Small Hydropower in Nigeria

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Ministry of Power & Steel

Nigeria

Nigeria is the most populaous black nation in the world. It has an area of 913,072 square kilometres. The country population is about 120 million. There are three major languages, Hausa, Yoruba and Igbo, although there is still more than 380 dialects in local languages. There are large number of household on the African continent that are unelectrified. In Nigeria about 70 million people remain literally in the dark without access to electricity. The majority of these numbers are in the rural areas.

This workshop is apt in a number of ways. It is a joint effort between government, private sector, the academic and other practitioners in small hydro power station, it is also a promotion of business and industrial activities as well as development of renewable energy resources. I wish to commend the organizers of this workshop. The focus of the workshop is relevant to the agenda of the Federal Ministry of Power and Steel and aspirations of the Federal Government of Nigeria to provide regular and steady electricity to majority of Nigerians before the end of year 2001.

Energy

The Federal Ministry of Power and Steel is responsible with all electricity related matter in Nigeria. Under the Ministry, National Electric Power Authority(NEPA), a state owned company is charge with the sole responsibility of generation, transmission and distribution of electricity. NEPA, currently has installed capacity of about 6,000MW, with only 2400MW available. Around 84% of Nigeria generating capacity is thermal (Gas turbine), with the remaining 16% hydroelectric and steam turbine respectively.

Recently government encouragement of independent power producer(IPP) has seen the private sector producing additional 90MW from installed capacity of 270MW and additional 30MW from Emergency Power Plant (EPP) at Abuja. This poor state of electricity has calls for a development of hydropower potential and utilizing the abundant gas in thermal, which are at feasibility study stage.

Electricity

The power sector in Nigeria had in the past witnessed considerable neglect despite its strategic importance to the nation. The present administration is addressing the problems of this sector by:

(a) short term programme to generate & deliver 4000MW by the end of the year 2001.
(b) a medium to long term programme for power sector reform and deregulation.

Short Term Measures

The present Government of Nigeria is committed to the immediate improvement of the power supply of the country.

Consequently, the government has embarked on the rehabilitation of the existing power stations and an emergency power programme so that by the end of the year 2001, 2672MW will be added. Thus by the end of 2001, 4000MW will be available at any one time.

Medium to Long Term Measures

Meeting the immediate load demand is very important but even more important is meeting the medium to long term demand. In order to be able to meet the future demand, it is estimated that generation capacity of 12,000MW will be required by year 2005 and 25,000MW by year 2010. Moreover, with the West African Power Pool, Nigeria may have to supply power to some of the ECOWAS Countries.

In order to meet the 2010 demand, major improvement are required and these include:

(i) Expanding access by Rural Electrification, both grid and off-grid, and other sources of supply.
(ii) Private participate in the operation and maintenance of the transmission company.
(iii) Encouragement of Independent Power Producers (IPP) and Rehabilitate Operate and Transfer (ROT) Operators.
(iv) Rehabilitation of existing generation facilities to ensure availability of at least 5000MW.
(v) Additional generation capacity of 20,000MW.
(vi) Restructuring and unbundling of the National Electric Power Authority (NEPA) into generation, transmission, distribution and marketing companies.
(vii) Privatization of the generation, distribution and marketing companies.

Power Generation

There are total of eight generating stations in Nigeria of which five are thermal stations while the remaining three are Hydropower Stations.

Table 1 Shows the generation profile of both the hydropower and thermal stations excluding small hydropower stations in a week of August 2001.

Station	AVAIL.Units	INST.AVAIL CAP(MW)	AVAIL Capability (MW)	REMARKS
KAINJI Hydropower	IG6&9	200	160	1G10&12 N/A
JEBBA Hydropower	2G2,3,5&6	385.6	380	2GI, & 4Unavail
SHIRORO Hydropower	411G1,2&4	450	435	411G3 N/A
EGBIN Steam/ Thermal	STI,2.3&5	880	859	
SAPELE Steam Turbine	STI,2.&6	360	183	
AFAM Thermal	NIL	NIL	NIL	GT6,7 N/A
DELTA Thermal	GT6,10,15,16&17	341	319	GT13.N/A
IJORA Thermal	GTS	20	15	Fuel Shortage
G.TOTAL	24 Units	2636.6	2369	

HYDROLOGICAL DATA

DETAILS	KAINJI	JEBBA	SHIRORO
INFLOW(M3/SE)	186	846	NIL
TUB.DISCH	471	901	257
SPILLAGE	403	NIL	NIL
TOTAL DISCH	874	901	257
STORAGE	-688	-53	-257
HWE	139.81	101.74	367.60
TWE	103.59	73.80	271.00
GOH	36.22	27.94	96.60

The three Hydropower Stations, namely Kainji, Jebba and Shiroro, have each installed available capacity of 200MW, 3856.6MW, 450MW. But the available capacity of any one time are 160MW, 380MW and 435 MW. The difference is as a result of non-availability of some of the units which is due to level of water in hydro & fuel shortage in thermal stations. Therefore the current hydropower potential is 975MW that is link to the national grid excluding the small hydropower that are off grid.

In government's effort to projects for the future power demand in the country, the Ministry of Power & Steel & NEPA have proposed and identified potential hydro stations nationwide and will soon embark on the construction of the following new hydropower plants.

(i)	Mambilla	- 1320MW & 260MW 1st & 2nd phase
(ii)	Zungeru	- 950MW
(iii)	Makurdi	- 1062MW
(iv)	Lokoja	- 1870MW
(v)	Onitsha	- 1050MW
(vi)	Ikom	- 736MW
(vii)	Gurara(Abuja)	- 300MW

Rural Electrification Programme

The Electrical Inspectorate Services Department of the Ministry executes the rural electrification programme of the Federal Government in conjunction with the Rural Electrification Department of NEPA. The objective of the scheme is to electrify and connect all Local Government Headquarters including other large and strategic towns like border towns, some towns with military, economic and social institutions to the national grid supply system.

This is in realization of the fact that the provision of adequate electricity supply is vital for the upliftment of the quality of life in our rural area. There is, therefore, no doubt that the development of small hydropower is very important since the power needed to electrify this town and villages can't all be tapped from the national grid.

Small Hydro Power

The capacity range of Small Hydropower plant is not exactly defined. There is no distinctive capacity classification of small hydropower in Nigeria. However, in some part of the country like Plateau State where there are quite a number of small hydropower stations that are off grid, the ranges are between 3-40MW. And until recently the Federal Ministry has approved the consultancy services of two Small Hydropower Stations in Dadin Kowa 34MW and Oyan Dam 9MW.

Nigeria is in support of the idea and the need for the development of energy-efficiency projects, particularly of mini hydroelectric, wind power and solar energy projects. For instance, there is need to develop Small Hydro Power Station as an alternative source of energy(Energy in rural development). Apart from its benefits, it is a way of tackling the challenges posed by globalization. In order for these energy projects to be successful, there is also need for regions to pool resources together to strengthen and accelerate regional co-operation among one another. There is therefore need for Nigeria to contribute to the development of small hydropower stations for its own benefits and that of other members countries. However, in my own view, renewable energy for 21st century would no doubt be beneficial to the African regions particularly in the rural areas where provision of vital infrastructures for adequate electricity supply would uplift out rural areas. However, I suggest that African regions should focus their attention on how to harness small hydropower to alleviate the problems of energy poverty issues as well as respond to problems of energy and environments.

Conclusion

May I conclude by saying that the importance of this workshop is to create awareness to help Africa and other developing countries to proffer ways and means of clean energy transfer to mitigate green house gas emission in the world.

In particular, development of small hydropower station could play significant complementary roles as isolated power systems for lighting non-urban areas, powering water pumping stations, communications packages in remotes areas, or medical appliances in cottage hospitals.

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Electric Power and SHP in Egypt

Gamal Ali El Ouni

Mechanical Works of Maintenance and Operation for SHP & Diesel Engine

Egypt

1 Land and People

Location: Northeast Africa.
Bordered by the Mediterranean to the north.
Sudan to the south.
Red Sea and Suez Gulf to east
Palestine & Israel to the northeast,
Libya to west

Area:1.002 Million km^2 , and inhabited area is about 5%.

Capital: Cairo

Climate: Hot dry in summer.
Warm rainy in winter.

Lower Egypt temperature Year, average 20° in day and 7° at night

Upper Egypt temperature year, average 25° Max. and 17° min.

Population:about 63 Million

Average growth rate of population is 2.4%.

Administrative Divisions:The Arab Republic of Egypt is divided into 26 governorates.

Language:Arabic is the official language of the state.

Currency:Egyptian pund(L.E.).

Topography:Arab Republic of Egypt divided into 7 parts.

1) River Nile valley and Delta < 4% of total area.
2) Western Desert, about 671,000 km^2.
3) Eastern Desert, about 225,000 km^2.
4) The Sinai Peninsula, about 60,000 km^2.

Water Resources:Annually available water volume is 61 billion m^3.
The River Nile: 55.5 billion m^3.
Subterraneau waters ≌3 billion m^3
Recycled drainage water ≌ 2.5 billion m^3(For irrigation).

2 History and Civilization

Egypt is a country of ancient genuine civilization. The pharaonic is one of the most ancient and highly important civilization. The ancient Egyptian State hosted the oldest political system in History at large.

3 Agriculture and Irrigation

The Agriculture sector is one of the main Egyptian national economies. It contributes 21% of the national income and 34% of the local manpower and is responsible for securing food sufficiency in Egypt. Through this sector, several major materials required for industry are produced. The agricultural exports are considered a main source of foreign currency.

The Suez Canal has a long history setting a wonderful example for the Egyptian Man's will struggle and aspirations. It is the artery of life linking East and West and promoting trade and culture among world nations. The Suez Canal carries 14% of world Trade, 26% of Gulf oil exports, 41% of common cargo in Gulf ports, 22% of canned cargo from and to the Red Sea, Gulf and eastern ports of Africa. It generates higher revenues in the balance of payments, bringing in foreign currencies.

4 Electricity

The electric energy is a major pillar on which the State's economic structure rests such as industrial, agricultural, urban and desert-control projects together with food security projects, and daily sevices. It further provides direct communication with the people for domestic usage of lighting.

The electricity sector adopts an ambition to something as follows:

1) Provide electric energy for diversified usages, observing sustainable feeding being vital to National economy.

2) Provide electric energy for projects of the State's socio-economic development plan so as to face up the natural growth at the short and long terms.

3) Improve the standard of electric services for beneficiaries to match the international one.

4) Optimal use of energy sources:water or petroleum in generating electrity, concentrating on other substitutes enevitable to lesson the consumption of petroleum in this respect.

5) Rationalize the consumption of electric energy.

6) Expand the setting up of electric industries and developing available ones with a view to effecting self sufficiency, curbing importation and saving foreign currency. Consequently,

it will be possible to improve the balance of payments and support national economy.

7) Define and assess new energy sources to be used at a larger scale with a view to developing their systems of local manufacturing potentials so as to achieve optimal rationalization of conventional ones.

4.1 Electricity Generation Energy

4.1.1 Hydraulically-Generated Energy

Egypt still occupies a pioneering position in this field. It is highly dependent on the Nile water. Total Hydro electric installed capacity was 2810 MW which represents about 20% of the total Installed capacity.

4.1.2 Petroleum and Natural Gas

One of the important local sources serving as fuel for producing electricity. The amount of natural gas taken up by the electricity sector for energy generation purposes stands at nearly half of the country's overall production.

Table 1 Crude Oil and Natural Gas Reserves(BBOE)

Year	Crudc oil	Natural gas
1997/1998	2.97	7
1996/1997	3.03	6.32
Growth rate	(1.98%)	10.80%

(BBOE:billion barrel of oil equivalent)

4.1.3 Coal

Local available coal reserves are estimated at 50 million tons. It is used mainly as a raw material in Egypt.

4.1.4 Nuclear Station

The use of nuclear stations for electricity purposes has now become an absolute imperative.

4.1.5 Solar Energy

Egypt is geographically located in the solar belt between 22 and 39 north. The average solar energy at this latitude is 5.73 kw/h/m per day. Egypt enjoys about 2300-4000 hour/year of sun shines. Egyptian program for solar energy focuses on developing and constructing stations for electricity generation by using the solar system.

4.1.6 Wind Energy

Some regions in Egypt have a high average wind speed to generate electrical energy through windmills and wind farms. The important regions are the Red Sea coast. Wind speed could reach 20-30 km/hr which is the economic speed range to generate electricty. The first large installed capacity of wind energy is about 600MW by year 2005.

4.1.7 Biomass Energy

Biomass energy potential such as agricultural, animal, human and solid wastes is high in Egypt. This can be utilized as a cheap thermal energy resource as fertilizers and to improve the environment by getting rid of these wastes.

4.1.8 Five Hydro Power Plants

The usage of hydro power stations return to the year 1926 hence have been installed in Fyom. The frist station is EL azab by capacity of 680 kW. The following of the two power plants are in this year 1926 in Fyom in other region by capacity of 2.6 MW an so in year of 1960 in Naga Hamaady SHP of capacity of 2.7MW. In 1960 the work was finished in a big station of Aswan by capacity of 345 MW called Aswan(I). In 1967 began the working of the high dam by compound capacity 12 unit × 175MW in this time it is the bigger station. Aswan(II) by capacity of 4 unit × 76MW and Esna station by capacity of 90MW, then renewable of SHP in Naga Hamaady by four units 4 ×16MW, then establishing Lahhon station in Fyom by capacity of 785kW. The authority of electricity studies the sources of the water which may be enabled to be used in small hydro power on the Egypt's Nile River and its tributary.

5.1 The small hydro power in Egypt

1) Sation of El AZB in Fyom by capacity of 680kW.

2) Station of Hawarit addlaan by capacity of 2.6MW in Fyom.

3) Station of Naga Hamaady by capacity of 2.7MW.

4) Station of Naga Hamaady by capaciy of 3 units × 1.5M=4.5M

5) The work is continuous in station of Laahoon in Fyon by capacity of 785kW.

6) The work is continuous in the station of new Naga Hamaady by capacity of four units(4 Units × 16MW=64M).

5.2 There are studies on the places at the Nile river and its tributary.

1)KanaTer AsuiT project by 40 MW.

2)KanaTer EL Delta(Domiat pranch by 12MW).

3) Project of station Qutarace Low.

Table 2 The new studies

Site	Head(m)	Discharge(m^3/s)	Power(MW)
1.Mixture	21	4.9	1
2.Kanater rashid	3	180	6
3.Tawfikg	2	139	2
4.Asuit	1	230	3
5.Gamgra	2	50	1
6.Abasy	1	137	2
7.Ibrabimy	1	114	2
8.Behiry	1	188	2
9.Monofy	1	173	2
10.West Nagga	1	81	1
11.Karanin	1	80	1
12.Sharakawia	1	232	2
13.Yoosef	1	120	1

HRC's International Technical Cooperation and Training Workshop

Work implemented in 2001

- Entrusted by the Chinese Ministry of Foreign Trade and Economic Cooperation, successfully conducted two TCDC international training courses on SHP, with 32 engineers from 16 countries. During the courses, lectures were combined with discussions and study tours as well as sightseeing during weekends. It not only well disseminated Chinese SHP technology, but also helped the participants to know more about China and played an important role in China's contribution to TCDC/ECDC.
- Received three ministerial delegations respectively from Cuba, India and Bangladesh.
- Made exchange and discussions with the visiting experts from Vietnam, UK, India, Canada, Holland, USA, etc.
- Received over 20 ESCAP officials from 16 countries.
- Dispatched staffs to UK, Cuba and Mongolia for visiting and exploring business.
- Dispatched delegations to DPR Korea, Pakistan and Vietnam, as implementation of joint projects between governments, which were approved by Chinese MOFTEC.
- Made further progress on "948" project, i.e. a task from the Ministry of Water Resource, to introduce advanced technology from Canada, USA, Singapore, etc. Especially, the automatic control system on SHP with no/fewer staff on duty has been checked and accepted by MWR, and been popularized and applied in many stations.
- Entrusted by MOFTEC, completed the design for the two SHP stations in Cuba, which are to be built with donation of Chinese government.
- Entrusted by the International Organization for Bamboo and Rattan, made a study report on social & economic benefit of isolated MHP station, with the aim to solve the power supply for the development of bamboo industry.
- Kept further cooperation of SHP projects concerned in Nepal, Pakistan, Mongolia, Canada and Malaysia.
- Made continuous efforts on publication of "Small Hydro Power" (Bimonthly, in Chinese) and "SHP News" (Quarterly, in English). Since the information exchange on SHP is regarded as one of the important duties of HRC, so we try our best to publish at home and abroad.

Work Plan in 2002

- Entrusted by MOFTEC, to conduct two TCDC international training courses on SHP.
- To set up a pilot micro hydropower station base.
- To set up a water-pumped storage power plant, in technical cooperation with Mongolia.
- To apply the automatic control & supervision system for 2 hydropower stations, in technical cooperation with Vietnam.
- To reconstruct 3 hydropower stations, in technical cooperation with DPR Korea.
- To made development of micro hydropower, in technical cooperation with Pakistan.
- To make further efforts on compiling and publishing of "Small Hydro Power" and "SHP News".

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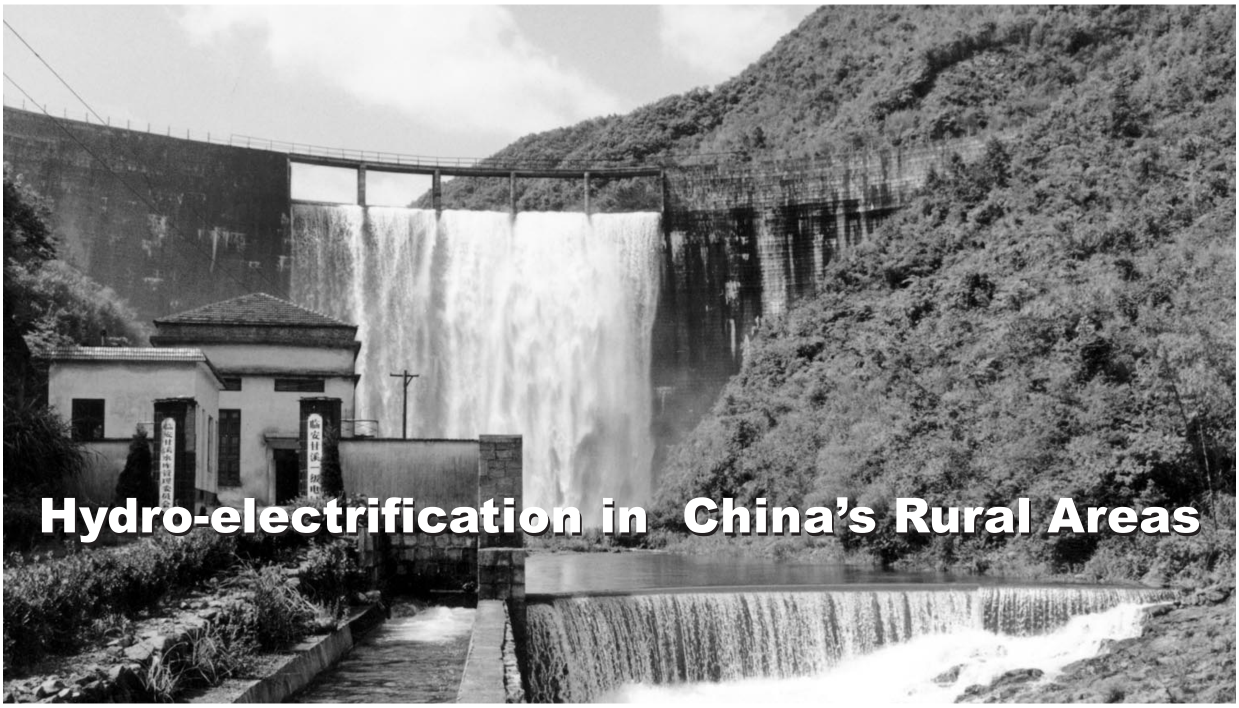

Hydro-electrification in China's Rural Areas

I. Remarkable achievements on the rural hydropower development and the establishment of preliminarily hydro-electrified counties

The installed capacity of hydropower stations rises rapidly, and in the whole country 800 counties are mainly depending on the electric power from small hydropower stations and their power grids. By the end of 2000, the installed capacity of hydropower from the water resources administrative bodies had amounted to 31.1GW, and the annual generation reached 94.5 billion kWh, among which, the installed capacity in rural regions was 27.51GW and the annual generation of 87.9 billion kWh. Correspondingly, the power grids configured with hydropower stations are swiftly developed, and over 800 county-level power grids and more than 40 trans-county grids have been set up, which extend more than 1 million km of transmission & dispatching lines. By the end of 2000, the estate of power generation & supply from the hydro authorities had risen to RMB150 billion yuan, the yearly income from power sale amounted to RMB40 billion yuan, and RMB6.4 billion yuan exempted as the annual duties. The rural hydropower has already become the important basic infrastructures and the backbone of the agriculture & economic development in hilly rural districts. At present, about 1/2 of China's territory, which equals to 1/3 of all counties or 1/4 population, mainly depends on the electric energy from rural hydropower stations and the auxiliary power grids. In China, there are totally 48,000 medium & small hydropower stations built, which make more than 300 million residents accessible to electricity, and the preliminary hydro-electrification plays a key role in the economic development of the vast hilly poverty-stricken areas and minority-resided regions, improving the local living standards as well.

From the "7th Five-year Plan" to the "9th Five-year Plan", in whole China, there are 3 batches totaling 653 rural counties which have been preliminarily electrified, among which 335 rural counties electrified during the "9th Five-year Plan" period. During that period, RMB42.01 billion, accumulatively, was put into the rural hydropower construction, and among which, RMB1.35 billion from China central government, that means, when one yuan granted from China central government, RMB24 yuan attracted from the whole society. The built 653 rural hydro-electrified counties embrace 252 million population, cover an area of 2.74 million m^2, and more than 82% of these counties are located in the middle & west China and over 80% situated in the old, minority-resided, remote and poor regions. Owing to hydropower construction and the rural electrification, in these areas the GDP, financial revenue, farmers' per capita income and the per capita power-consumption doubled, and the economic structure was completely transformed, as well as the urbanization procedure accelerated, ecological environment remarkably improved and the social & economic conditions bettered.

In the 335 preliminarily electrified counties which were set up in the "9th Five-year Plan" period, the GDP was increased from RMB234.5 billion to RMB477.8 billion within 5 years, with rise rate doubling that of the whole country. The financial revenue of these counties was increased from RMB15 billion to RMB25.5 billion, and the per capita net income of farmers rose from RMB 1082 to RMB1914, with the annual mean rise rate of 8.1%, 1.7 times of the average rise rate of whole China (4.7%). The proportion of industry's added value was increased by 9% in the GDP of China. By the means of developing the rural hydropower and establishing the preliminarily electrified counties, the small hydropower was applied to replace the firewood, which improved the energy structure in rural areas, protected the natural forests and even return the arable land to the forest. Presently in rural districts with electric energy supplied by hydropower, about 20 million households are adopting electricity for cooking instead of firewood, protected the local forests and the soil erosion alleviated. During the recent 15 years, the average forests coverage among these 653 preliminarily electrified counties was increased by 9.88%, 5.4% higher than the average rate of China.

During these 15 years of realizing the preliminary hydro-electrification in rural counties, water conservancy and power generation were combined together, which accessed 120 million people in remote areas to the electric power, initially conserved thousands of medium & small rivers, increased 50 billion m^3 of reservoirs' capacity and another 25.3 million mu (Chinese area unit) arable lands can be irrigated, provided 64.25 million people and 47.42 million herds with dinking water, as well as improved the agricultural condition and farmers' living condition, and bettered the flood control and anti-drought capability.

II. The objectives of hydropower and rural electrification

1.To set up 400 hydro-electrified rural counties

During the "10th Five-year Plan", another 400 rural counties shall be hydro-electrified according to the principles of "the investor or constructor shall own, manage and be benefited", "self-construction, self-management and self-consumption" and "SHP shall has its power-supplied areas", to promote the rural electrification in China. In these hydro-electrified rural counties, every village shall have access to electricity, 98% households shall be provided with electric power and the power-consumption guarantee shall be more than 95%. The annual mean per capita power-consumption amounted to 500kWh, and 30% of households adopted the electric power from SHP, instead of consuming firewood. These requirements for minority-resied areas and hilly regions can be suitably lowered down. The sectors concerning water resources shall effectively administrate all the performances in hydropower fields.

2.To develop SHP and the power grids remarkably

During these five years, from the water-resources sectors of whole China 8GW installed capacity of hydropower was increased (among which, 6GW increased for rural areas), so the total installed capacity amounted to 39GW and the annual generation reached 120 billion kWh, covering about 40% of the total hydropower in China. While exploiting the rural hydropower, measures were taken to promote the power grids, with a group of SHP development bases established.

3.To construct the pilot ecological project with SHP replacing firewood

During the "10th Five-year Plan" period, on the upstream of Yangtze River, middle & downstream of Yellow River, upstream of Pearl River and other places where SHP can be applied to replace the firewood as energy, a group of ecological pilot districts with SHP replacing the firewood shall be set up. By means of developing SHP and the power grids, the fuels or energy shall be provided steadily for farmers' living and agricultural activities in the "returning arable land to forests" areas, natural forests regions, nature-reserve areas, the key anti-soil-erosion districts and mountainous areas, so as to protect the ecological environment and even to eliminate the deforestation in these pilot areas.

4.To upgrade the rural power grids in water-resources sectors

5.To develop the medium & small-sized hydropower resources in west China

6.To tackle the power-consuming problems for farmers in remote regions

7.To build a batch of pilot hydropower stations and corollary power grids.

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

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

2.Date: From 9 May to 18 June 2002, Hangzhou, P.R. China.

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

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

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

6. Medium of Instruction: English

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

8.Methods for Evaluation: presenting country report on SHP

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

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

11.Application and Admission

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

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

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

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A Chinese Magazine "Small Hydropower" by HRC

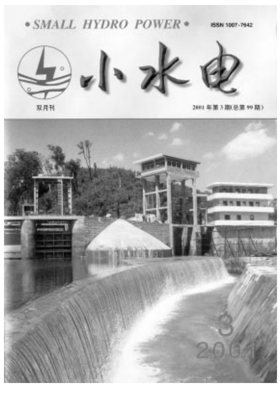
The Chinese "Small Hydropower", a magazine that National Research Institute for Rural Electrification (NRIRE) and Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power has edited and published for 100 issues (bimonthly), allocated with the International Standard Serial Number ISSN 0256-3118, and China Standard Serial Number CN33-1204/TV. It was published in Chinese and with English titles. Special features are technical experience of SHP development in China. Information of international SHP activities and important events in the field of SHP have also been widely included.

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

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

Subscription rates (1 year):USD40.00

The main contents of the 99th issue (2001 No 3) read as follow.



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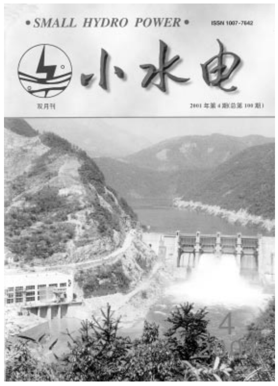

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Hydropower Development Programming in China

In the light of the speech delivered by Mr.Zhou Dabing, Deputy Manager General of China National Electric Power Corporation, on its hosted "Hydropower Developing Seminar", during the national "10th Five-year Plan" and the "Farsight Program to 2015", the installed capacity of hydropower shall be up to 75GW by 2000, which covers 24% of the total installed capacity in electric power. By 2005 the installed capacity of hydropower shall amount to 95GW, which covers 27% of the total installed capacity in electric power; by 2010 the installed capacity of hydropower shall amount to 125GW, which covers 28% of the total installed capacity; and by 2015 the installed capacity shall amount to 150GW, which maintains 28% of the total installed capacity. At that time 40% of the hydropower sources shall be exploited.

In order to realize the above mentioned hydropower developing target, China National Electric Power Corporation shall abide by the basic principle for promoting the electric power industries, that is, take an active part in exploiting hydropower sources, optimize the thermal generation, and suitably set up nuclear power station. According to the actual local conditions, new and renewable energy shall be develoed, and much more attention shall be paid to build and refurbish the township and rural power grids, and finally a whole national power grid expects to be set up. Therefore, directed by the market demand, oriented on the economic benefit, based on the optimum configuration of sources and improving the electric power structrue, in a certain period the China National Electric Power Corporation shall be mainly committed to developing the large-sized hydropower stations with sound regulation performance and superb hydro-energetic indices. Meanwhile, some medium & small-sized hydropower stations shall be also set up in line with their actual situations to benefit the local economy. When the key hydropower stations are cared, the cascade development in a basin shall be undertaken too. Nowadays, hydropower development on the upper reach of Yellow River, the middle & lower reaches of Yangtze River and their branches, and in the basins of Honghui River, the middle & lower reaches of Lanchang River, Wu River etc. shall be paid with much more attention. The strategy on "Electric Power Transmitted from the West China to the East China" shall be put on the schedule, to actively push forward the hydropower development in the middle & western areas of China and the minority regions. In these regions such as the middle part of China, Fujian, Jiangxi, Sichuan and other provinces where are abundant in hydropower sources and short of coal mines, some medium & small-sized rivers with super regulation performance and high electric power quality shall be executed continuously for their cascade developments. At the power grid with poor peak-regulation capability and large peak-valley difference, the pumped storage power plants can be proposed at suitable sites, besides strengthening the peak-regulation schematization.

Narrow canyon cuts cost of constructing hydro plant

The use of narrow canyon to construct a small hydro power plant in southwest China means that the cost of building the plant will be cut by up to two-thirds.

The Shiziguan hydro power plant will be built on the Hongjiahe river in central China's Hubei Province. The 180m high dam impounds a small reservoir with a capacity of 126Mm^3.

The hydro plant is designed to have an installed generation capacity of 10MW and is expected to begin operation by the end of 2001, with an annual power gneration of 26.7GWh.

Meanwhile, provinces in central and western China say they will make the construction of small hydro power plants a priority in terms of their economic development according to the Xinhua news agency.

Investment in small hydro power projects this year will total approximately US$1.86B and China will have 43,000 small hydro power plants with an annual generating capacity of 72BkWh.

Boosting the assessment of Ungauged small hydro sites

Small hydro sites located in mountain environments are often on ungauged streams. A software package called the Integrated Method for Power (IMP 4.0) was designed to assist inexperienced, potential developers of small hydro sites in situations where the cost of professional engineering advice would be prohibitive. The goal was to use an appropriate methodology to enhance the hydrologic information for ungauged small hydro sites and to provide a screening tool that would help to estimate the appropriate level of investment. The basic approach is to use topographic and weather data to compute the time series of streamflow.

IMP was developed in North America over a period of 20 years, and was funded at various stages by BC Hydro, the Washington State Department of Ecology, City of Seattle and Alberta Environment. Natural Resources Canada provided the funding to bring the various independent computer programs into an integrated Windows environment.

IMP considers the time series hydrograph flow, which is usually unknown for small mountain streams, and uses it to:

- *Develop a flood frequency curve.*
- *Select an appropriate penstock-turbine-generator set.*
- *Calculate the energy capability and economic optimisation of the installed capacity.*
- *Assess the impact of a development on instream habitat for fish.*

The features provided by IMP include those which are common to many resource engineering situation. These include:

- *Hydrology model.*
- *Flood frequency model.*
- *Power study model.*
- *River hydraulics model.*
- *Fish habitat model.*
- *Instream flow model.*

IMP's basic assessment of a small hydro site begins with an analysis of the hydrology, usually without access to streamflow data. In mountain environments, the local climate, and hence the flow, can vary significantly with elevation and over short distances. One side of a valley often experiences different precipitation than the other side, and snow accumulation and melt are elevation dependant because of the vertical lapse rate for temperature and precipitation. The weather data that are inputs to IMP must be carefully interpreted to be representative of the actual weather conditions above the site. Some of this interpretation is considered automatically by elevation dependant routines in IMP.

The software uses a conceptual model to break down the hydrological analysis into two components. The first deals with the regional climate, and how it can be applied to estimate average precipitation and temperatures in the vicinity of the site. This usually requires advice from a meteorologist familiar with local differences in the climate of the region. The second component is a model of the effect of elevation on these regional climate parameters.

The conceptual hydrologic model generates daily and hourly streamflow on an ungauged watershed from topographic data and a time series of daily precipitation and maximum and miniumum temperature. Data may be in US or Canadian weather services format, or may be imported from text files.

Adapted from the University of British Columbia(UBC) watershed model developed for BC Hydro, the hydrologic model is well suited to climatologically heterogeneous mountainous areas like British Columbia in Canada. The model includes quick and slow groundwater routing; surface runoff from impervious areas; snow and glacier accumulation and melt; and surface and ground water storage. Water losses from tree cover are included. The watershed can be divided into sub-basins, each with distinct topography and hydrological parameters.

The UBC model was modified by removing computational hydrologic routines that are not relevant to small hydro sites. For this reason, caution should be exercised in using the hydrologic model in IMP for large watersheds.

Hydrologic Simulation

Data describing the watershed above the power site are readily obtained from topographic maps and aerial photographs. The IMP package includes default values of hydrologic parameters that have been calibrated for six regions in British Columbia, and for streams in Manitoba, Newfoundland and Yukon. The regions cover a range of conditions including glaciated mountains on the Pacific coast, in the interior, and the arid interior plateau. The calibration was achieved by adjusting model parameters until a good agreement was reached between the computer output and the observed flows of small gauged watersheds in each region.

Hydrologic simulation will produce daily flows from daily precipitation and maximum and minimum temperatures. In some cases, daily average flows are inadequate for small flashy streams. In other cases, the hydrograph varies diurnally in response to the daily cycle of melting during the day and refreezing at night. IMP provides a facility for using hourly precipitation patterns to prorate daily runoff to hourly values. Daily snowmelt is distributed hourly based on a diurnal temperature cycle. The hydrologic simulation will then produce hourly flows for analysis of hourly energy production and spill.

The watershed model provides opportunities to explore the sensitivity of hydrologic sequences to factors such as tree cover, soil types, land slopes, and the range of elevation. A particular watershed can also be transposed to a different climate to show the relative importance of watershed and climate parameters. As there are no observed flows, and the simulated record normally would be too short, the hydrologic simulation model is not used to estimate flows for flood frequency analysis. Instead, a completely different approach is used, which is ideal for quantifying judgements about the climate extremes encountered on an ungauged watershed.

A theory for the closed form mathematical model of flood frequency was developed in 1972. The model can be thought of as an application of the technique of derived probability distributions.

The flood frequency model comprises two components. The first defines the transformation from rainfall (and snow melt) to direct runoff by providing overland and channel routing equations for the time of concentration as a function of the watershed shape, size, and slope and the precipitation intensity. These data are similar to the watershed description used for conceptual hydrologic simulation. Infiltration and groundwater return flows are not included in this model. Water that does not contribute to the flood peak is eliminated by two coefficients:one represents water losses, the other is the ratio of direct runoff to total precipitation. IMP provides advice for selecting these coefficients.

A joint probability distribution function for precipitation events is the second component of the flood frequency model. This provides the flood probability distribution function by numerical integration with the routing equations in the limits of integration. The parameters of the joint probability distribution function for precipitation are easily estimated, even for an ungauged site. They are the reciprocals of the average intensity and average duration of precipitation events. The flood frequency curve is then obtained from the average annual number of events, which can also be estimated.

The method separates the watershed properties from the climatological parameters that influence flood frequency. To assist in transposing precipitation statistical parameters to ungauged areas, IMP compares the mathematically derived flood frequency curves with flood frequency curves developed from recorded discharges on other streams in the region.

Large watersheds

The method has proved to be useful for very large watersheds, as well as those of interest to IMP. On large watersheds, snowmelt may contribute significantly to flood frequency. The contribution of snowmelt to flood frequency is included by providing equivalent parameters developed from analysis of simulated daily snowmelt. IMP will then identify the separate contributions of rain and snow, where the curves cross, and their combined effect.

The flood frequency method provides an opportunity to develop the unsteady flow routing equations from first principles, to apply them to real watersheds, and to gain experience rapidly in understanding the practical role played by fundamental theoretical approximations.

The power study model provides simulation for a power station with one generating unit and with the option of having one reservoir. IMP provides efficiency curves for several types of hydraulic turbine and rough coefficients for a selection of penstock materials. Inflows may be the output from the watershed model (simulated hydrographs), or actual recorded streamflow (in US Geological Survey or Canadian format). The outputs are the firm energy, average annual energy, and the time series of energy, spill and reservoir storage. An optimisation routine conducts a post-analysis around the simulated design and recomends the installed capacity at which the marginal value of the energy generated equals the marginal cost of additional capacity.

The power study model provides opportunities to develop an understanding of the significance of the hydrologic sequence in evaluating a power site. The model can also be used to develop the data for a trade-off curve between reservoir capacity and costs, and generating capacity and costs. The model clearly shows the relationship between energy output and the penstock capacity and identifies the maximum energy that can be developed from a given penstock diameter and material.

The purpose of this model is to provide a quantitative description of the velocity and depth regimes that provide fish habitat. The analysis is for a single cross-section. The results are interpreted in the fish habitat model as "habitat area", described by a strip of unit width extending across the river at a particular location. At each point along this strip the hydraulic model determines the velocity and depth.

The river hydraulics model uses the Manning equation and a stage-dishcharge rating curve to determine variations in velocity and depth along a cross-section of the river, as a function of discharge. Manning's "n" can be different at each point across the river, reflecting changes in substrate materials. Data are provided for several river location. The model does not deal with back eddies. This model provides an understanding of how habitat hydraulic conditions vary as the stage and discharge change at a particular location.

Fish Habitat

Using fish habitat preference curves and the output from the hydraulic model of the river, the fish habitat model determines the portion of the river cross-section area that provides the most suitable fish habitat.

Fish habitat preference curves relate the velocity and depth at specific locations to the purported preferences of fish. For each species, and for each life stage, the curves are different. In practice the curves ideally would be developed from a subsurface snorkel survey in the river to identify the locations, velocity and depth preferred by the fish of interest. IMP provides default data for several species and life stages, which can be adequate for a preliminary assessment.

IMP illustrates how the river cross-sectional shape affects its suitability as habitat for specific types of fish and life stages at the specific flows that are likely to be experienced below the site.

Instream flow

The instream flow model determines the time series sequence of habitat from the time series sequence of flows in the river. The calculation of habitat uses the functional relationship between discharge and habitat that was developed by the habitat model. The instream flows can be the natural flow sequence, the regulated power house flow sequence, or the flows in the bypass reach that receives only spills. Frequency analysis provides a convenient method for comparing the habitat impacts of alternative design concepts.

There is often more than one species and life stage present in the river at the same time. This complicates water management decisions that protect fish. IMP provides a hypothetical "equivalent fish" that reflects the combined preferences of a number of species and life stages. This highlights the multiple objective nature of habitat protection and enhancement.

On-Line help

The on-line help module of IMP 4.0 is a hyper-textbook containing tips on how to use the software, charts, equations and documentation describing details of the methods used in the modules.

IMP was developed for the Hydraulic Energy Programme of CANMET-Natural resources Canada. Version 4.0 is available free of charge and version 5.0 is currently being developed. For more information contact the authors.

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Source:International Water Power and Dam Construction

Small hydro policy and potential in Spain

Small hydro in Spain

Spain has 662 small hydro installations, as registered in the "Special Regimen" of 31 December 1999, with 1,271,573 kW of installed power producing the equivalent of the electricity consumed by 1.1 million families, avoiding emissions of 2.6 million tonnes of CO_2 per year and substituting 250,000 toe.

During 1999, 15 new small hydro plants were registered, and they added 23,698 kW to the total power installed. According to several studies, there is technical potential for the installation of a further 1000 MW of small hydro on Spanish rivers. Already, following the 'Plan de Fomento de las Energias Renovables' ('Promotion Plan for RES', IDAE, Madrid, December 1999), 100 small hydro plants have already been built and are awaiting official authorization to start operation.

The share of hydro in Spain's total energy production is 2.5%. This share will be progressively reduced, as energy demand is rising at a rate of 7% per year-and the share of wind energy is rising much faster. It is very important to bear in mind that the trend of Spanish dependence on primary energy sources will increase from the present 70% to 85% by 2020 (according to EU sources). The figure across the European Union suggests a rise from 50% to 70% in the year 2030.

Environmental impact

Small hydro promoters in Spain are still puzzled by the existing situation: as is discussed below, small hydro has perhaps the lowest environmental impact of all energy sources, including other renewable energies. Considering the ambivalent treatment given to small hydro in all institutional action and legislation, the sector believes there should be a clear differentiation between large and small hydro in the hydro concept. 'Both [are] renewable sources of energy, but obviously with a very important difference of impacts in the environment', says José María González Vélez.

The study Environmental Impacts of the Production of Electricity, developed by the APPA together with highly regarded Spanish institutions and organizations involved in energy issues, aims to quantify-using scientific methods-the environmental damage caused by the generation of electricity from eight technologies: lignite, coal, fuel oil, natural gas, nuclear, wind, small hydro and solar photovoltaics.

The conclusions of this study are quite clear:

- renewable energies have 31 times less impact than conventional energy sources, and 1kWh produced by small hydro is 300 times 'cleaner' than a kWh produced by lignite.
- small hydro does not have a significant impact on the environment:there are no emissions of gases scuh as SO_2, CO_2 or NO_X, nor is there anything that causes ground or water acidification, acid rain, climate change, ozone layer depletion, etc.

The unit used in the study for measuring the environmental impacts of the eight, tested generation systems is the 'ecopoint'-a unit of environmental penalty. These were calculated by considering the following environmental factors: global warming, ozone layer depletion, acidification, eutrophication (oxygen depletion of water), heavy metal pollution, emission of carinogenic substances, winter smog, summer smog, generation of industrial wastes, radioactivity, radioactive waste and depletion of energy sources. The more ecopoints obtained by a generation system, the greater environmental impact it will have. The full listing is given in Table 1.

Table 1. Ecopoint listing of eight tested energy generation systems

System	Ecopoints
Lignite	1735
Fuel oil	1398
Coal	1356
Nuclear	672
Solar PV	461
Natural gas	267
Wind	65
Small hydro	5

Other studies have shown similar outcomes, as seen in Table 2.

The larger, well known environmental organizations generally support the responsible development of small hydro, recognizing the benefits of renewable technology as part of the broad environmental picture. There are other-usually small and local-organizations which resist individual installations on 'environmental' grounds, failing to appreciate the wider benefits of renewable energy. Just as wind turbines do not kill large numbers of birds, so small hydro plants do not alter or reduce the variety of flora and fauna in the rivers. These groups tend to ignore the benefits of renewable energy in combating climate change:'If greenhouse gases were coloured yellow or grey, then the[se] institutions would definitely support all the renewable energy technologies', González Vélez commented.

Market prices and competitiveness

Coming back to Amendment 6 of the Directive, it is worth remembering that only in the 'Justification' is the following established: 'Hydroelectric power plants, in particular large ones, can generally produce energy at market prices. They should therefore not be included in the support schemes. However, this wording has been chosen in order to make it possible, in exceptional cases, e.g. following necessary modernisation, to fully exploit potential that has not been used at market prices.'

This justification, where small hydro is not specifically mentioned, is based on arguments such as 'energy market prices' and the 'competitiveness' of hydro power plants, which is not absolutely fair. Small hydro is, as we have shown, a very clean means of energy generation, and has a lower environmental impact than large hydro. Therefore, the price per kilowatt hour produced by this technology must correspond to the external costs, i.e. take into account the avoided environmental impacts and should not be based in the 'energy market price' argument.

Comparison of the costs of the different energy generation systems must reflect the total cost, to guarantee the efficiency, and to account for the distortions in the energy market. This total cost needs to be calculated from the internal costs for generation per kWh, plus the external costs or benefits. The following are definitions included in the Community guidelines on state aid for environmental protection of the European Commission.

- *Prices to reflect costs.* This principle states that the prices of goods or services should incorporate the external costs associated with the negative impact on the environment of their production and marketing.
- *The concept of the internalization of costs.* In these guidelines the 'internalization of costs' means the principle that all costs associated with the protection of the environment should be included in firms' production costs.

Administrative barriers

In the Spanish small hydro sector, the biggest problem with present legislation is that it has not been carried through. For instance, it is more difficult to refurbish a 100 kW small hydro plant in the Spanish region of Castillay León , than it is to install a 30,000kW gas plant.

In the framwork of the local administration, the problem is not an easy one to solve. The village or the local area receives nothing for the installation of a small hydro plant in their zone, yet its promoter will profit from the water from 'the river of the village'. This is not an unusual situation and it will always happen.

Juan Fraga, General Director of Hidronorte, S.A. and General Secretary of EUFORES, observes that 'small hydro plants are usually installed in small villages with very few possibilities of financing, and this installation is probably the only industry that will be implemented in their municipality'. The small hydro sector proposes, therefore, a new initiative to help to the those small villages-that is, the cancellation of the electricity tax on the inhabitants of those municipalities where plant was installed.

Other barriers

Small hydro firms could do more themselves. There is a lack of quality information disseminated to environmental groups by small hydro firms, and a lack of promotion of the technology, which together slow the rate of development of this renewable energy. This phenomenon relates to the 'It is our river' effect. 'It is more attractive for the press to publish [reports] that a small hydro plant has destroyed the salmon fishing, than to look for the real causes (disposal of wastes, over-fishing, poaching, etc.)', in the words of González Vélez.

Socio-economic impact of small hydro development

In Table 3, we can see the estimates for employment creation associated with installations of specific technologies in Spain. The achievement of the 12% objective would provide the Spanish small hydro sector with 18.6 new jobs per megawatt installed-about 1250 of them fixed jobs.

Environmental impact study for a small hydro plant

Hidronorte, S.A. could well serve as a representative Spanish company in this sector. Hidronorte is a company which promotes not only small hydro, but also wind and biomass energy. The company owns 12 small hydro plants in Spain, with 57,000kW of power installed by the end of the year 2000, with a median yearly production of 170 GWh.

The company contracted an independent advisory company, in collaboration with the University of

Vigo, Pontevedra, to develop a Programme for Environmental Vigilance for the river Tambre, and more specifically, the part affected by the installation of the hydroelectric plant at Fecha, in the municipality of Santiago de Compostela, A Coruña. The objectives of the study, were:

- the analysis of environmental impact during the first year of the plant's operation, and the observation of the environmental legislation presently in effect.
- checking the reformed measures applied during the construction and operation of the plant.
- preparing a proposal for new reformed measures to minimize or compensate for the identified possible negative effects.

Results

No dead fish have ever been found in the channel itself, nor downstream of the plant. The trashrack cleaner of the channel and the forebay has fulfilled its function in a satisfactory way. The figures were as follows:

- level of noise:50/52 db at 25 metres.
- 47/48 db at 50 metres.
- it can be established that in at 75 metres the only audible sounds are those of the natural environment.

In the study, the positive effect on the aquatic fauna in the water of the weir section of the Fecha plant has been established. From information supplied by the Forestry Guard and local anglers, it was discovered that the main type of fish was large rainbow trout. This fact supports the idea that the water allocated in the weirs is characterized by low depth and excellent quality, as well as by the high vegetation content in both sides of the river. This vegetation diversifies the habitats for this kind of fish, serving for refuges and reproduction areas for those aged between 4-5 years.

- The water quality classifies the Tambre River as Type I(highest quality), meaning it is clean water with no contammination, even in the part of the river affected by plant.
- The vegetation from both sides of the river is well suited to conservation measures, with good-sized plants on both sides of the river, increasing the biodiversity of the flora and landscape of the area.
- The visual impact of the structure of the plant has been evaluated as medium to low.
- New, reformed measures have been identified to minimize impacts, following on from ones already developed:
  - construction of a fish channel, suitable even for young fish.
  - an acoustic fish guidance system, to prevent the fish entering the forebay of the plant.
- The study will be repeated in four years' time.

These conclusions show that small hydro plants do not have a negative effect on the environment if construction work and operation of the plants are carried out with respect for the environment and within legal guidelines-a small hydro plant cannot create disturbances capable of weakening the fluvial econsystem.

Table 2. Life-cycle emissions of electricity generation systems(g/kWh)
Sources:AIE(1998),CIEMAT(1998)

	CO_2	SO_2	NO_X
Large hydro	9	0.03	0.07
Small hydro	3.6-11.6	0.009-0.024	0.003-0.006
Solar PV	98-167	0.20-0.34	0.18-0.30
Solar thermo-electric	26-38	0.13-0.27	0.06-0.13
Wind	14.9	0.02-0.09	0.02-0.06
Geothermal	79	0.02	0.28
Coal	1026	1.2	1.8
Natural gas(combined cycle)	402	0.2	0.3

Table 3. Potential employment creation in Spanish renewables. Source:IDAE(1998)

Technology	Type of instailation	Employment installation	Direct employment in operation and maintenance
Wind	20MW	13 EE/MW(25% direct)	0.2 EE/MW
Small hydro	1.7MW	18.6 EE/MW(40% direct)	0.4 EE/MW
Solar thermal	100m^2	0.1 EE/MW(direct and indirect)	0.01 EE Mptas
Solar PV	1kWp	82.8 EE/MW(direct and indirect)	0.2 EE/MW

EE-Employment equivalent to 1800 hours/person year. 35 hours per week; **EE/MW**-Employment created per MW installed; **EE Mptas**-Employment created per million pesetas invested

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Source:Renewable ENERGY World/September-October 2001

Contract for new Scottish hydro station

A £4M (US$6M) Contract has been awarded to Miller Civil Engineering Services for the construction of Scottish and Southern Energy's new 3MW hydro power station on the river Cuileig, near Ullapool in Scotland. The plant will be the power company's first new hydroelectric station since the 1960s. Construction is set to take 12 months, beginning in mid November, and Cuileig will be operational from October 2001. Work will include building a samll intake weir and a 2.5km pipeline.

Scottish and Southern Energy's hydro generation manager, David Lee, said: 'The potential of the catchment of the river Cuileig has been recognised since the 1950s but we have taken care to design a project that recognises the needs of the environment and will bury the pipeline and power station underground.'

Ian Greg, civils unit director of Miller Civil Engineering Services, added: 'We are proud to be in the vanguard of the new generation of hydro schemes, adding to energy assets in Scotland. We look forward to working with our designers Mott MacDonaid.'

Consent for the Cuileig station was given by the Scottish Executive earlier this year and the project was accepted under the Scottish Renewables Order(SR01). ■

Underground hydro scheme for Ullapool

Scottish and Southern Energy has awarded a contract for a new hydropower plant Scotland, the company's first hydro project since the 1960s. The $6 million scheme will be built by Miller Civil Engineering Services Ltd.

The plant is to be sited on the river Culeig near Ullapool. With environmental and visual impact a key consideration, the power station and penstock will be buried underground.

The station will have a generating capacity of 3MW. Work was due to start before the end of 2000 and the unit is expected to become operational in October 2001.

The project will involve construction of a small intake weir from which water will be taken via a 2.5km pipeline to the power station. From the turbine it will be returned to the river. The plant will operate from a head of 150m.

The potential for developing the catchment area around the river Cuileig has been recognized since the 1950s, according to Scottish and Southern Energy spokesman David Lee. "The power station will be a useful addition to Scotland's renewable energy resources and contribute to the targets to reduce emissions." Consent for the project was granted earlier this year by the Scottish Executive. ■

Srisailam unit set for operations

India's Srisailam power plant is due to begin operations by the end of November, according to reports in The Hindu. The first 150MW unit of the 900MW station is almost complete and the remaining five units are to come on stream at six month intervals. However, the paper also records that 27 people have died in the construction so far, mostly due to land silips. Each of the victims' families will receive Rp2 lakhs ($4376) in compensation. The project is backed by the Japan Bank for International Cooperation to the tune of Rp390 crore($853.4 million) and is using equipment supplied by Sumitomo, Hitachi and Mitsubishi. ■

Source:Modern Power Systems

Manso gets ready to generate

The first of the four gnerating units for the Manso hydroelectric power project in Mato Grosso, Brazil, have been erected successfully, according to Impsa Hydro.

The erection work took five months and required 15 people to install the 15t generator, which is 6.5m in diameter and 1.5m high.

Impsa's involvement in the project included design, manufacturing, transport, erection supervision and commissioning tests for the turbines and generators. Impsa also supplied hydromechanical equipment, control and automation systems and electrical and mechanical associated systems for the project.

The first 53.6MW unit is expected to start operating on 30 November 2000, a month earlier than scheduled.

Vital statistics

*** Turbines**

Type:Four Francis vertical shaft
Diameter:3.4m
Rated output:53.6MW
Speed:180rpm
Head:57.5m

***Generators**

Type:Four synchronous vertical shaft
Rated capacity:55.5MVA
Power factor:0.95
Speed:180rpm
Rated voltage:138.kV ■

Australia looks to small hydro for greenhouse gas reductions

A press release, issued by the government of the state of New South Wales (NSW) in Australia, says water releases from the state's dams could be used to provide renewable, pollution-free electricity, as well as eliminate the production of more than 260,000 tonnes of carbon dioxide each year.

The Sustainable Energy Development Authority (SEDA), a NSW government agency, has identified 32 existing dams in the state as potential small hydro sites.

Work has already started on the construction of a mini hydro project at Toonumbar dam, operated by State Water, an agency under the Department of Land and Water Conservation. At Toonumbar power is to be generated using a pump modified to operate as a turbine, with an efficiency of about 82%. This turbine is directly connected to an asynchronous generator which avoids synchronizing, voltage regulating and other equipment which a synchoronous generator would require.

The Toonumbar project will be automatically controlled, with the power output determined by the water level in the dam.

When commissioned it is expcted to avoid the burning of 200 tonnes of coal and the production of 400 tonnes of greenhouse gases each year. Each megawatt of electricity generated at a hydroelectric plant prevents the production of one tonne of carbon dioxide for each hour it operates.

Small hydro plants at Burrinjuck, Glenbawn, Copeton, Keepit, Wyangala and Burrendong dams are generating a combined total of 71MW of electricity-enough to meet the needs of about 35,500 homes. With work now under way at Toonumbar dam, State Water is focusing on another three hydro power projects which are expected to begin construction in coming months at Brogo dam near Bega, Lostock dam near Maitland and Glennies Creek dam, near Muswellbrook. Along with these dams, a further six weirs on the Mur-rumbidgee are expected to begin generating hydroelectricity next year. ■

Progress at Tis Abay II

The construction of the Tis Abay II hydro power project in Ethiopia, which is considered to be a key element in Ethiopia's power development programme, is nearing completion. It is hoped that the US$63M project, which is funded by the Ethiopian government, will help the country meet its 10-12% annual growth in electricity demand and support the expanding economy. A lack of rain which has failed to fill existing dams in a country where consecutive droughts have caused widespread crop failures, is also pushing completion of the project.

Tis Abay II is located near Lake Tana in the northwest of Ethiopia. It includes a 2km power canal, two 140m penstocks and a power house. Substations at Tis Abay and Bahir Dar are linked to the grid by a 28km, 132kV transmission line. The plant has two Francis units with a total capacity of 72MW at a head of 53.5m. Spiral case installation has been completed and installation of the turbine generators is about to begin.

Construction work has already been completed at the Chara-Chara weir site, approximately 30km upstream form Tis Abay, on the Lake Tana outlet. The weir provides some storage regulation in the lake which, at 5584km^2, is the largest in the country.

Engineering services for Tis Abay are being provided by an international joint venture of PB Power and Howard Humphreys & Partners of the UK, with Coyne et Bellier of France. The joint vendture was responsible for the feasibility study, tender design and preparation of tender documents for construction, and is now supervising construction design and works.

The contractors were required to work to an accelerated construction programme for completion of the project in 24 months. Despite disruption due to war with Eritrea, the project should be completed early in 2001. ■

Micro hydro demo in the Philippines

The Philippine department of Energy (DOE) has signed a memorandum of agreement with the Japanese government for a P33.5M (US$0.67M) demonstration project. The 65kW micro hydro power system will benefit about 200 households in Leyte.

The Leyte micro hydro system is the New Energy Foundation (NEF's) pilot project in the Philippines. Japan's Ministry of Economic Trade and Industry commissioned NEF to provide the DOE with technical and funding assistance to set up the facility. ■

A world's first for wave power connection to UK grid

The World's first commercial wave power station has successfully fed electricity into the UK's national grid on the Scottish island of Islay. The station has secured a 15-year power purchase agreement with the mjor public electricity suppliers in Scotland.

Wavegen and Queen's University Belfast (QUB) jointly developed the land installed marine powered energy transformer (LIMPET) with European Union support. LIMPET is rated at 0.5MW and is able to provide enough electricity for about 400 local homes. Managing director of Wavegen, Allan Thomson, said: 'This is a big day for us. Wave power has joined the important group of commercially viable, competitive and clean forms of sustainable energy; this is the launch of a new global market.'

QUB installed a small research wave energy station on Islay in 1990. The successful operation of this plant enabled the development of the LIMPET project. 'It is very satisfying to find 20 years of collaborative academic research being developed commercially, Professor Trevor Whittaker of QUB said. 'LIMPET is an important milestone in the development of this vast ocean resource'.

Philippe Schild, European Commission scientific officer for LIMPET said LIMPET is there to prove that energy can be extracted commercially from the ocean. ■

New contracts in Costa Rica

Sweden-based NCC Civil Engineering has won contracts for two hydro power plants in Costa Rica, as well as a hydro dam facility and water supply project in the Dominican Republic.

One of the hydro power plants in Costa Rica, Brasil II, is located on the Rio Virilla river, just outside the capital city, San Jose. The power plant will be located about 2km downstream of the Brasil I plant which was constructed by NCC and completed in 1998. The project consists of a concrete dam, a transmission tunnel, concrete conduit, a pressure pipe line and a surface power plant. The plant will generate 31MW. The second power plant, E1 Encanto, is located about 100km northwest of San Jose on the Aranjuez river. E1 Encanto comprises a concrete dam, a long transmission tunnel lined with concrete, penstocks and a surface power plant. The projct generates 9MW. Both hydro power plants will be constructed by a consortium, Consortio Noruego, which in addition to NCC includes General Electric Energy Norway and Alstom Norway. Statkraft Grxner is the designer. NCC's share of the order amount is about US$50M.

In the Dominican Republic, the contract involves the construction of a dam on the Camu river in La Vega province in the center of the western part of the country. The main function of the dam is to provide flood control but it will also provide secure water supplies to the area, for drinking water and farm irrigation. The project involves a 70m high ballast-filled dam with an asphalt core and a 3-4MW surface power plant. NCC's share of the project will amount to approxi-mately US$35M. ■

Source:International Water Power & Dam Construction

India invites tenders for new project

India's National Hydroelectric Power Corporation(NHPC) has announced the imple-mentation of the 3 × 10MW Kishanganga hydro project in the state of Jammu and Kashmir.

NHPC is inviting tenders for construction of the dam, tunnel and power house ,which are expected to take seven years to complete. The project envisages the construction of:

- A 101m high concrete gravity dam.
- A 620m long and 6.5m diameter diversion tunnel.
- A 21.7km long and 6.5 diameter water conductor system along with a suitable intake structure.
- A 15m diameter surge shaft.
- A 3.5m diameter steel-lined pressure shaft.
- 2m diameter penstocks.
- An underground power house with 3 × 110MW units.
- A 977m long tailrace system comprising a 4.1m diameter Dshaped tunnel.

The work will involve design and engineering, supply of construction materials, civil construction, fabrication, transportation, installation and erection of equipment, testing and commissioning. Bidding ends on 24 november 2000.

In Brief

- Bhutan's 45MW Kurichu hydro power project will be expanded by the addition of a fourth 15MW unit. The project consists of a 57m high dam and a dam-toe power house. The original 3 × 5MW phase of Kurichu, presently under construction by India's National Hydropower Corporation, is supposed to be completed by September 2001 at a cost of about US$ 56M.

India small hydro funding to foster 110MW

The India Renewable Energy Development Agency (IREDA) hopes to fund 30 to 40 new small hydro projects, totaling about 110MW, from US$110 million available for development of private sector projects in India's northern and central states. The World Bank approved US$135 million in funding to IREDA, of which US$110 million is to be used to develop private sector small hydro projects in India's northern and central states; the other US$25 million is to be spent on energy efficiency programs. The small hydro projects are to include canal-based and dam toe schemes, run-of-river schemes, rehabilitation of old plants, cooling water systems of thermal power plants, and stand-alone micro-hydro schemes. The World Bank said the initiative is to reduce power shortages and greenhouse gas emissions by tapping part of India's estimated 10,000MW in small hydro resources. It said small hydro resources totaling about 500MW have been commissioned to date, with another 500MW under way. ■

Source:HRW

Update on Kukule

The construction of the 70MW Kukule hydro power project in southwestern Sri Lanka will now be completed by the end of 2002.

The project began in 1999 and consists of a 16m high and 110m long concrete dam, a 5.7km long and 5.6m diameter power tunnel. The underground power house is 200m below the surface, 52m long, 16m wide and 29m high. The tailrace tunnel is 1.6km long. The tunnels will be largely unlined as tests have indicated rock of very good quality.

The Ceylon Electricity Board, a state-owned utility and owner of the project, has signed a contract with Mitsui of Japan for the supply of turbines and generators. The turbines will be operated under a maximum head of 186m. ■

Alstom launches new mini hydro range

LSTOM POWER HYDRO has announced the launch of a complete mini hydro solution. Named Mini-Aqua, the product has been developed to integrate the hydro turbine, generator and control system in a single and optimised product.

The Mini-Aqua range, using standardised components, has been designed for a broad range of head. The targeted delivery time is eight to ten months, depending upon size and model.

The control system used in Mini-Aqua is the Aqua, which provides all the necessary control, monitoring, voltage regulation, speed governing and electrical protection in one compact package, said the company.

For high head applications, Mini-Aqua incorporates Pelton type turbines, and high speed generators directly coupled to them. Two configurations are available:horizontal shaft, with one or two injectors; and vertical shaft, with four or more injectors.

For medium head applications, Mini-Aqua incorporates Francis turbines, with three configurations available. Choices are Francis horizontal shaft, single runner; Francis horizontal shaft, double runner; or Francis vertical shaft.

For low head applications, the product incorporate Kaplan turbines of the S type family, with generators coupled directly to it, or indirectly through a gearbox for larger outputs under a lower head. For very low head applications, Kaplan turbines are incorporated with high speed generators coupled indirectly through a gearbox.

According to Alstom, first customer reactions are very positive, as demonstrated by the recent orders for 15 machines in Brazil, and two machines in Morocco. ■

Source:International Water Power & Dam Construction

BC Hydro signs power purchase agreement

Canadian Utility BC Hydro has signed a power purchase agreement with Miller Creek Power Limited (MCPL). MPCL proposes to develop a 25MW, run-of-river hydro project to be built near Pemberton in British Columbia, Canada. As part of its integrated electricity plan, BC Hydro, a provincially owned utility, is committed to meeting up to 10% of its load growth with green energy resources over the next few years.

The MCPL project will provide approximately 100GWh of energy each year, enough to meet the annual needs of about 10,000 residential customers. The development includes two water intakes, an undergound water pipeline, a small power house, a 2.5km power line and road access. The project will be located approximately 5km northwest of Pemberton, and about 125km north of Vancouver in British Columbia.

The construction of the project is planned to start in spring 2001 and should begin generating electricity in spring 2003. ■

Nepal and India may increase power trading

Nepal and India may increase the quantity of power exchanged between the two nations to meet shortages in bordering areas. Technical paneles from the two countries have recommended that the power exchange be raised from 50MW to 150MW, according to Bholanath Chalise, chief of the state-run Nepal Electricity Authority(NEA).

Under a 27-year-old arrangement, Nepal and India exchange power at various points across their 1580km border to compensate for local shortages. Nepal has been facing acute power shortages as the peak hour demand of 380MW exceeds its generation capacity of 300MW. In addition to the imported energy from India, the deficit is met through scheduled power cuts. Chalise said the shortage was likely to ease further when two private facilities—the 60MW Khimti hydro power project and the 36MW Bhote Koshi scheme — come into operation from June 2000. Officials said Nepal would become a net power exporter within two years once the 144MW Kali Gandaki hydro project, being financed by the Japanese government and the Asia Development Bank, is commissioned. ■

Private power producers urged to cut rates in Nepal

The government of Nepal has urged Norwegian and US utility companies operating in the country to slash the price of the electricity they sell to the state-owned power distributor,Nepal Electricity Authority(NEA).

NEA, the only utility autho-rised to sell electricity to consumers in Nepal, has agreements with the operators of the Khimti and Bhote Koshi hydro power plants to buy their electricity at about seven US cents a unit. The Khimti plant, a joint venture with Norway's Statkraft, is now generating 60MW while the Bhote Koshi project, a 36MW Nepali-US private venture, is ready to come on line. ■

Update on Elsie Dam

BC Hydro has now completed work on stage 1 of the Elsie dam upgrade in Vancouver Island, Canada. The dam, part of the 27MW Ash river hydroelectric facility built in 1958, is being upgraded to resists major seismic events. Dam safety investigations had shown that a thin layer of saturated loose material in the main dam at approximately el 326m would liquefy during a major earthquake.

Stage 1 of the upgrade included excavation of a 100m wide slot in the spillway, to keep the reservoir level below el 326m, and thereby prevent the saturation of the loose material layer.

The second stage of the upgrade work will see the replacement of the loose layer in the main dam, as well as placing a rock berm on the downstream side of the dam. This work is planned for April to October 2001. Once the second stage work is complete the temporary spillway channel will be plugged with concrete to re-establish normal reservoir levels. ■

Progress in Pakistan

The government of Pakistan has announced a new hydro power policy which aims to meet the future electricity demands of the country at reasonable rated. The Ministry of Water Power Resources has organised a committee to prepare its recommendations for the new policy. The committee will also identify new projects.

Meanwhile, Pakistan's chief secretary of northern areas. Sung Marjan, says there is great potential for producing electricity if natural resources are exploited in the region. At a workshop on hydro power potential in northern areas, five prime sites for hydro power were identified.

They are: Naltar, 22MW; Phunder, 87MW; Harcho(Astore), 40MW; Basho(Skardu), 24MW; and Dioan(Astore), 25MW. Feasibility studies are already under way for these projects.

The Water and Power Development Authority (WAPDA) is also echoing Marjan's plea for new projects, expressing concern about sedimentation which has caused a 24% reduction in the capacity of Tarbela reservoir, and the need to construct new dams to meet the irrigation and power requirements of the country.

Finally, about 50% of the work on the world's largest run-of-river hydro power project, Ghazi Barotha, has been completed and the first 290MW unit will be commissioned on 14 August 2002, according to WAPDA sources. All five of the generating units will be commissioned by July 2003 and it will produce 1450MW of hydro power annually. ■

Source:International Water Power & Dam Construction