania and Portugal, 2, 69 in Poland, 2,82 in Greece, 2,06 in Turkey, 1,72 in Norway, 1-1,5 MW for Italy, Spain, France, Finland and UK, down to the 200-300 kW range in countries like Germany, Czech Republic, Slovakia and Slovenia. The pattern reflects the water potentials of the respective countries as well as the age of the industry: countries which started early using SHP feature a larger degree of smaller or mini hydropower plants, whereas "newcomers" like Portugal, Greece or Tur-

* Source : esha@arcadis.be. The Survey covers over 90% of the SHP production in the EU and 13 other European countries including Norway, Switzerland, Czech Republic, Hungary, Poland, Turkey and others.

** for OECD Europe, Source: IEA

key started with plants of bigger capacity. Plants in the "traditional" SHP countries like Germany are the oldest with nearly 50% being over 60 years old. Portugal, Spain, UK, Greece and the Eastern European countries have the "youngest" installations with most plants counting less than 20 years.

Prices paid to SHP producers vary considerably among European countries with the lowest tariffs in Finland, Norway and Sweden (1,2 to 3 Eurocent/kWh) followed by a medium range of 4 to 6 Eurocent/kWh in UK, Ireland, Spain, Portugal up to tariffs which include a promotional element such as 9 Eurocent/kWh in Belgium and Switzerland, 90% of end user tariff in Greece or 65%-80% in Germany.

In the future, SHP production will also benefit from carbon money under the so-called Joint Implementation mechanism. Projects located in countries where green house gas emission targets are met—first countries will probably be UK and Germany—can earn additional revenue for the emission reduction being achieved. Emission reductions can be credited for a period of five years if they are certified to fulfill the criteria of "environmental additionality". First transactions are reported by Eco Securities of UK, e.g., a forward contract for 6,1 million CO_2 in 2008-2012 worth 3 million Euro resulting from a 55-MW hydro plant in Romania, or a purchase of the environmental benefits of a 8,2-MW run-of-the-river plant in Guatemala for a ten-year period.

In most European countries the economically feasible hydro potential has been harnessed to a great extent (see Table 2). From the still untapped potential the SHP plants have a better chance for realization than large hydro with reservoirs, which face severe opposition due to their considerable environmental impact.

Table 1: Installed capacity and production of SHP plants (up to 10 MW) in 30 European countries

Country	MW	GWh	Number	MW/Plant
EU Countries	**1.863**	**35.833**	**13.359**	**0,76**
Austria	848	4.246	1.110	0,76
Belgium	95	385	39	2,44
Denmark	11	30	38	0,29
Finland	320	1.280	225	1,42
France	1.977	7.100	1.700	1,16
Germany	1.502	6.253	5.625	0,27
Greece	48	160	17	2,82
Ireland	32	120	44	0,72
Italy	2.209	8.320	1.668	1,32
Luxemburg	39	195	29	1,34
Netherlands	30	60	7	4,28
Portugal	280	1.100	60	4,67
Spain	1.548	5.390	1.056	1,47
Sweden	1.050	4.600	1.615	0,65
UK	160	840	126	1,26
Non-EU Countries	**2.468**	**10.556**	**4.104**	**0,62**
Croatia	30	120	13	0,23
Czech Republic	250	677	1.136	0,22
Norway	941	4.305	547	1,72
Poland	127	705	472	2,69
Romania	44	176	9	4,89
Slovakia	31	175	180	0,17
Slovenia	77	270	413	0,19
Switzerland	757	3.300	1.109	0,68
Turkey	138	500	67	2,06
6 other non EU	73	328	158	0,46
Grand total - 30	**12.617**	**50.635**	**17.463**	**0,72**

Source: ESHA Study and ACE computations; GWh for Croatia and Romania estimated taking four (4) GWh per MW. Figures for Netherlands from Hydro Power and Dams World Atlas 2001.

Table 2: Estimated Hydropower Potential and Exploitation in Europe

Countries	Econ. Feasible Potential (GWh/a)	Prodn. from Hydro Plants (GWh/a)	Exploitation Ratio (%)
15 EU Countries of which	390.000	320.000	82
Austria	50.000	38.000	76
France	72.000	70.000	97
Germany	25.000	25.000	100
Italy	55.000	52.000	95
Spain	40.000	35.000	88
Sweden	85.000	68.000	80
Selected non-EU Countries of which	480.000	250.000	52
Norway	180.000	120.000	67
Romania	30.000	16.000	53
Switzerland	36.000	34.000	94
Turkey	120.000	40.000	33

Source: IEA, Eurostat, Hydropower & Dams and own interpolation/computations

Yet even the small and mini hydro run-of-the-river plants meet various obstacles. Although feed-in regulations are now in place in almost all European countries, the licensing and contract procedures are cumbersome and time consuming. Opposition from environmental groups, often based more on emotion than rational arguments, has to be countered. Requirements for minimum water of the original river or stream limit the exploitable flow. Demands for the installation of fish ladders or changes in civil structures in line with the natural environment can drive up civil engineering costs to levels where the investment is not any more economical.

The ESHA study estimates, that from a purely technical viewpoint, additional 2100 MW of SHP could be made available by upgrading the existing plants and restarting abandoned ones. Environmental concerns, however, would reduce this volume to around 1.100 MW. The potential for new SHP is estimated to be theoretically, i.e. without any constraints, more than 14.000 MW, mainly for the large unexploited capacities in Norway and Switzerland. Taking in account environmental and economic constraints the study assumes a potential of 6.700 MW still to be exploited. Both potentials combined add up to 7.800 MW which is 62% of present installed SHP capacity. Consequently, despite the high exploitation ratio in Europe there is still ample room for further development.

SHP Industry and Technologies

Different from other RES technologies, the SHP industry has been slow in exploiting the opportunities offered by the deregulation of the energy markets and the trend toward clean energy. A considerable number of small-scale SHP manufacturers closed down and some leading turbine manufacturers discontinued their SHP production lines. The SHP industry is estimated to about 60-70 turbine manufacturers employing around 8000 people. In addition the installation of SHP plants provides work for consultants and contractors in the water engineering and electric power fields. The job creation in these fields exceeds the employment in the turbine manufacturing industry.

Investment costs differ from country to country, which reflects not only t he wage level and construction cost, but also the sophistication of SHP plants. Switzerland and Germany report the highest costs namely 4.000-10.000 and 4.000-6.000 Euro/ kW, respectively. At the lower end of the scale are Poland with 500–1.200, Spain and Norway with 1.000-1.500 and Greece, Slovakia and Slovenia with 1.000–2.000 Euro/kW. The average of 2.000-2.500 Euro/kW applies to 14 other countries which reported their SHP investment costs in the ESHA survey.

SHP is a proven technology which has reached a high degree of efficiency and reliability. However, the industry has developed a number of new technologies to further improve efficiency and operation. Some recent technical innovations include new designs and the use of new composite materials for low-head turbines, high speed generators and variable speed operation, submersible technologies, new types of computer-based digital controllers for remote diagnostic and automatic monitoring, and web cameras to allow regular checks on remote-control basis.

Market Prospects

Europe is a market leader in SHP technology. Optimal turbine designs are available and new technical developments offer automated operation of SHP. Production costs for SHP equipment have been lowered considerably and standardization will allow European manufacturers to reduce the present price level even further. Therefore, from the technical side, there should be no obstacles for increasing SHP production and meeting the 2010 target of the EU White Paper.

The EU White Paper estimates the investment for implementing its strategy to 950.000 million Euro, a great part of which would have to be for SHP development. Taking the figure of 7.800 MW for the SHP market potential—which might be on the low side— and an average investment of 2.000 Euro per installed kW, a market volume of minimum 15.000 million Euro can be estimated.

Additional markets can be tapped in Asia, South America and Africa. Table 3 shows a relatively high hydro exploitation ratio for Europe. However, it is obvious that the Asian market offers a fantastic market potential. In contrast to Africa and South America, Asia is a vibrant market where investment capital can be raised and capable joint-venture partners are found. In India, the Ministry of Non-Conventional Energy Sources would be a good address to identify interested partners. For the 10 ASEAN countries, the ASEAN Centre for Energy (ACE) in Jakarta will establish contracts with suitable companies or institutions in any of the 10 ASEAN member countries. For China, the H a n g z h o u Regional Centre for Small Hydro Power could be approached as an entry point. ■

Table 3: Economic Hydropower Potential by Continent and % Exploitation

Region	Economic Hydro Potential	% Exploitation
Africa	12%	8
Asia	45%	25
Europe	10%	75
North & Central America	13%	75
South America	20%	30

Brazilian Proinfa small hydro prices announced

ELECTROBRAS, BRAZIL'S STATE owned electricity utility, has published the power purchase price (PPP) for small hydro developers under its Proinfa programme.

The prices announced were considered low by investors, due to high financing costs. The government has set a price of US$40.10/MWh for small scale hydroelectric projects, while investors believe about US$42.84/MWh, would be reasonable.

Electrobras is still registering companies interested in developing renewable energy projects under the Proinfa initiative. Under the programme, Electrobrás will buy electricity produced from the different renewable resources under contracts of up to 20 years.

In April 2002, the Brazilian government passed Law 10.438, or Proinfa, which was designed to stimulate development of biomass cogeneration, wind power and small hydro by guaranteeing power sale contracts to the first 1100MW of projects under each renewable source. The companies included in the register will also be eligible to obtain financing for 70% of the projects from national development bank BNDES. ■

(Source: International Water Power and Dam Construction)

Watts up in China

CHINA PRODUCED 479.4 BkWh of electricity in the first quarter of 2004. Although this indicates a 15.7% increase in power production compared to the same period in 2003, most regions of the country, where the economy grew rapidly, still suffered from power shortages.

Of the total power generated, hydro facilities produced 45.6BkWh, up 2.2%, and thermo power plants generated 419.9BkWh, increasing by 17.3%, with the remaining 11.2BkWh contributed by nuclear power stations, up 15.4%.

Despite the 2.2% point increase in hydro power output, boosted by the launch of generating facilities at the Three Gorges project, production had fallen overall. The provinces of Yunnan, Guangxi, Fujian, Hunan and Guizhou, which usually rely on hydro, reported output declines of up to 70% between January and March. The shortfall in output was attributed to low rainfall in these areas.

Meanwhile, power consumption nationwide climbed by 16.6% compared to the same period in 2003, reaching 477.0BkWh. Due to power shortages, blackouts were seen in 23 provinces over the quarter. ■

(Source: International Water Power and Dam Construction)

Small hydro plan for Austrian weir

A US$17.9M SMALL HYDRO power plant is to be installed at the intake of the Vienna Danube canal in Nussdorf, Austria.

The scheme is to be built near Schemerl weir and will consist of a 30m long, 12m wide and 7m high overflow hollow body weir with attached pneumatically operated spillway gates. It will also feature twelve VA Tech Hydro Hydromatrix units and an operation building.

Work is to be carried out by VA Tech Hydro in consortium with its Austrian-based partners Porr Technobau and Verbundplan, the leader of the group, with commissioning of the plant expected in summer 2005. ■

(Source: International Water Power and Dam Construction)

Enel takes over five US plants

Enel North America, a division of Italian utility Enel, has announced the acquisition of five hydro power plants in the US.

In doing so, the company has taken control of some 27MW of hydro power generating capacity in North America.

The facilities are the Bypass, Hazelton A and Elk Creek hydro projects in Idaho and the Rock Creek and Montgomery Creek schemes in California. ■

(Source: International Water Power and Dam Construction)

HRC's Supervision & Consultation Co., Ltd. Won a Bidding

HRC's Supervision & Consultation Co. Ltd. participated in and finally succeeded in a bidding for supervising the reclamation project for Ding Mountain's second-phase engineering on March 31st 2004, with the total supervision fee 1,888,000 Yuan RMB. According to the plan, the major project should be launched in May 2004 and the whole project is to be completed before December 2006. ■

(Source: SHP NEWS Editorial office http://www.hrcshp.org)

SHP Periodical donated to the She Ethnic Minority County

In June 2004, over 1,300 pieces of **"Small Hydropower"** periodical to the value of more than RMB 10,000 yuan were given free by the SHP Editorial Office to the SHP Association in Jingning She Autonomous County, Zhejiang Province, China. The magazines are to be distributed to the owners of the 145 SHP stations in this county. On June 23, a letter of acknowledgement was not only sent to the SHP Editorial Office by the Jingning SHP Association, but also published in the local newspaper "She Town News" to show gratitude on behalf of all the SHP owners and professionals in the county.

Honoured with the title of "Town of Small Hydropower in China", Jingning is very rich in water resources. The theoretical SHP potential in this county is 666.2 MW, with 530.4 MW as economically exploitable, which accounting for 1/10 of the total in Zhejiang Province. The SHP development has been undertaken to the rivers or tributaries in all the 24 towns under the county. By the end of 2003, 111 SHP stations had been built, with the total installed capacity of more than 180 MW. There are 69 SHP projects still under construction or to be built.

As the unique SHP professional periodical in China, the **"Small Hydropower"** insists on all along the principle of "combining the social benefits with the economic benefits", and keeps to the right editorial tenet and orientation, therefore it enjoys good reputation in the field of medium and small sized hydropower nationwide. Since 1997, selected as one of the "scientific and technical magazines to be donated to the poor areas" by the Poverty-Alleviation Office of the State Department, volumes of the **"Small Hydropower"** periodical, amounting to 6,000 pieces, have been distributed free to 62 poor counties lacking of electricity (including the 10 counties in Tibet to be aided by the Ministry of Water Resource, which are with water resources but with no power).

The SHP Editorial Office further plans to donate, in near future, another amount of 600 **"Small Hydropower"** periodical to Taishun County, the only poor county in Zhejiang Province, which however, is abundant of water resources. ■

(Source: SHP NEWS Editorial office http://www.hrcshp.org)

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Pacific Hydro starts generating power at First Fiji Hydro unit

Pacific Hydro, an Australian hydropower and wind energy company, it started generating power at its first hydro-electric plant in Fiji as part of a venture to reduce the island's diesel imports.

The 6.5 MW Wainikasou power station is part of Pacific's plan to install as much as 100 megawatts of hydro and wind power generation capacity in Fiji in the next five years.

Pacific Hydro said in a statement to the Australian Stock Exchange. A second hydro plant is scheduled to start up at Vaturu in the fourth quarter, it said.

Melbourne-based Pacific Hydro, which is 15 percent owned by American Electric Power Co., formed a venture last May with the Fiji Electrical Authority to spend as much as A$100 million($69.6 million) on renewable energy projects. The first two plants cost A$16.5 million and the venture is also studying the feasibility of a 50 megawatt hydropower project on Fiji's main island of Vitu Levu, it said.

"The joint venture has secured a 15 year power purchase agreement with the Fiji Electrical Authority, which un-derpins the returns expected for our investment in overseas projects," Rob Grant, Pacific Hydro's general manager, business development and operations, said in the statement. ■

(Source: Asian Power)

Philippines' boost for small hydro

The Philippine Board of Investments (BoI) has lowered the minimum investment requirements for power projects utilising new and renewable energy (NRE) sources.

Projects using NRE sources that would be connected to main power grids should cost at least US$1.25M for wind power, US$200, 000 for hydro power, and US$1.8M for biomass.

The policy, which was recommended and approved by the Department of Energy, is aimed at encouraging the establishment of developmental power projects using NRE sources. ■

(Source: International Water Power and Dam Construction)

ANEEL authorizes new projects in Brazil

Agencia Nacional de Energia Eletrica(ANEEL) authorized Usina Eletrica do Prata Ltda. to build four small hydroelectric projects totaling 40.3 MW in the city of Juscimeira, located in Brazil's Mato Grosso State. ANEEL said the projects represent total investment of 65.2 million reais (US$22.6million).

Projects include:

- 10-MW Agua Branca, May 2006;
- 13-MW Agua Brava, August 2006;
- 4-MW Agua Clara, February 2007; and
- 13.3-MW Agua Prata, September 2006. ■

(Source: HRW)

Clean Energy cancels Universal licensing deal

Clean Energy Inc. of Canada canceled an October 2003 licensing agreement that would have allowed it to market and develop small hydro projects in Africa and Europe employing generating technology developed by Universal Electric Power Corp. of the United States.

Universal has focused on developing a siphon-type turbine-generator module that could be installed with limited operational or environmental effects and low cost at existing low-head dams.

Clean Energy cited Universal's failure to complete critical items in the agreement for the decision. ■

(Source: HRW)

Indian state encourages development of canal drops

The Haryana State Development Agency of Chandigarh, India, is recruiting developers to build, own, and operate four small hydro projects on canal drops.

The proposed projects are:

- 1.7-MW baliyala Fall at Fatehabad, 3.6 meters(m) head, 60 cubic meters per second (cms) flow;
- 125-kW Ditch Channel Cross Regulator at Yamuna Nagar, 6m head, 2.5 cms flow;
- 200-kW Jaidhari Distributory at Yamuna Nagar, 4.5m head, 3cms flow; and
- 800-kW Munak at Panipat, 2.2 m head, 45 cms flow. ■

(Source: HRW)

GE Energy to replace unit at Mexico's Botello plant

Contractor Cegelec SA de CV of Mexico awarded a US$2 million contract to GE Energy to replace one of two turbine-generators at the 8.1-MW Botello hydroelectric project, on the Angulo River in Michoacan State.

GE Energy will replace a 90-year-old 4-MW unit with a 9.22-MW horizontal Francis turbine. GE also is to provide a generator, governor, excitation system, valves, and auxiliary equipment for Botello, which is ownd by Mexican utility Comision Federal de Electricidad.

The equipment will be manufactured at GE facilities in Brazil. ■

(Source: HRW)

PLN eyes 72 new plants for next decade

INDONESIA'S STATE-OWNED electricity utility company Perusahaan Listrik Negara (PLN) proposes to build 72 new hydro power plants in the next ten years to forestall a shortage in the country's power supply.

The proposed power plants, with a total capacity of 7380MW, will be made up of 24 units in Sumatra, 15 in Sulawesi, 11 in Java-Madura, eight in Bali-Nusatenggara, seven in Kalimantan, five in Maluku and two in Papua. Three of the plants, totalling 261MW in generation capacity, are already in the final phase of preparation for construction. PLN currently has 41 units of hydro power plants in all with a generating capacity of 3266MW and producing 10,536GWh of electricity every year. ■

(Source: International Water Power and Dam Construction)

World Bank lends for private hydro in Turkey

The World Bank Board approved a US$202 million loan that is to stimulate development of privately owned hydro and wind generation in Turkey under the market-based framework of Turkey's 2001 electricity market law. The main component of the Renewable Energy Project is a Special Purpose Debt Facility to leverage equity investment from local private developers, export credit financing, and other forms of local debt financing to provide total investment of more than US$500 million in renewables generation. The World Bank noted Turkey's small hydropower potential is estimated at 14.1 terawatt-hours, little of which has been developed. The bank said preliminary studies of 26 basins identify 344 hydro sites of under 30 MW, totaling 3,400 MW. In addition, it said topographical analysis indicates there might be another 5,000 MW of small hydro potential. A World Bank project appraisal document lists 27 small hydro projects that might be eligible for assistance under the program in the short term of 2004-2005. ■

(Source: HRW)

Waterpower XIV abstracts requested

Abstracts of papers for the Waterpower XIV Conference are due September 1 to the conference organizer, HCI Publications.

Authors whose abstracts are accepted will be invited to submit papers for inclusion in the official publication on CD-ROM that will be distributed to all delegates at the conference, July 18-22, 2005, in Austin, Texas, U.S.A.

Authors are to be notified of acceptance October 4. The papers submittal deadline is February 14, 2005.

Preference will be given to papers of sufficient technical quality with non-commercial focus on innovative, practical, and proven technologies and methodologies. Abstracts of a maximum 400 words should be submitted.

To submit an abstract, download an Abstract Submittal form from Internet site www.hcipub.com/wp/papers. asp, or send an e-mail to techpapers@hcipub.com with “Waterpower XIV Abstract Submittal” in the subject line. HCI will send an abstract submittal form by return e-mail.

For information, contact (1) 816-931-1311; E-mail:techpapers@hcipub.com. ■

(Source: HRW)

Consortium to develop Nussdorf lock hydro

Verbund Austrian Hydro Power AG, EVN, and Wienstrom awarded a 15 million euro(US$19 million) contract to a consortium that will develop the 5-MW Kleinwasserkraftwerk Nussdorf small hydropower plant. The project will be built at the Nussdorflock on the Danube Canal in Vienn, Austria.

Verbundplan, VA Tech Hydro, and Porr Technobau are members of the winning consortium.

The plant will feature VA Tech’s Hydromatrix technology, which employs factory-assembled modules of small turbine-generators that are installed on existing dams.

Nussdorf will include a 30-meter-long, 12-meter-wide, 7-meter-tall overflow hollow body weir with pneumatically operated spillway gates, 12 Hydromatrix units, and an operating building. The project will use an unused discharge of the canal to generate electricity.

The Project is to go on line in mid-2005. ■

(Source: HRW)

Turnkey contractor chosen for India’s Sikasar project

Bharat Heavy Electricals Ltd. won a contract worth nearly 300 million rupees (US$6.6 million) for turnkey construction of the 7-MW Sikasar hydroelectric project.

Chhattisgarh State Electricity Board is building the project at Sikasar in the Raipur District. The project is to be completed in 2006. ■

(Source: HRW)

Italian utility names suppliers for three projects

Enelpower SpA awarded contracts for three hydro projects in Italy.

The electric utility awarded a 4.9 million euro (US$6.2 million) contract to Voith Riva Hydro SpA of Italy to supply a 10.6-MW vertical Francis turbine for the Chievo hydropower plant.

Additionally, Enel awarded a 2 million euro (US$2.6 million) contract to Andino Hydropower Engineering Sarl of France to supply two 6.8-MW vertical Francis turbines for the 13.6-MW Pescara project.

Enel also awarded Andino a 672, 261 euro (US$851,000) contract to supply a 9.4-MW horizontal Pelton turbine for the Campliccioli plant. ■

(Source: HRW)

Japan bank funds two India hydro projects

Officials of Japan Bank for International Cooperation(JBIC) signed loan agreements with Indian officials, providing funding for the construction of two major hydroelectric projects.

JBIC agreed to provide a total of 125.004 billion yen (US$1.18 billion) for eight projects intended to reduce poverty, support economic growth, and improve trade ties with India. Included is funding to build the 900-MW Purulia Pumped-Storage project and the 280-MW Dhauliganga hydro project.

Purulia is being developed by West Bengal State Electricity Board (WBSEB) and India’s National Hydroelectric Power Corp. in West Bengal State. Contractors include Mitsubishi Heavy Industries and Taisei Corp. of Japan, and Hindustan Construction Co.,Ltd. and L&T ECC Construction Group of India.

National Hydroelectric Power Corp. expects to complete Dhauliganga in 2005 on the Dhauliganga River in Uttaranchal State. Contractors include Alstom of France, Noell Stahl-und Maschinenbau GmbH of Germany, Tungabhadra Steel Production Ltd. and Hindustan Construction Co. of India, Daewoo Corp. and Samsung Corp. of South Korea, and Kajima Corp. of Japan. ■

(Source: HRW)

A Chinese Magazine
"Small Hydropower" by HRC

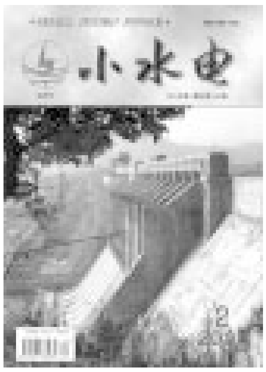
The Chinese "Small Hydropower", a magazine that National Research Institute for Rural Electrification (NRIRE) and Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power has edited and published for 117 issues (bi-monthly), was allocated with the International Standard Serial Number ISSN 1007-7642, and China Standard Serial Number CN33-1204/TV. It was published in Chinese attached with title of articles in English. Its 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 carries 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. ■

The main contents of issue No.116 (2004 No 2) read as follow.

Strategy and Policy
Pay great effort to do the pilot project well for actively pushing forward construction of the 'SHP replacing firewood' project
Rural Electrification
Implementing rural electrification and pushing forward the comprehensive development of society & economy in Chenzhou city
International Exchange
Country reports at The Third World Water Forum: India
Difference of technology in SHP equipment between Chinese and international sectors
Technology Exchange
The stability of small unit with high speed and high head
Grounding disturbance and restrain of the weak current system in generation stations and substations
Application of new type hydro-automatic flap gate in SHP stations
Preparation of minimum bid in the tendering document of hydropower project
Determination of the longer span of 10kV transmition line in mountatinous area in Mengla county
Planning and Design
What has been learned in the design of No.2 stage SHP station in Liubaizhang
Project Construction
Application of geomembrane for anti-seepage treatment in channels
Application of technology of mining dam material through chamber blasting
Control blasting of rock excavation at sensitive and dangerous zone
Computer Application
Introduction and application of 560PMC automatic supervisory control intelligence system
The computer-based supervisory control system at Feilaixia SHP station
Electrical and Mechanical Equipment
The selection of middle and small hydro turbine governor
Characteristic and application of SLT-type full digital microcomputer speed governor
Renovation
Renovation of gate locking device in ship lock in Jiangkou power station
Improvement and perfection of automatic control circuit
Service and Maintenance
Discussion on management of private hydropower station
Experience of safety operation in Erhezha SHP station
Treatment of over swing of hydro turbine-generator unit in Jinlan SHP station



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