Study on Sustainable Development of Small Hydropower in China

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1 Foreword

China bears a high relief in the west and low in the east, with complex topography, totaling 2/3 of the whole country's area for mountains, hilly regions and zigzag plateaus. Therefore the hydraulic resources are abundant, with potential hydraulic amount of about 680000 MW, of which, small hydropower resource is very rich too and has great exploitable potential. According to general investigation in early 1980s, the exploitable amount reached 87000MW, ranking the top in the world. These small hydro is distributed among more than 1600 counties in the country, of which, 58280MW exploitable small hydropower in the west, accounting for 67% of the whole country, 44740MW for 6 provinces (regions and municipalities) such as Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet and Enshizhou of Hubei and Xiangxizhou of Hunan in the southwest part, which are the most richest regions for small hydropower resources in our country, accounting for 51.4%, 13540MW for 6 provinces (regions) such as Inner Mongolia, Shaanxi, Gansu, Qinghai and Xinjiang in the northwest part, which are relatively concentrated in distribution of small hydropower resources, accounting for 15.6%, 14370MW for mountainous areas of Zhejiang, Fujian and Guangdong in the east part, accounting for 16.5%.

The small hydropower resources in our country show the following major characteristics and advantages: First of all, small hydropower is mainly distributed at remote mountainous areas, national areas and old revolutionary area, where there is wide land, scarce population and scattered load, so the great grids are inaccessible and not fit for long distance power supply. While the small hydro has the characteristics of scattered development, in-situ grid setup and power supply, low power generation cost and power supply cost, which are natural and helpful supplement for great grids and can't be replaced. Secondly, small hydropower is clean and renewable energy, and fully confirmed by the world. Development of small hydropower is beneficial to ecological environmental improvement, coordinating progress of population, resource and environment in our country. Thirdly, Our country's small hydropower resources are widely distributed and largely covered, accounting for 23% of the total, playing important role in adjustment of power structure. Small hydropower is medium scaled, cost saving, short construction schedule and effective, helpful for mobilizing people's initiative in each level, suitable for government, local, collective and private development. Owing to the above advantages, our country, since early 1980s, has made out series of policies to encourage small hydropower development, solve regional power consumption and promote social and economic development in the region. Through over 20 years' construction, great achievements have been made in small hydropower exploitation. By the end of 2000, more than 40 thousand small hydropower stations have been built in the country, with installed capacity of 24850MW, accounting for 32.4% of the whole country, and over 40% of the world's small hydropower exploitation, annual output of 80 billion kWh, accounting for 36.2% of the whole country.

Currently, how to transform the advantages of small hydropower resource into wealth in the countryside to promote poverty-relief and economic development in poor areas, promote environmental protection with coal instead of electricity, promote river regulation and social stability. All these have become utmost important topic for our country's hydropower development. Through more than twenty years' development, great achievements for small hydropower undertakings have been made in our country, however, many problems still exist in development of small hydropower, for example, serious imbalance in exploitation of national small hydropower exploitation, i.e. high exploitation rate in the coastal east part, low exploitation rate in the remote west part, lagging behind in power system reform, not good for competition among small hydropower enterprises, insufficient capital for small hydropower construction etc. Successful development of small hydropower lies in the capability of solving these restrictions and obstacles, among which, financing is one of the major problems we are facing now. Therefore, a reasonable and effective small hydropower investment system shall be established to ensure effective input of funds in development of small hydropower and promote booming of small hydropower industry and whole national economy. Reasonable investment system includes two

aspects, one is investment system suitable for small hydropower development and the other is corresponding policy system. That is to say, investment system or opening hydropower investment market would not absorb funds into the hydropower market without renovation in electricity price and grid policies.

2 Benefit of Hydropower Development and Selection of Hydropower Investment Mode by the Country

2.1 Benefit of Small Hydropower Exploitation

Benefit of small hydropower exploitation is mainly composed of ecological benefit, social benefit and economic benefit.

Economic benefit can be explained from two points, first of all, direct economic profit from small hydropower development. With glorious progress of small hydropower undertakings for several decades, a complete set of policies, management system and construction specification and codes have been established. According to the statistics, the whole nation's assets reach more than 100 billion Yuan and annual business income for power supply, generation more than 40 billion Yuan, tax more than 7 billion Yuan, gaining marvelous and great economic benefit. More than ten provinces (self-governance regions and municipalities) such as Sichuan and Guangxi, set up provincial hydropower group corporations engaged mainly in small hydropower, some of them own several billions of assets. Over 70 trans-county regional hydropower group corporations are also established in the country, of which, there are 9 listed corporations in the stock market. These listed corporations have obtained direct economic benefits from hydropower resource exploitation. Secondly, economic benefit refers to as much as possible saving resource for profit by adopting hydraulic power instead of thermal power generation. Hydropower resources, different from those of timber and coal, belong to renewable resources, therefore, the cost of hydropower resource consumed by the equal energy is apparently lower than that generated by the other modes. From this point of view, small hydropower development would obtain economic benefit by saving the resources.

Ecological benefit is also called environmental benefit. Ecological and environmental benefits co-exit. Special space for both economy and environment constitutes a great environmental and economic system. The people's activities rely on superb energy and material from environment, at the same time, giving back some low quality energy and material to environment. Therefore, the people's activities carried out in the great environmental and economic system would not only obtain some economic benefit, but also bring about big or small impact on environmental system definitely. The beneficial or significant impact structure on environmental system resulted from people's activities is called ecological benefit. Hydropower resources, owing to their cleanness and non-pollution, enjoy good ecological benefit. First of all, small hydropower exploitation has less environmental pollution. In 1999, small hydropower generation in the country of more than 72 billion kW is equal to that of 3.4 ~ 4.4 million ton standard coal, equal to exemption of 850 thousand ton of smoky dust, 900 thousand tons of sulphur dioxide, 85 million ton of carbon monoxide, 320 thousand ton of nitrogen chloride by coal fired generation and large quantities of wastes and sewages on environment impact and damage. Secondly, the available power from small hydropower exploitation utilized in the people's daily life may replace the domestic necessary firewood, so that timber resources are saved, By electricity in place of firewood from small hydropower exploitation, there are 20 million households using electricity for cooking in the power supplied area. About 9 million cu.m of timber is saved annually to upgrade the ecological environment without cutting down trees. The forestation coverage rate for initial electrification counties increased on average 9.88% in 15 years, up 5.4% in comparison with the country. By electricity in place of firewood, magnificent benefits have been obtained, decreasing tree cutting down, upgrading forest coverage rate and effective protection of ecological environment.

Small hydropower exploitation signifies our country's demand for clean energy structure and sustainable development, therefore it possesses good social benefit in addition to economic and ecological benefits. The social benefit lies in solving the local production and living electricity consumption. At present, 8000 counties in the country are mainly provided by small hydropower and their grids. Formation of small hydropower grids experienced local exploitation, local power supply, grid connection among several stations, regional power supply, county grids and tran-county grids. Nowadays, 1/2 of land, 1/3 of counties and 1/4 population depend on power supply from small hydropower. Small hydropower, with its unique low power supply cost, provides cheap power for remote mountainous area, national areas and revolutionary areas. Thus more than 300 million people have got rid of pine torches and changed their original ways of life (i.e. getting up at sun rise and lying down at sun set), with obvious social benefit. In agricultural power

consumption, industrial and agricultural staple food process accounts for about 62.9%. Cheap power source from small hydropower gives the development opportunity for most of the county and town industry, which is a great support for the agricultural economy. Take Fujiang province as an example, among 47 counties generating and managing power, the household electricity price for 41 counties is lower than 0.53 Yuan/kWh, for 30 counties is lower than 0.40 Yuan/kWh, for 22 counties is lower than 0.35 Yuan/kWh. All these counties enjoy the household electricity price lower than national average price of about 1 Yuan. In addition to the people's production and domestic power consumption, direct and indirect agricultural irrigation benefit and flood control benefit and flood control benefit result. Development of small hydropower has regulated initially thousands of medium and small rivers, increased reservoir volume of 50 billion cu.m, by over 100 billion cu.m, increase irrigation area of 25.3 million mu, solved drinking water problem for 64.25 million people and 47.42 million livestock, promoted water conservancy in mountainous areas with small hydropower as guidance, improved flood and dry control, and water conservancy served for agriculture, upgraded regional flood control capability, besides, solved farmers' reemployment.

2.2 Study on Corresponding Small Hydropower Investment Mode

Benefits among three parties' interests shall be considered in establishing our country's small hydropower investment mode since small hydropower exploitation owns the above three benefits. In our country, hydropower resources belong to national property. Public ownership of hydropower resources is what our country abides by. But execution of public ownership does not mean we need not explore resource property system and resource utilization system suitable for socialism market economy development, otherwise, effective utilization of hydropower resources would not be ensured, failing to meet the interests among investors, consumers and country. In the long period, our country's government has concentrated the ownership of hydropower resources, utilization right and social administrative authority. Long-year practice shows the traditional hydropower resource system bears serious torsion of interests, unclear definition of property right and absence of property person. These problems are not good for market economic development, seriously restrictive to social production development and low effect in source utilization. Therefore, government obligation and enterprise management system should be changed in exploiting small hydropower to realize separation between utilization right and ownership right. Investors are given utilization rights so that the hydropower resources are developed non-gratuitously, reasonable and high efficient small hydropower investment and capital introduction system are established.

The national profit right for hydropower resource, which is state-owned shall be realized by selling the utilization (management) right to micro-economy non-gratuitously and restrictively. According to the current property theory represented by "Kesi Principle", malpractice of traditional resource property shall be reviewed in exploitation and utilization of hydropower resources to deepen further reform and change management institution, actually realizing the separation between ownership and utilization of resources. As a matter of fact, utilization efficiency and economical reasonability of hydropower resources mainly depend on suitable property system for social development requirement, i.e. property relation between ownership and utilization of resources, and clarification degree among interest parties defined herewith. Therefore, the main body of property right shall be defined in the form of rules and agreements, defining strictly right, interest and responsibility between ownership and utilization of resources so as to form hard restriction of property relation among main bodies of each interest. Reasonable and efficient utilization of hydropower resources and investment system, for the country, the owner of resources, under the condition of ensuring the final ownership of resources, selling non-gratuitously and restrictively, are significant for realization of profit right of hydropower resources and settlement of merchandisation management as well, arousing resource users' initiative for reasonable utilization of resources and encouraging their management talents. For hydropower resource users (investors), on one hand, independent property right has been obtained within specified limit of years after paying rents of resources, on the other hand, acquire of resource utilization right and corresponding profit is conditional, i.e. property responsibility shall be undertaken economically and lawfully

Reasonable and efficient utilization of hydropower resources and investment system will assure to sell the utilization right non-gratuitously and restrictively for the country – owner of the resources, which not only realize profit right of hydropower resources, but also solve the problems of managers for merchandisation of resources. Consequently, they will make good advantages of resources and show their own talents fully. For users (investors) of hydropower resources,

on one hand, independent ownership right has been obtained after paying rents in specified year, and on the other hand, utilization right of resources and corresponding profit are conditional, i.e. will bear property responsibility economically and lawfully. Therefore, users and investors of hydropower resources will obtain short term and long term profit after gaining self-investment and efforts, providing good excitation for self-accumulation and self-development. Of course, exploitation of hydropower resources bears obvious social benefit, the government is considering to give compensation for the resulted social benefit and ecological benefit in the process of exploitation of hydropower resources while establishing investment and capital introduction system, such as compensation for environment benefit, public welfare hydraulic projects such as flood control and poverty relief compensation, so as to greatly encourage the initiative of investors and developers.

3 Reasonable Decision and Non-gratuitous Exploitation of Hydropower Resources

3.1 Basis of Reasonable Decision for Hydropower Investors – Economic Benefit

Economic motive is a source of initiative resulted from production and business activities for small hydropower investors and developers so as to encourage users of the resources in quest of their economic interests. What concerns the investors most is the economic interest for investing hydropower stations, i.e. min. cost and max. profit. Concretely speaking, the profit in hydropower investment comes from mainly two aspects: one is the economic profit from hydropower stations, i.e. quantity of electricity on the grid after power generation times the rate of electricity; and the other is government allowance and compensation. Exploitation of small hydropower is very social and beneficial, so the government will encourage the investors by way of allowance, which is something like government allowance in international trading. On the other hand, Exploitation of small hydropower will bring out direct ecological and social benefit, so the government will also give corresponding compensation according to different managers, both of which constitutes part of investors' profit. The investment cost is mainly composed of previous dealing cost, indicating pre-stage input and compensation for the residents upstream and downstream. While the construction cost indicates the total cost of construction of power stations and business cost indicates all the cost in management.

The investors of small hydropower aim at cost and profit to expect max. profit. Investors and owners of hydropower sources share the unity of opposites. Different interest objects and effective functions exist between investor and the government in exploitation and utilization of hydropower source, this difference will certainly cause the conflicts of interests and contradiction between the two parties.

Uniform is shown in the fact that owners of hydropower resources in quest for their interests will not completely hinder main interests of users, while the investors on hydropower exploitation will not completely disregard main interests of owners to realize their profit. Therefore, interests for both owners of hydropower resources and investment users are closely related. Outer excitation and restrictive condition of main interests for investors shall be created and provided by owners of resources. macroscopically speaking, main interests of owners of resources, increase or decrease, to some extent are subject to users' action microcosmically. Thus, there will be two phenomena of interest relation between two main parts of interests in hydropower investment, one is good cycling for mutual promotion of interests and the other is bad cycling for mutual damage of interests. If the users of hydropower investment, with upgrading of their interests, also promote the interests among nation, society and consumers, then good cycling is formed, otherwise, the users, with loss of their interests, also damage the other main parts of interests, then bad cycling is formed. Therefore, in establishing small hydropower investment and exploitation mode, what we seek after is a good cycling and sustainable development mode by which, upgrading investors' interests and the other main parts. Market regulation system for non-gratuitous utilization and transfer will significantly realize optimized combination of multi-party interests.

3.2 Non-gratuitous Transfer of Utilization Right for Hydropower Resources

Before establishing non-gratuitous transfer system of small hydropower resources, property right of small hydropower resources shall be strictly defined. Reasonable definition on property right of resources will make the utilization right of hydropower resources to be a special commodity entering the market. Flow and transfer of utilization right will guide the resources as an economic unit in effective utilization so as to realize optimization of resources. Therefore, in selection of investment mode of small hydropower, a market disposition system for non-gratuitous transfer of utilization right on

the basis of restrict definition of property right of hydropower resources so as to make the best use of small hydropower resources in our country and meet the demands for each party.

1) Establishment of Development Right Acquisition of Hydropower Resources by Competition

Competition system is quite recommended by economists so as to give full play for the market system, full realization of the consumers' interests, optimize arrangement of resources and upgrade efficiency. Therefore, competition system shall be established while acquiring development right of hydropower resources so as to improve utilization efficiency of hydropower resources. Non-gratuitous transfer of hydropower resources is similar to that of general resources. There are two forms: one is transfer by agreement, which is used when there are only a few competitive investors, the other is to determine developer at public auction, which is adopted when many investors scramble for developing right of resources, in that case , the market competition is preferred.

Take Zhejiang as an example, in recent years, economic development and exploitation of small hydropower resouces in Zhejiang province create better condition for adoption of competition system. The exploitable hydropower resorces are scarce. Basin planning and professional hydropower planning have been completed so as to make best use of the resources. Hydropower investment is acknowledged by the public. In 2000, publication of uniform electricity rate scheme changes the previous adoption of one rate for one power station so that the investors may predict the future profit. Zhejiang is quite developed in privately managed enterprises and the investors have high market and economic consciousness. Under this condition, the competition system adopted by the government attracts great amount of investment capital and greatly promote development of small hydropower development. The statistics from Zhejiang Provincial Hydropower Development and Management Center show that, there are more than 2800 existing completed and under construction small hydropower stations, with total installed capacity of 1890MW. The total investment of the small hydropower stations is 14.1 billion Yuan calculated at 7500 Yuan of average investment per kW, of which, above 70% is from the local people's investment.

2) Rate System for Utilization of Hydropower Resources

The rate is the most effective regulating means in the market-oriented economy, so the rate system in conformity with the utilization of resources in the process of developing hydropower resources. The rate of hydropower resources is established on the cost of resources, which include two parts: one is fixed part, i.e. payable rate of water resources for per kWh, the other is floating part, increasing with the total installed capacity and increasing with lowering of investment cost per energy, quite related with development and construction cost, and management cost. Under market- oriented economy, unit energy producing cost can be expressed as: unit energy producing cost = cost of resources + development and construction cost + management cost. The current electricity rate is based on the average social producing cost of unit energy rather than on that of individual enterprises. That is to say, with lowering of development and construction cost and management cost, the rate of resources will be higher, otherwise, if the resources are poor, i.e. summation of development and construction cost and management cost, reaching or nearing average social cost, the false joint venture of resource market shall be zero or near zero. What's more, if summation of development and construction cost and management cost, exceeding average social cost, the value of resources is negative, for example, auxiliary power stations for flood control projects need allowances from the government so as to attract investment. Therefore, when the electricity rate is uniformed, profit making for hydropower stations is subject to the quality of resources. Non-gratuitous transfer or public auction of resources rationalizes the development cost, which is also an effective way of suppressing the electricity rate.

3) Pertinent Problems in Non-gratuitous Transferring System

In addition to competition system and price system, the following shall be noticed in establishing non-gratuitous transfer system of hydropower resources. The government departments shall reveal the information in corresponding media according to different investment quota in dealing with non-gratuitous transfer and remove the entrance barriers. For multi-purpose water resource development projects, especially for public beneficial projects for flood control and waterlogging drainage, the market competition might possibly make the price of development right negative, i.e. necessary for government financial allowance. In fact, the summation of the government allowance and transfer price of water resource is equivalent to the project investment quota of public beneficial function except power generation, which shall be input by the government, so the transfer price of development right is actually positive. If the participants are not enough to carry out competitive

auctions, both parties shall adopt the agreement for non-gratuitous transfer and determine a certain resource price. When the government is intended to support the investors, participation of shares as resource shares can be adopted, but the right of shares belong to the nation, rather than to the local residents.

4 Corresponding Policy for Small Hydropower Investment System

The corresponding policies are necessary to ensure the effective operation of small hydropower investment system.

1) Establishment of Perfect Grid Electricity Rate Policy Relative to Economic Development

Seriously twisting phenomena of the electricity rate system are still existing for the environment. Especially, the thermal power raw material is low in price, the environment cost caused by pollution is not calculated into the production cost and environmental space is utilized non-gratuitously. The current electricity rate entering the national grid for small hydropower is about 0.20 Yuan, and the local buying rate from the national grid is normally above 0.48 Yuan. Seriously polluted thermal power amount with high price is utilized on one hand, and clean and recycle small and medium scaled hydropower is allowed to enter the grid with low price and restrictive amount or as ineffective electricity amount (i.e. non-settling electricity rate) on the other hand, which fails to reflect the market economic rule and stimulus the power management initiative. Therefore, in the future, establishment of electricity rate system shall consider the environmental factors so that the electricity rate will effectively reflect the true value for power and environment, thus setting up a sustainable developing system. It is suggested that the rural small hydropower rate be compensated and the grid electricity rate at least be not lower than the rate of thermal power in the current twisting electricity rate. After separation of power plant and grid, and price competition, the government gives protection for the rural small hydropower grid price. Normal energy competition will not be directly participated and the average electricity rate above the grid is listed in grid maintenance cost and allocated in the whole grid. Besides, Clean resource distribution system is adopted to ensure sufficient grid and upgrade the ratio of clean energy.

2) Preferential Tax Policy

Preferential tax policies shall be adopted for small hydropower development to encourage investors' initiative. In 1994 before reform of national tax reform, only 5% of hydropower income was charged as product business tax. Preferential value added tax of 6% was executed starting from 1994. The income tax is surcharged 33% of the profit. Some places returned all or part of the income taxes to the enterprises for producing electricity with electricity. In the future hydropower development, two years of income tax exemption and three years of half income tax exemption for water conservancy and hydropower enterprises, and 6% value added tax for small hydropower would still be adopted. It shall be made clear that small hydropower, not providing electricity to the great grid, shall be surcharged 6% and 11% exemption with VAT invoice, checked by the grid power supply department, or surcharging first and returning then so as to ensure the execution of lessening tax of small hydropower. At the same time, according to the overseas experience, active energy environmental tax policy shall be made out, setting discharge expense for the environmental pollution, especially the greenhouse gas such as carbon dioxide in the energy producing process. All the expense will be used in the clean and recycle energy construction such as small hydropower as allowances.

3) Financing Policy Beneficial to Small Hydropower Development

Financial policy for small hydropower construction is significant to our country's small hydropower development, but for years there is not sufficient fund for small hydropower construction. On one hand, less capital was input by the government, with absence of state-owned small hydropower asset representative; on the other hand, the regions where small hydropower stations are located are poverty-stricken mountainous areas and the local banks are restricted in loan. Distribution and loaning by the high level bank will bring about greater loan cost and risk, leading to blockage in loan channel. Therefore, financing policy beneficial to small hydropower development shall be established. First of all, small hydropower is strongly beneficial, and the government is proposed to give support in financial budgetary estimate, financing channel and credit market so that more funds will be invested in the rural small hydropower. It is recommended that investment plans for small hydropower be listed in the national financial budgetary estimate in each level. The financial funds mare mainly used in distribution of the principal, technical advancement for small hydropower, quality inspection and after-sale service system etc. replenishing interests. Special loan for rural small hydropower construction shall be recovered, with loan period of 25 ~ 30 years. Diversification of investment main body and financing small hydropower construction fund in various channels and places are carried out by opening the markets, ab-

sorbing social, foreign funds and private enterprises. Secondly, financial organizations shall give the small hydropower construction the preferential loan with interest. The funds for local hydropower construction mainly comes from the financial organizations, in which, the Agricultural Bank and the Construction Bank have set up a special loan, listing scale of credit, lengthening loan repayment period and making low interest or financial loan with interest.

4) Lowering Financing Cost by Utilizing Capital Market

Up to now, the listed companies for hydropower gain financing of 5. 2172 billion yuan totally, of which, the first issued financing of 3.914 billion yuan, accounting for 75.02% of the total financing, share distributed financing of 11.5315 billion yuan, accounting for 22.1% of the total financing. It is shown that the listed companies for hydropower are very poor in utilizing the share markets to distribute the resources and their financing capability have not been given full play. Owing to insufficient hydropower construction funds, the current exploitation rate of small hydropower is only 28.6% and great amount of clean and recycle energy are wasted. Re-grouping of assets, buying and merge by utilizing the capital markets will quicken the development of listed companies for small and medium scaled hydropower so as to form leading enterprises, solve the insufficient funds for small hydropower construction and promote the upgrading and fast progress for our country's small and medium scaled hydropower industry, which mainly includes: *(1) "Upgrading on the existing amount" and financing project construction principal, i.e. selling the small hydropower plants which are in good efficiency and putting into commission to the listed company to get the capital of hydropower construction from the capital market for further development of new projects. So insufficient capital will be solved, at the same time the listed company, with its good credit, can provide guarantee of hydropower projects for the bank loan, making contributions to the regional or development of hydropower bases. (2) Joint venture or cooperation. The listed companies have good financing advantages, with whom, the small hydropower enterprises may undertake joint venture or cooperation, pooling together various resources and capability. The listed companies and non-listed enterprises share the advantages and resources to promote common development.*

5 Conclusion

Through years of development, great achievements have been made in the national small hydropower industry. Small hydropower has met the mountainous poverty stricken population for poverty relief and making rich and domestic power consumption, improved agricultural infrastructures and agricultural production capability. The rural electrification has promoted rural industrialization and urbanization, optimum upgrading of industrial structure and small town construction. The country's assets of small hydropower has reached nearly 300 billion Yuan. However, the small hydropower installed capacity in our country accounts only for 29% of the exploitable resources. The rural initial electrification counties which have been executed or are under construction have average annual power consumption of 280kWh, a big difference in comparison with the developed countries. About 80% of population is living in the countryside, in which, electricity supply is unavailable for more than 75 million people. In rural areas, about 600 million ton of standard coal will be consumed every year. Most part of the energy supply depends on the plants burning directly with low efficiency, thus local vegetation and ecological environment are being seriously damaged, causing much natural disasters.

Development of small hydropower based on actual conditions is a necessary component of execution of sustainable development strategy. Our country's small hydropower still has a great development potential. Establishment of small hydropower investment system will assure a good and sustainable development in longer periods. Our country's small hydropower investment system is set up according to the following key points: *(1) Property right of small hydropower resources shall be strictly defined by using the modern theory of property right, separating ownership right and utilization right, determining the right, interest and responsibility between ownership right and utilization right so as to form hard restrictions of property relation among the interest parties. (2) The market distribution system for non-gratuitous utilization right transfer shall be set up, taking care of social benefit and ecological benefit according to the interests of investors so as to make our country's small hydropower resources fully utilized and meet the overall requirements. (3) Small hydropower development shall seek after renovation of the systems and various forms of public-owned system so as to establish and improve the modern enterprise system for share-holding system and group companies. (4) Corresponding policies for effective operation of small hydropower investment system shall be set up, such as electricity rate system on the grid, tax system and financing policy etc.* ■

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Private Participation in Small Hydropower Development in China

— Comparison with International Communities

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Abstract *In recent years, Chinese private investment in SHP (small hydropower) has been booming like mushrooms after rain. Globally, many developing countries have formulated a series of incentive policies to encourage the mobilization of private capital for SHP, but the recent enforcement is far from meeting expectation. This article overviews private enterprises investing in SHP domestically, analyzes similarities and differences between China and international communities, as well as the comparability and mutual referential values, and also explores some approaches for improvement. Furthermore, this article presents several particular issues in this respect, with a hope to further promote the sound development of SHP privately financed. Attached here are 2 tables and 2 figures.*

Key words *SHP, private enterprises, hydropower development, investment, incentive policies*

1 General of SHP development and private investment in China

1.1 An overview of SHP in China

In China, a hydropower station with an installed capacity of no more than 50MW is included in the SHP category, which is mainly situated in rural areas, developed and managed locally along with extension of local grids. Actually, SHP in China, not only suitcases all the hydropower stations each with an installed capacity up to 50MW, but also local power grids correspondingly.

The exploitable SHP resources in China amounts to 87,000MW, up to 23% of the exploitable hydropower resources in the whole nation, and ranks the first in the world. By the end of 2002, over 48,000 rural hydropower stations had been built, with the installed capacity of 31,040MW and the annual output of 103.7 billion kWh in a total, which covers about 40% of the total hydropower capacity and 10% of the total electric power output respectively in China, and also takes world's first place. In some provinces, the rural hydropower accounts for 20~30% of the total power generation.

SHP is usually dispersed, easy to be exploited and integrated into local grids for power supply. As a favorable makeup to large grids, SHP can effectively meet the local power demand. At present, SHP resources in China is principally scattered in old revolutionary, minority nationality, remote and poverty-stricken regions, where the population and the load are sparsely distributed, and the large grid is far from reaching and thus not economically feasible. SHP has already become a backbone industry in the economy of many counties.

1.2 Recent situation of Chinese private enterprises funding SHP

Owing to low investment and risk, long service life, constant profit and low operation cost of a SHP plant, there lifts an upsurge in SHP financing in China with backup of various favorable policies. Especially in recent 2~3 years, private investment in SHP has been springing up like mushrooms after rain as a result of nationwide power shortage, and even continues to be heated.

Before 1990, the construction of rural hydropower mainly counted on central and local governments in a state-owned manner. The 16th National Congress of CPC put forward that "non-public capital is permitted to enter the infrastructure, public utility and other sectors or fields which are not prohibited by laws and rules". This decision undoubtedly paved the way for private enterprises entering the important field of hydropower development. The economic developing strategy "with the public sector remaining dominant and diverse sectors of the economy developing side by side", brought a far-reaching influence to rural hydropower development.

Since 1990s, the financing system for rural hydropower has undergone a reform, and all social sectors are encouraged to develop hydropower through different means such as share holding etc., as to balance power demand and supply as well as meet the government's shortage of fund. For over 10 years, many

private enterprises have more or less taken part in the hydropower construction for China's rural areas. The fund ratio for rural hydropower has gradually changed from the government-oriented to the private-oriented. It is estimated that share-holding and private power plants account for a very large proportion among the installed capacity increased each year. For instance, during 1994~2002 there was a total capacity of 1,058MW from new SHP in Zhejiang province, and the investment amounted to US$1.33 billion, in which US$1 billion was mobilized from private enterprises, more than 70% of the total. In Jingning county of Zhejiang, US$105,562,300 was accumulated from private enterprises for setting up 91 SHP stations with a total capacity of 155.4MW since 1990. In Guangdong, a total SHP capacity of 1,230MW emerged during the "9th Five year Plan" period, which attracted an investment of US$839,178,000, with over a half from the private. In Hunan, now the installed capacity of SHP has risen to 3,270MW, half of the total hydropower, and the annual output is more than 11 billion kWh for supplying half of the population in this province. In 2003 there are still 639 stations under construction, with the installed capacity of 145MW and total investment of US$780 million, and over 80% of fund is from private and foreign investors. Table 1 declares some indices of state-owned and non-state-owned SHP stations in 2001.

Table 1 State-owned and non-state-owned SHP stations (year 2001)

Ownership		State-owned	Non-state-owned (including private-funded)	Total
Stations	Number	8,244	34,783	43,027
	Ratio (%)	19.2	80.8	100
Installed capacity	MW	17,500	8,762	26,262
	Ratio (%)	66.6	33.4	100
Annual output	GWh	62,954	24,187	87,141
	Ratio (%)	72.2	27.8	100

In a nationwide scale, 66.6% of the SHP installed capacity is still state-owned.

1.3 The features of Chinese private enterprise funding SHP

It can be roughly wrapped up as follows:

1) PPP–Public Private Participation, which includes:
—Cooperative development between enterprises from water resources sector and electric power sector;
—Cooperative development between provincial & county-level investment companies and private enterprises;
—Development with investment from private enterprises;
—Foreign invested or joint venture for SHP development.

Any one of above modes can be registered as a limited liability company or a share-holding company limited.

The stock-sharing modes of a company is diverse. Besides capital, the right of land use, labor force, equipment, technology, construction fund etc. can also be taken as shares and even water right can be used for shares as to alleviate the water-use conflict between power station and downstream villages.

Meanwhile, private enterprises not only invest in new hydropower stations, but also directly purchase some medium & small-sized stations under operation in the grid. A development strategy of "walking on two legs" has been emerged in the private investment.

2) Private enterprises only finance the construction of power plants, and that for power grids relies on the government or state-owned enterprises.

3) Salient benefit.

Where private enterprises favor SHP investment, there is generally short of electric power, and the off-take tariff is relatively high, often above US$0.03 or even up to US$0.06 per kWh. When the construction cost is controlled within US$730~970/kW, and the utilization hour in the range of 3,000~4,000 hours annually, the rate of investment return is mostly over 10%, that is to say, the investment can be repaid less than 10 years, which is acceptable to most Chinese private enterprises.

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

4) The initiatives of private investors for SHP increase in full swing. In some provinces where condition permits, various rules or regulations are formulated for a paid transfer of water resources. This transfer can be implemented through public bidding, competitive auction or negotiated concession etc. In recent years, bidding and auctioning on water resources have become white-heated

in Zhejiang province. Taking Wencheng county for example, where 30 private investors have been involved in competing for the exploitation right of a hydropower station with capacity of 3MW, finally an ordinary citizen surnamed Lin won the right with a ceiling price of US$438,000. Meanwhile, 9 investors competed for 2 SHP stations with an installed capacity of 1,500kW and 2,500kW respectively in Suichang county, each with a bidding quotation starting from US$8,160 and US$13,300, and finally ending at US$120,300 and US$142, 700.

5) Effective policies and measures. In those provinces with abundant water and exploitable conditions, favorable policies are formulated and certain measures taken to encourage private enterprises to finance SHP in recent years, such as "Decision on Quickening the Development of Medium & Small-sized Hydropower in Yunan Province", "Regulation on Transferring the Right of Development and Utilization of Water Resources in Guizhou Province" and "Regulations on Strengthening Development & Management of Hydropower Resources in Zhejiang Province" etc. In spite of some differences, there are many similarities, including:

—Policy on tariff: it is defined that electricity taken out of rural hydropower is not included in the national power-supply plan, and can be sold under market adjustment. SHP tariff can be determined by the local price administrative authority with a principle of generation cost plus tax and a certain profit. On May 19, 2003 the Electric Power Company Ltd. of Guangxi Autonomous Region brought forward an official document called "Regulation of Energy Sold to the Grid From SHP", with an aim to actively support and encourage the local SHP to connect with power grids, optimize the allocation of power resources, and to fully use the surplus seasonal power of local SHP. A managing model was established with orientation on market and economic profit, as to spin with the demand of market variation. Thus in Guangxi, the problem baffling SHP integration was fairly settled.

—Taxation policy: since 1994, a favorable VAT (value-added tax) of 6% is levied upon SHP (versus 17% on large/medium hydropower), and 33% of the profit levied as the income tax. In some regions, no tax is required on SHP during the first 2 years after operation, and in the second 3 years a certain amount of tax can be deduced. In other areas tax is levied firstly, then one part or even all returned back for further investment, and this is the so-called "supporting electricity with electricity" policy. In Hunan it's stipulated that, a certain amount of tax can be deduced before getting back all construction costs.

—Discount loan: banks always offer support or convenience to SHP when granting loans.

—Governmental support: much attention is paid to areas with favorable situations for SHP development, for overall planning and management on hydropower resources, such as formulation of "Regulation on Transferring the Right of Water Resources Development and Utilization" etc.

—Others such as procedures simplified for project approval and land-use application, or favorable policies on off-take quantity and tariff when SHP integrated with a power grid etc. For instance, Guangdong has given priority to purchase electric power from SHP since 2003, and the electricity sold to grid ascended from US$0.021 to US$0.036 per kWh. Furthermore, each US$60.5 per kW was subsidized in discounted loan for project construction.

The above policies vary with different cases in different places, or lots of difficulties remain to be addressed yet, but these favorable situations are undoubtedly the basic requisites for a rapid SHP development.

6) Recently, a large number of private enterprises are emerging, along with the speedy development of China's economy, and a relatively huge asset being collected in the private enterprises, which lays the most important foundation of financial capability. Taking Zhejiang for example, the non-state-owned investment covers more than 60% of the total in recent years. By the end of 2002, there were over 300,000 private enterprises. In the total production value of this province US$111.25 billion, 70% attributed to private economy. It's about the same with other developed costal areas. After growing up, the private enterprises need to find outlets for their funds. Meanwhile, fierce competition exists in most professional sectors, and rightly the power-deficiency provides a golden opportunity. The investment return of SHP may not be very rich, but is relatively stable and reliable. The SHP field thus seems to be a land of promise to private enterprises. Private financing SHP initially started from developed regions in east China, with fund mainly from local investors. However in middle & west China, SHP mainly attracts private enterprises from east China, cooperating with local private companies.

Inside the arising tide of private funding SHP, some negative effects are also brought about, such as illegal campaign of "seizing river section" in which investors scramble for rights of river development. The rights are even transferred illegally in a few places and speculation and profiteering happened in disguised forms. As a result, a batch of so-called "4-withouts" illegal stations are built, i.e., without approval, design, acceptance test or normal management in

some areas, which leads to a serious result and damage. Emergent measures were taken by the government to weed out nearly 3,000 illegal stations. These negative effects are also adverse currents in the heated investment attributed to power shortage and chance of making money from SHP. This seems different from other countries which have already experienced the privatization of power industry for a long time, while private participation in SHP in China is just started. Based on the international practice, supervision on private power sector would be a very tough task.

2 International overview of private participation in hydropower projects

There are some similarities between China and others all over the world with regard to the investment, ownership and operating right etc. in hydropower field (including SHP), and even the whole power industry all definitely under control of state or public ownership. But since the 1980s, the trend of deregulation and privatization began in most of the countries with various scales and speeds. It certainly purposes attracting the capital of private enterprises for construction of electric power (hydropower), with coexistence of various ownerships or PPP (public & private participation) model, so that hydropower construction can be accelerated, and its management and benefit be improved. In the 1990s, this action was universally motivated. However in recent years, the investment of private enterprises in hydropower is not developed as expected in the world, and its further development is hindered evidently. In March 2004 issue of HRW (<Hydro Review Worldwide>) an article by Mr. Trouille, vice president at MWH (Montgomery Watson Harza) in the U.S. emphasizes that, "in recent years, the situation for private financing hydropower seems not favorable. Recent statements made by private developers canceling their hydropower projects illustrates that the current model used to develop and finance private hydro projects is inadequate". Besides, a working paper entitled "Consequences of Investment Behaviour of Public and Private Enterprises Participating in the Liberalised Power Sector of Colombia" written by Environmental Policy and Management Group, Environmental Science and Technology, Imperial College of Science, Technology and Medicine of Colombia also points out, "investment by the private sector has declined over the last couple of years raising the issue of who will finance the infrastructure development in the region (Latin America)". All the European countries generally show their active attitudes to implement the Kyoto Protocol for promoting the development of renewable energies (including SHP), but practically some issues still need to be addressed. During recent discussion with experts from Renewable Energy Association of Austria, we were informed that SHP in Austria mainly belongs to state-owned power corporations, and its off-take tariff cannot compete with large power stations, especially nuclear power. Private investment for SHP is walking with difficulty. Although a series of incentive policies have been formulated to promote private financing for SHP in many developing countries in Asia, such as India, the Philippines etc., the implementation in recent years is far from anticipated. For the above aspects, all the nations are analyzing and taking measures to push forward the development of SHP privately funded.

2.1 The cause of widespread decline

There are numbers of reasons for private financing decline in SHP (including hydropower) recently in many countries, the generalized issues of which are as follow:

1) The generation cost is relatively high in early operation (i.e. the first 10-year loan payback period) of a hydropower station, which makes it uncompetitive with the conventional large station in power grids.

As per the analysis (see Figure 1) made by Mr. Teouille with Montgomery Watson Harza in U.S., the average generation or production cost of private funded hydropower stations shall be compared with those of other electric utilities on grids (adopting the typical tariff range of each) in order to ensure the off-take tariff for making private hydropower financially viable. The 100-year time frame shown by the horizontal ordinate in Figure 1 reflects the long economic life of civil works associated with dams and hydropower facilities, because the construction costs for the civil works often represent 50-75% of the total investment costs.

The high initial investment cost associated with hydropower typically requires high tariffs in the first 10~20 years to repay the loans, satisfy the bank's debt coverage ratios and provide an acceptable return on equity. Figure 1 shows a typical range of US$4~8 cents per kWh. Once the investment loans are repaid, the cost of hydropower drops dramatically since one needs only to pay for operations and maintenance (O&M) cost, royalty payments, and regular electro-mechanical refurbishments and upgrades. Over time, the cost is very stable and is not subject to fuel price fluctuations as thermal power plants. It is estimated that the average production costs are often below 1 U.S. cent per kWh in many countries after the loans for these

hydropower stations are repaid. It is 1~3 U.S. cents per kWh in Figure 1.

In contrast to the high initial tariffs often required for hydro projects, the average cost of generation or production is currently between 1 and 5 U.S. cents per kWh. The comparison is made with the average overall generation cost rather than an alternative tariff for a thermal plant. This is also to highlight the current low range of U.S. 1~2 cents per kWh found in many places with abundant existing hydropower facilities that have been fully depreciated and in other places where the construction of thermal power plants had been greatly subsidized.

Figure 1 clearly shows the problems currently facing the private hydropower industry. The high initial tariffs required to make private hydro financially viable in the first 10-20 years of operation is often not competitive with current bulk power tariffs paid by customers or for alternative thermal options. As a result, very few projects have reached financial closing during the past three years.

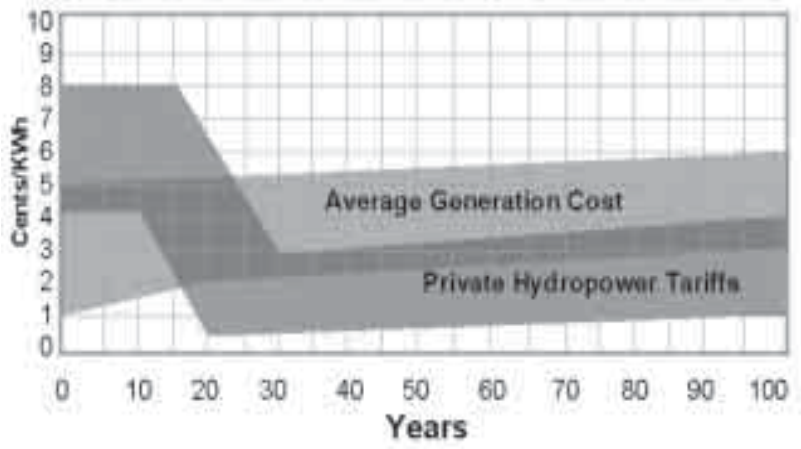

Figure 1 High tariffs in the first 10-20 years of operation can deter private investment in hydropower

Table 2 Installed megawatt capacity for projects financed between 1994 and 2000

Region	Fossil	Hydropower	Other	Non-hydro renewable	Total
Americas	31,591	1,648	9,866	600	43,705
Asia	35,726	1,860	11,654	2,466	51,706
Europe and Central Asia	16,339	1,999	8,386	1,179	27,903
Middle East and North Africa	5,791	0	3,112	0	8,903
Sub-Saharian Africa	808	0	42	0	850
Total	90,255	5,507	33,060	4,245	133,067
Total (percent)	67.8	4.1	24.9	3.2	100

Note: other includes Waste to Energy, Cogeneration, and Multi-fuel Generation.

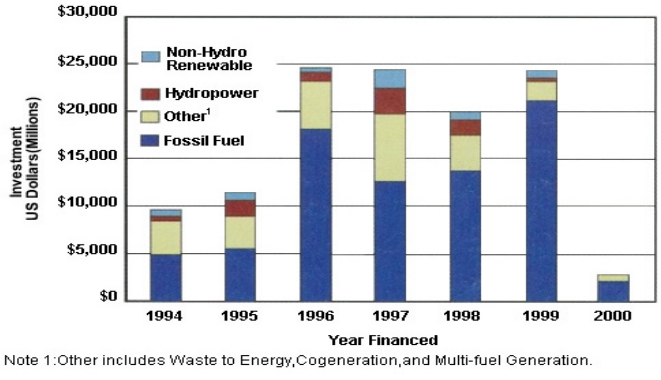

Figure 2 From 1994 to 2000,international energy investments show that significantly less investment was made in hydropower compared to many other types of energy. For the shake of clarity, costs and tariffs are shown in 2002 US dollars.

Table 2 and Figure 2 document a sharp decline in financed projects. Table 2 summarizes regional trends in installed megawatt capacity in financed projects from 1994 to 2000. The total amount of hydropower capacity was 5,507 MW, or 4.1 percent of the installed capacity for projects financed during the 6-year period. Figure 2 shows the distribution of annual investments in financed projects over time. It reveals that less investment was made in hydropower in relation to total investments in energy production from 1999 to 2000 than in the preceding four years (1994 to 1998). This trend toward a sharp downturn in the development of new hydro has been confirmed during the past 24-month period.

The data also indicate that there was substantial activity in the power sector with an average annual investment of US$20 billion to US$25 billion from 1996 to 1999, but very little investment in hydropower. The limited number of hydropower projects that went through financial closing with private developers during that period had a total investment of US$4.2 billion for an installed capacity of 3,133 MW.

2) The necessary financing for preparing a hydropower project should be provided, or a streamline investment cannot be realized. Generally, private enterprises would not take a high risk for putting too much in the front-end work such as river planning, reconnaissance, site selection, feasibility study and project approval etc., and it can be up to 15% of the total project investment in some countries, so that in the competitive bidding process many projects are lack of extensive & intensive feasibility and environmental impact assessment studies.

3) Lack of a package of clear and exercisable investment policies for hydropower development in some countries. Policies have been made out from different governmental departments, and lack of well-coordinated efforts from host governments to promote hydropower developments.

4) The procedures for proposing, examining and approving a hydropower project or contract negotiation (for instance, power purchase agreement) etc. still need to be simplified in some countries, otherwise it would be time-consuming and spoil the enthusiasm of private investors. In Austria, as a visiting expert said, a SHP project may wait for several years at the least, or even 10 years for approval, and finally nobody would inquire about it (possibly there is sufficient power).

5) Non-power benefits such as flood control, aquaculture, recreation, irrigation, water supply or other purposes are very important but are not bringing any financial revenues to the privately developed projects.

6) Affected communities, publics, environmental agencies and NGOs cannot be involved earlier in the project planning, which often deters the construction process or results in conflicts afterwards.

7) The economic downturn and changed investment climate in many less-developed countries, and current liquidity crises confront many independent power producers (IPP). Furthermore, political turmoil and uncertainties in the rate of currency exchange in several countries destroy the confidence of foreign investors.

2. 2 Measures proposed by international professionals

With regard to the decline of private financing for SHP, suggestion have been raised by international professionals to explore new ideas and approaches for solving the following critical issues on SHP development:

1) The host governments must formulate for the private-funded hydropower projects a set of clear, well-coordinated and exercisable policies, monitoring measures, and legal & contractual framework to eliminate the different decisions from various departments, power corporations and other governmental agencies. The short-sight actions of officials due to short tenure of appointment through elections shall be prevented.

2) All front-end studies on projects shall be financially supported by host governments, developers and concerned donor agencies.

3) Project proposing, examination & approving procedures and contractual negotiations shall be carried out in advance.

4) An overall analysis shall be conducted for the long-term and comprehensive benefits of a hydropower project. Multi-lateral, bilateral and donor agencies need to support the host government in financing a hydropower project to cover its non-power values such as flood control, irrigation, aquaculture, tourism and so on.

5) The abilities of consumers and utilities payable to the market-based tariff need to be assessed and forecasted. Extensive front-end technical, environmental, socio-economic studies and site investigations are required to determine the project's optimum parameters, and power-supply area, off-take or power-purchase agreement (on quantity and price) and taxation etc. need to be negotiated. Marginal costs of generation need to be defined and financial scenarioes analyzed in a deregulated market to render the project financially viable.

6) Communities, public, environmental agencies and NGOs in the location or under affection of the hydropower project shall be involved in advance for discussing and addressing related issues.

7) In case of a joint finance of public and private, the equity proportion of each party should be early determined.

All in all, many countries in the world now are facing challenges in pushing forward the private investment in SHP. But SHP development, including private financing sector, is also embracing favorable opportunities under the global voice for environment protection and the daily increasing expectation on renewable energy. If serious measures are adopted under the joint efforts of the host countries and international agencies as well as non-governmental organizations to solve the aware exist-

ing problems, the situation of private investment in small hydropower is able to get out of the low valley and achieve its due development.

3 Comparability between international and China's situation and their mutual referential values

Internationally, privatization, liberalization or de-regulation has been pushed forward in electric power and hydropower sectors (including SHP) since 1990s, and a big voice in publicity and encouragement has been motivated for this sake. But over 20 years, it has not been carried out well as expected, and at the beginning of the 21st century, it seems to cool down quietly. Presently, some nations, international agencies and experts are exploring the ways to sustain the PPP (Public & Private Participation) investment mode. China seems to be different. Privatization and liberalization have never been posed except the strategy of "public sector remaining dominant and diverse sectors of the economy developing side by side". Since 1990s, private investment in SHP quietly warmed up and even continued to be heated. In many places, the new capacity of SHP takes the lead overwhelmingly, and operates with evident profits. Currently, private-funded SHP has already been developed to a relatively large scale in China. However in other developing countries, it seems still at a trial stage with scattered development. Of course, the social, economic and political backgrounds between China and others differ from each other, and distinctive discrepancies are also existed in resources, market conditions, policies and measures etc., apart from similarities. Here some comparable aspects are drawn from the following issues for discussion in the purpose that something valuable can be taken as a reference:

1) Potentials of private fund

Chinese private enterprises have been developed shortly, but their impetus is swift and powerful. Up to now, the production value of private enterprises in the country amounts to US$447.4 billion, 1/3 of the total GDP. During 1980-2000, an investment of US$91.9 million was from private enterprises, covering 33% of the social fixed assets investment in this period. As the power market is opening up, private financing SHP also rapidly booms thanks to the stimulation of favorable policies. In recent years, most of the private capital is mobilized domestically for hundreds of MW, or even nearly one million kW in capacity annually, with simple financing approaches. In many developing countries, private funds for SHP construction mainly rely on international sectors, instead of domestic enterprises, thus complicating the financing channel, formalities and procedures, and is not easy to get success. Therefore, when this issue is talked about in foreign countries, appeals are usually made towards international financial agencies to adopt effective measures and consider whether the requirements on the risk of exchange rate and the front-end work for small hydro similar to large hydropower is reasonable? Unfortunately, much has been talked but little was done.

2) Background of power market

In recent years, electric power is deadly deficient everywhere in China, as a result of continuous and quick development of economy. In many regions, especially developed provinces, the demand for electric power is like "a hungry person not choosy about his food", and even small diesel generators are extensively used just as drinking poison to quench thirst, without concerning the cost and environmental pollution. Thereby, SHP naturally becomes a highlight to investors in those regions where conditions and resources for SHP exploitation are available. This seems different abroad, as electric power is not insufficient in developed countries such as Europe. Meanwhile, rural hydropower in developing countries is far less important as to affect the local economy. So it can be concluded that, macro economy and power market background are basic conditions that affect private enterprise funding rural hydropower.

3) Market admittance and approval system

Since de-regulation policy is adopted in most countries, there is no obstacle, in principle, for SHP accessing the power market as an IPP (independent power producer). But PPA (power purchase agreement) is still not easy to be reached with respect to the application for grid connection, off-take quantity and tariff. Regarding the development of small rivers, policies about paid transfer and competitive winning of the use right have already been executed in China. However, free application and transfer are available in many other countries, which is much more favorable. In China, it's very simple to get approved since SHP stations are managed by local governments, but on the contrary, nearly all the SHP stations in other developing countries are placed under the jurisdiction of central government, thus resulting in a complex examining and approval process, and there would be additional obstacles in case of foreign investment. These differences are not the key factors, but they always bring about adverse effects.

4) Benefit issue

Just as mentioned above, the off-take power quantity and tariff directly affect the enthusiasm of investors. A specific amount of financial subsidy still has to be used to stimulate private financing SHP in some countries. In China, the off-take tariff of SHP has also been limited at about US$0.024 per kW in many areas years before, which not only hindered private but also public financing. Responding the call for green energy in the globe, SHP, as the most practical green energy, can possibly be improved in its economic benefit with supports from various incentive policies, and finally steps out of the present downcast state.

5) Incentive policies

The above-listed indicate that, all objective unfavorable factors can only be addressed by the incentive policies of relevant government and the effective coordination of related international organizations. It is well known, a set of incentive policies have already been formulated in many countries, but why is the effect little? By wrapping up the experience in China and abroad, it is cognized that an overall package and coordination of policies is one of important factors. For many years, Chinese government has been continuously making out and revising a complete set of incentive policies, which plays an important role in promoting the private financing and even the development of whole SHP sector. Even though, there are still some issues underlying the power system reform.

4 Several special issues related to SHP privately financed in China

Although hydropower industry privately financed becomes so heated at present, the problems impeding the further SHP development will most probably emerge and intensify in the future, along with the gradual alleviation of power shortage and execution of the policy of "separation of power plant from grid, and competitive pricing for integration into grid".

Although some provinces with abundant hydropower resources have already formulated regulatory rules for hydro development, generally speaking, there are still many problems. It is necessary to draft a long/medium-term planning adaptable to the restructuring of power industry and aiming at serving the local economy for strengthening the guidance and standardizing the management. The risk of depleting hydro resources cannot be taken for sake of immediate interests, and the disordered exploitation of hydro-energy resources in some regions should be altered as soon as possible. Furthermore, the market-based allocation of development right for hydro-energy resources, as well as the paid transfer of development right on state-owned hydro energy shall be gradually practised for attracting high-quality capital and preventing corruption, as to ensure a sound and sustainable development of private funded hydropower etc.

Besides, the tariff-decision mechanism before the structural reform of power system is not reasonable. The construction of domestic power grids is lagged behind, which hinders the transmission of electricity from SHP. These two issues have always been obstacles need to be uprooted in the process of SHP development. Objectively, SHP is inherently disadvantageous with low regulating performance, seasonal generation, low quality and unreliability of power supply, which in a certain degree, endanger the economical operation and safety of large power grids. The monopoly of power management system is the main obstacle for SHP development. In the past, the power industry in China usually encompassed power generation and supply as a whole, and the grid dispatcher always played the roles of both "athlete" and "referee". Additionally, with the influence of planned economy, the arrangements of power generation and off-take quantity were often emphasized on large hydropower, but neglecting SHP in a long term, and large grids and power utilities cared more about their own benefits, despite of the overall situation. After the restructuring of power industry, in policy staffs of power sectors are allowed to finance SHP as stakeholders. Thereof, SHP shared by power sectors can enjoy a privilege for grid-connection and off-take tariff, which actually results in an unfair competition. Therefore, presently there are two obstacles that need to be overridden for SHP development: one is difficult grid-connection, and the other is low off-take tariff. These two issues have been addressed in some provinces and cities, however in a nationwide scale, more or less problems still exist. While speeding up the construction of power source, the construction of power grid should be carried out simultaneously.

Under the existing power management system, the private power utilities still confront some difficulty. The "Notice on the Scheme of Power System Reform" promulgated by State Council brought forth that, two monopolies shall be broken in the power system reform in China, one is the sectorial monopoly integrating power generation, transmission and distribution, and the other is the re-

gional monopoly of "one corporation in one province", which should be replaced by policies of "separation of stations from power grid, competitive pricing in grid connection, and separation of transmission for a competitive power supply". Several independent power generating corporations and power transmission corporations shall be set up in the whole country, and numerous power distribution corporations also be set up for shaping a fair, competitive, open, and healthy socialist power market. Now the power system reform is pushed forward steadily, but slowly, and the reform of "separation of transmission from distribution" is not brought into effect, the main and auxiliary grids are far from being separated, and the system of transmission and distribution as a whole needs to be broken. In order to improve this situation, the power system reform needs to be further deepened, for establishing a nationwide, more efficient and open power market system mainly based on a competitive & open regional power market, as well as socialist market economy. On June 25, 2004, the "Notice on Further Strengthening the Work of Rural Hydropower" from MWR reiterated that "the independent power distribution corporation shall be oriented to push forward the power system reform", which certainly will further advance the SHP funded by private enterprises to a sound, reliable and favorably rolling development in China.

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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 121 issues (bimonthly), 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 hydroelectrified, 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. ■

HRC's Annual Report for 2004

Hangzhou Regional Center(Asia-Pacific) for Small Hydropower

In response to "going global" approach and abiding by the principle of sustainable and coordinated development, much progress was scored in HRC's international SHP cooperation in 2004, particularly in terms of exploring and implementing concrete SHP engineering projects.

I International SHP Cooperation

1.1 Successful Implementation of 2004 TCDC Training Workshop on SHP Equipment

The 2004 TCDC (Technical Cooperation among Developing Countries) Training Workshop on SHP Equipment was held from 12 Oct to 22 Nov 2004 by HRC. Attended in the workshop altogether 25 participants from Africa, Asia, Eastern Europe and Oceania, with 17 participants from Africa.

Apart from classroom presentations, study tours were arranged to Shaoxing, Shengzhou, Xinchang, Linhai, Wenzhou, Haiyan, Ningbo, Nanjing and Shanghai, where the participants felt to have benefited much. In Ningbo, they visited a pumped storage station with installed capacity of 80 MW designed by HRC. In Wenzhou, participants were excited to visit the big private company Chint Corporation Ltd which has been fast growing in the recent years. The company is listed No 1 so far in China in the production of low voltage electric equipment. Its production line is highly automatic. In Nanjing, participants paid visit to Tiexinqiao Hydraulic Experimental Base which is China's largest hydraulic experimental base. In Haiyan, participants were delighted to be able to visit one of China's nuclear power plants — Qinshan Nuclear Power Company which is the first nuclear power station designed, constructed, tested and operated by the Chinese.

During the training workshop, HRC provided a forum for the exchange of SHP experience and technology. The participants were earnest to offer their presentations.

Apart from the training itself, many exchanges took place between HRC and participants. After going back, the participant from Rwanda reported to his organization which sent invitation to HRC for dispatching SHP specialists to conduct hydropower consultation mission and training in Rwanda, covering all the expenses. The participants from Tanzania were also active in coordinating the SHP and transmission engineering bidding between HRC and his own organization.

2004 TCDC Training Workshop on SHP Equipment that HRC implemented was a success. At the closing ceremony, the monitor who was from Nigeria put it: "The methodology of teaching and instruction was excellent and the lectures gave their best in terms of knowledge and experience in their field of study."

Around 60 SHP related training workshops have been conducted by HRC with the sponsorship from UNDP, ILO, UNIDO, ESCAP, FAO or China's MWR, MOFCOM, MOST and so on. Some 3000 participants including nearly 700 from 70 countries attended.

1.2 SHP Consultation Mission in Yunnan Entrusted by the World Bank

Entrusted by the World Bank, HRC expert together with another expert from Denmark, provided SHP consultation service on the status, policy and regulations, pricing system and invest risks for private investment in medium and small hydropower stations. The boom of private investment in medium and small hydropower in Yunnan attracts more attention of the World Bank, which will play an active role in further development of hydropower in this province.

1.3 Completion of Refurbishing SHP Stations in Xinjiang by the World Bank

Entrusted by the World Bank, HRC undertook feasibility study for a series of SHP stations in Xinjiang. Based on the investigation of over 20 SHP stations there, the feasibility study report was submitted to the World Bank.

1.4 Winning the Bidding for Taishir Project

HRC won the bidding for electric part of Taishir project in Mongolia together with other organization in 2004. This is the first bidding project that HRC has won internationally since its establishment in 1981. Currently, the project has started and it laid a solid

foundation for HRC's international SHP cooperation in future.

1.5 Agreement of SHP Cooperation with Peak Pacific

An agreement was reached between HRC and Peak Pacific, a US company.HRC was to seek investment opportunities for medium and small hydropower development and provide consultation for such projects to be invested.

1.6 Contract Signed for Two SHP Stations in Vietnam

The contract for HRC to design the two Vietnamese SHP stations was signed. The installed capacity of Dray H'linh was 2x8 MW and the other 2x4.5 MW. All the equipment needed would be from China. By the end of 2005 they are expected to operate.

1.7 On-site Testing and Training in Vietnam

"SHP development and automation system" is a long-term cooperative project of science and technology between China and Vietnam. The 1st phase contract was signed in Jan 2003 between HRC and HPC that HRC provide automatic system (high voltage) equipment to HPC. In 2004 HRC sent a group of experts to Vietnam to complete the on-site testing and training. Next phase of cooperation was explored and planned. SHP was just started in Vietnam and there will be bright prospect in SHP market in Vietnam.

1.8 Undertaking Project of Pump Design in Uzbekistan

HRC sent experts to Uzbekistan to provide on-site investigation service. The contract will be signed in 2005.

1.9 Second Phase in Providing Assistance for Moa and Corojo Projects in Cuba

The Chinese Ministry of Commerce continued to entrust HRC to provide technical assistance in electric design and equipment supply as the second phase for Moa and Corojo projects in Cuba.

2 International Conferences & Other Activities

2.1 Hosting 2004 Promotion Conference of International Advanced Water Technology

In order to further strengthen the links between foreign high-tech water enterprises and their Chinese customers, and promote exchange of water technology between China and foreign countries, on May 2004 the Promotion Conference of International Advanced Water Technology was held under the auspice of Science and Technology Promotion Center, MWR. HRC hosted this conference in Hangzhou attracting 220 representatives. This technical get-together suitcases 50 techniques from 15 countries and regions, which are mainly related to water resources, water environment, flood control and drought mitigation etc., and 32 items were evaluated and categorized for technical import in 2005.

2.2 Director Chen Shengshui Visiting Taiwan

Dr. Chen Shengshui, Director of HRC paid a visit to Taiwan for technical exchange with his presentations on "SHP Technical Development and Experience in China" and "Case Study on Medium & Small-sized Hydropower Development in China" .

2.3 Participation in United Nations Symposium on Hydropower and Sustainable Development

HRC's expert Mr. Zhao Jianda was invited for United Nations Symposium on Hydropower and Sustainable Development, on which he presented a paper called "Private Participation in Small Hydropower Development in China and Comparison with International Communities". This paper overviews the private enterprise investing in SHP domestically, analyzes similarities and differences between China and international communities, as well as the comparability and mutual referential values, and also it presents several particular issues in this regard.

2.4 Supporting China International Water Resources and Hydropower Equipment Exposition

As a promotion media, <Small Hydropower> sent a staff for joining China International Water Resources and Hydropower Equipment Exposition, a large-scale expo held in Beijing. On this expo, HRC, together with its periodical <Small Hydropower> got more popular to the water resources and hydropower circles, especially to equipment manufacturers and hydropower media professionals.

2.5 Presenting on the Annual Meeting of Chinese TCDC/ECDC Network

As a member of TCDC/ECDC Network in China, HRC sent staff to the annual meeting and presented a paper titled "International SHP Cooperation, An Important Part of TCDC/ECDC", and on the 9th annual meeting HRC's representative introduced means to explore for international SHP cooperative projects by means of hosting international SHP training workshops.

3 Publicity to Outside

3.1 HRC Website

HRC website has already been interlinked respectively with China Water Science Network (www.cws.net.cn), China Rural Hydropower and Electrification Info Network (www.shp.com.cn) and other key technical network in the fields of water resources and hydropower.

This year 70 important news was edited, and among them 40 pieces was in English. 32 pieces were contributed to China Water Science Network, China Rural Hydropower and Electrification Info Network and China Water Resources News etc. Meanwhile, HRC network cooperated with China Water Science Network for delivering special reports on 2004 Promotion Conference of International Advanced Water Technology and the country reports of the 3rd World Water Forum.

In 2004, 4 issues of English periodical <SHP News> were edited and distributed not only in the Mainland China, but also to 86 foreign countries and regions.

3.2 Interviewed by CCTV-9

CCTV International (Channel 9) sent its reporters to HRC for interviewing the SHP development in China, and also went to Liubaizhang SHP Station in Shitai County of Anhui Province for photograph and site interview. This interview emphasized the essential role that SHP plays to improve the rural eco-environment and the economic benefit. Furthermore, reporters visited local farmers, officials and schools and investigated the plantation resources there. This interview was broadcasted on CCTV News of that channel.

4 Scientific Research

4.1 The Book of <Rural Hydropower and Electrification in China> Published

In order to further introduce the rural hydropower and electrification in China, and push forward the export of Chinese electromechanical equipment, HRC organized experts to compile a book titled "Rural Hydropower and Electrification in China" (English version) which was published by China Water Power Press in March 2004.

4.2 Study Report on the SHP Development Situation and the Main Issues in Asia-Pacific Region Completed

Based on the developing countries in Asia-Pacific region, this study report covered some developed countries in this region or other countries in the world as well. This study aimed to provide SHP decision makers an overall, informative and profound document for reference, and also offer some technical supports to China, other developing countries and even developed countries for a better cooperation and exchange, as well as provide international communities a comprehensive research material about the global SHP development.

5 Overseas Missions and Foreign Guests to HRC

5.1 Overseas Missions by HRC

1)At the request of the Ministry of Commerce, a delegation to Guyana from Feb. 24 to March 12, 2004 was organized by the Northern Exploration and Design Institute, CWE, for dealing with the penstock rehabilitation of MOCO-MOCO Hydropower Station. Mr. Huang Jianping, deputy chief engineer, took part in this mission. During their stay in Guyana, the experts visited the sites, analyzed the accident, exchanged the ideas and drew out a primary scheme.

2)At the request of CNTIC Trading Co.Ltd., Mr. Wu Weiguo and other two experts joined the delegation to Uzbekistan during March 26-April 8, 2004, undertaking the project for refurbishing the pump station. The primary schemes on 5 stations of the first batch were worked out, and a memorandum for cooperation was signed.

3)At the invitation of Third Power Company,Vietnam, and Dongfang Electric Corporation, Sichuan, Mr. Wu Weiguo and Mr. Lu Jianping paid a visit to Vietnam, aiming at reaching the agreement on equipment supply and technical service. The details on configuration and layout of the main equipment and the auxiliaries were discussed closely and the original design scheme made by the Vietnamese side was modified and optimized.

4)At the invitation of VWIRR, Vietnam, a 3-member delegation headed by Dr. Xu Jincai, visited Vietnam from 3 to 14 August, 2004, implementing the long-term cooperative project on SHP automation. The on-site equipment test and technical training has been conducted, and the agreement for further cooperation was reached.

5)At the invitation of Fuel and Energy Authority, Mongolia, Mr. Wu Weiguo and Mr. Lu Jianping, together with the members of COMCO, Beijing, went to Mongolia from 1 to 10 August, 2004, carrying out the technical negotiation and signing the contract for the construction of TAISHIR Hydropower Project, the

bid of which had been won successfully with the joint efforts of HRC and COMCO. During the visit, the items concerning equipment supply and technical requirements were further clarified, the installation and layout of equipment were discussed and the commercial and technical agreements were signed.

6) At the invitation of Fuel and Energy Authority, Mongolia, Mr. Wu Weiguo, along with the delegates of COMCO, paid a visit to Mongolia again from 8 to 16, Sept. 2004 for TAISHIR Hydropower Project. In addition to sign the commercial contract in due form, the two sides held discussions on electromechanical design, manufacture, equipment supply, transportation and installation, etc. The agreement was reached finally.

5.2 Foreign Guests to HRC

In 2004, HRC hosted 13 delegations of 59 overseas guests in total. The visits enhanced the mutual understanding and promoted the international SHP cooperation.

6 Working Plan for 2005

1) To apply and conduct the 2005 TCDC Training Course on SHP. Furthermore, one or two bilateral SHP training workshops are also highly expected.

2)To carry out the research on the CDM (Clean Development Mechanism) application in SHP. The project has been supported with the scientific fund set up by Nanjing Hydraulic Research Institute.

3)To dispatch a group of four SHP specialists to Rwanda for national energy planning and SHP consultation mission in March 2005.

4)To further promote the SHP international cooperation with Tanzania, Zambia, Vietnam, Malaysia, Sri Lanka, Canada, Cuba, and Indonesia, etc.

5)To hold an international conference, focusing on the "Public & Private Financing in SHP development". HRC is in the process to get the sponsorship from World Bank and ESCAP.

6)To publish <Introduction to SHP Development in Asia-Pacific> in English. The book introduces objectively SHP resources, exploitation, issues, solutions, economic development and electrification in particular for the developing countries in the Asia-Pacific region. It will provide the valuable and prospective reference in detail for decision-makers of energy especially renewable energy in the region.

7)To continuously make full use of the SHP-internet resources. In 2005, HRC will contact participants who have ever attended the previous SHP Training workshops in HRC, and invite them to act as the reporters for the column of global SHP Forum to be added in the HRC-internet homepage with the aim to promote the international SHP cooperation and development. ■

Delegations or Guests hosted by HRC in 2004

No	Organization/ Country/Region	Number	Time	Main activity
1	Peninsula Technikon, South Africa	2	Jan.	The two engineers who are now studying in Hohai University for master degree were participants of TCDC training workshop run by HRC years ago. They paid a visit to HRC again with pleasure.
2	Energy sectors in Switzerland and Hong Kong	3	March	To discuss the new technology and the potential for cooperation in the field of renewable energy
3	Energy sectors in Austrian	9	April	To learn more about HRC and the SHP development in China, focusing on the items concerning the electromechanical equipment, the electricity price, the water right, the nuclear power and the renewable energy, etc. The potential cooperation is expected.
4	Indian professor	1	June	To discuss about the presentation for the SHP international training course.
5	Peak Pacific Investment Co. Ltd., USA	1	August	To discuss the cooperation and investment in SHP.
6	American Journalist	1	Oct.	To understand about the SHP development in China, and publish the article concerned.
7	13 countries	25	Oct. ~ Nov.	To attend the 2004 TCDC Training Course on SHP Equipment.
8	Angola Electrical Corporation	5	Dec.	To enhance the relationship, and hold the discussion on cooperation.
9	e3V; Blue Moon Fund, USA	5	Dec.	To discuss the possibility for exploring the Indian and Brazilian MHP markets, setting up the joint venture and improving the local operating ability. The further plan is expected.
10	IT Power, UK	1	Dec.	To discuss the cooperation on MHP equipment.
11	Powerbase, Canada	4	Dec.	To discuss the technical items on the cooperative project.
12	APACE, Australia	1	Dec.	To discuss the items on bilateral cooperation, and reach the agreement on training and information exchange.
13	Ministry of Electricity, Sudan	1	Dec.	To discuss the items on SHP cooperation and technical training. A memorandum of Understanding for SHP development in Sudan was signed.

Small Hydro Power--An Important Renewable Energy Sources for Rural Electrification in Nigeria

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Abstract

This paper is trying to highlight the importance of constructing small hydropower station as the alternative source of energy for rural electrification in Nigeria and stressed the need for the Federal Government of Nigeria to provide a clear open policy that will make environment favourable and safe for local and foreign private investors on small Hydropower.

1 Introduction

The pre-requisite for socioeconomic development of an area includes the provision of basic infrastructure such as good roads water and electricity and other social amenities. Statistic of data from United Nation shows a total install capacity of 85 GW should be newly added in Worlds rural areas so that the un-electrified rural area inhabited 1.7 billion people will be primarily electrified (Exclusive of industrials and agricultural loads).

However, due to the limitations of conventional energy resources and shortage of funds and expertise etc, only some millions of rural people in the world can be electrified in a year. In Nigeria therefore, the shortage of electricity becomes a great constraint to the rural areas and even to the National economic development.

With the development of technology, the present SHP is neither the miniature of large hydro, nor the simple repetition of old SHP techniques, but a more advance type of technique appropriated for developed and developing countries.

The boom-bust cycle of SHP development shows that in the early 20th century, after several decades of SHP booming as an embryonic form of hydro power in industrialized countries a tendency of building large project to replace SHP emerged up to the late 1970's SHP world wide was greatly reduce or even almost eliminated.

The mid 1970's marked the beginning of energy crises as drastic inflation of petroleum prices occurred and SHP now became attractive in many developed countries. Revitalisation of SHP was set to surge in countries with rich resources, while some developing countries jus started to construct SHP to replace diesel generating in rural areas to save foreign currency from importing diesel, therefore the installed capacity in many countries rises from few hundred KW to tens or hundreds of MW of electricity.

United Nation Policies and Resolutions on Small Hydropower as Renewable Energy Source

The appeal for green energy has in the world during the past 20 years, actions and resolutions has been adopted by the international institution and importance conference e.g. World energy conference committee and obstacle for renewable energy that SHP is advantageous and will be paid attention to, if it's supported by policies on renewable energy in the related countries.

UNIDO organized the first International SHP seminar on "technology transfer on mini hydro electric generating units" held in Katmandu Nepal, Hangzhou China and Manila Philippines in 1979, 1980, and 1981 respectively, the declaration were adopted and stressed the significance of SHP international cooperation and exchange of SHP experience. Also UN conference on new and renewable source of energy (UNCNRSE) held in Nairobi Kenya in 1981, SHP will have a great development from the "World summit on sustainable development" held in Johannesburg, South Africa in 2002 to the third World water forum" held in Kyoto Japan 2003.

However in 2004 the representatives of National and local Government, representatives of Utilities and private sector, United Nation agencies, multilateral, financial institution and other financial institution and non-Governmental organization met at the United Nations symposium on "Hydro Power and sustainable development held in Beijing- China. Adopted Millennium Development Goals (MDG) and Sustainable Development Gold's and targets contained in the Johannesburg plan of implementation (JPOI).

The declaration emphasize that improving access to energy will generate opportunities for economic growth, enhanced education, better health care, more training and employ-

ment as well as higher productivity in business, thereby contributing to sustained poverty reduction and for achieving the MDG's and JPOI targets and commitments.

2 Present Hydropower Situation in the Country

The present large scale hydro power potentials in Nigeria is very high, and presently accounts about 32% of he total installed capacity; these comprises of Kainji hydropower station as the first power station on Niger river which was commissioned in December 1968, with four units 7,8,9, & 10 respectively. Each of these four unit installed consist of an adjustable blade turbine (Kaplan type) with rated output of 80 MW. Unit 11 and 12 were later installed in 1970, with Hitachi adjustable propeller machine having the rated output of 100 MW each. Also in 1978 unit 5 and 6 were commissioned with a fixed propeller type of blade, the rated output is 120MW each. These brought the total installed capacity of Kainji power generating station to 760MW.

Jebba Hydropower station was the second hydropower station in Nigeria, it was built in order to fully utilize the potentials of the Niger River, it was commissioned in April 1985 with 6 units each having an output of 90 MW, and these brought the total installed capacity of Jebba hydropower station to 940MW.

Shiroro hydro power station was the third hydropower station, its located on the high point of Shiroro gorge on Kaduna River, it was commissioned in May 1990, with 4 units each has an out of 150MW. Therefore the total installed capacity of Shiroro power generating station is 600MW. A recent estimate of river Kaduna, Benue, and Cross river indicated a total capacity of about 4600MW, while Mambilla Plateau falls has 2330MW, therefore the total large scale hydropower resources potentials exploitable in Nigeria is in excess of 11, 000 MW.

3 Exploitation and Utilization of Water Resources for Small Hydropower Development for Small Rivers in Nigeria

Small River is generally defined as the river with catchment's area less than 500km^2 or in a precise sense, less than 300 km^2. From the point of view of small hydro power development, we are rather interested in river lets or stream with catchments area less than 100 km^2. However the exploitation and utilization of water resources should be closely related with the reduction of Natural disaster, it's obvious that to initiate welfare for people like rural electrification is very difficult if flood disaster is frequent, therefore the comprehensive exploitation and utilization of water resources aim for getting maximum benefit from that resources SHP when combine with the following provide the maximum efficient, and reliable benefit.

(a)Power generation with irrigation
(b)Power generation with water supply
(c)Power generation and flood prevention
(d)Power generation and navigation
(e)Power generation and fishery
(f)Power generation and environment.

4 Categorization of Small Hydropower as Renewable Energy

The capacity range of small hydropower plant in Nigeria is not well define until recently when the Federal Ministry of Power and Steel approved the consultancy services of 3 out of 278 already identified Un utilized small hydro potentials in the country they are:

a)Dadin Kowa (34 MW) in Gombe State
b)Oyam Dam (9 MW) in Ogun State
c)Ikere Gorge (6MW) in Oyo State

SHP plants can be set up in virtually all part of Nigeria. Their suitability for standard above utilization in the rural part of Nigeria can be further justified by noting that many viable small plants are actually run off-river schemes based on waterwheels that require a minimal amount of civil works.

Most small scale are around Jos Plateau with capacity of 2 MW located at Kwall water fall on Ngell river Kaduna and also 8MW station at kura fall this is developed by a private company (NESCO). As earlier mentioned there are 287 Un-utilized sites for small hydro power in Nigeria with a total installed capacity of 734 MW out of which only 5% so far exploited. There decentralized plant may be well prepared since smaller river and water fall are more prevalent and generally distributed than large water falls and therefore offers opportunities for SHP development, there shows that Nigeria is very rich in SHP potentials that is in commercial nature.

Benefits of Small Hydro Power Development

Small hydro power (SHP) has economic, social and environment benefits.

- It provides cheap power for local industry and agro-by-product processing.
- It increases revenue of local government and income of local people.
- Creating more jobs opportunities to people living around.
- It reduces rural people migration to cities.

• It reduces or replaces the use of fire wood for cooking hence reduces environmental degradation.
• It also promotes tourism in rural areas.
• If combine with irrigation & fisheries it increases crop yield.
• It facilitates social development in rural areas

If the system is well design, and for instance, with economic development of rural area there will be a large number of rural populations shifting to other industries. SHP development will help to establish more urban with appreciable number business town enterprises, providing more employment opportunities for the rural people. It is effective to prevent rural population shifting to cities. SHP does not only provide rural labour but also promotion of well articulated entrepreneur.

Substituting electricity for fire wood give positive effect on reducing deforestation and hence improving the ecological environment as well as hygiene of rural people.

5 Advantages of Small Hydropower Project Over Other Energy Sources

Most small hydropower in developing countries are located at remote areas relatively far from regional grid and supply electric energy for villages or small towns/ cities with population less than ten thousand, where others are usually equipped either diesel power or no electric power at all. SHP provides:
• Decentralized development.
• Mature technology and small investment risk
• Low operational cost, easy maintenance and reliable power supply.
• Lithe environment impact during construction with some positive impact on the environment.
• Obvious social benefits to developing local economy and improving material spiritual life for local residence.
• Longer life span.
• Reduce the effect of flooding as in large hydro.

6 Investment Opportunities on Small Hydropower in Nigeria and a Way Forward

SHP project are highly capital intensive the Federal government has to seek assistant from developed countries to finance sustainable hydro power, this should includes conventional multilateral and bilateral loans and guarantees, credits and grants as appropriate. The Government should then create a favourable environment to attract domestic and foreign private investment for co-financing SHP project. Also new policies and the constant review of the old government policies to bring more clearer and open policy that will attract and encourage both local and foreign investors.

The Government should allow the owner of SHP to operate on "self policy" i.e. self construction, self management and self consumption. It means that the people who invested and constructed SHP station should have the right to manage the plant, to use the output of SHP and to get benefit from the stations.

Considering the positive effect of SHP on environment the government should give preference to SHP developers in licensing of the project.

The government should give some preferential loans and exemption to SHP developers, similar preference are taken in other countries and it works well , e.g. in Nepal the government gives preference to SHP equipment manufacturing in loans and material, in Pakistan SHP construction was subsidized, in Latin America, some countries are speeding up the National energy exploitation giving SHP development special priority in addition some countries such as Canada and Czech & Slovakia provide favourable policy in tariff.

7 Conclusion

The main problem of developing small hydropower project is still its funding/financing, especially in its initial development stage. The funding of SHP should mainly rely on self reliance, grants or donations from international lending institution or develop countries are required to introduce advance technology only, therefore; SHP development in Nigeria should actually rely on domestic funding (local investors). This paper therefore, highlight the importance of constructing small hydro power stations as alternative source of energy for rural development

Statistic of 25 developing countries shows that about 41, 000 MW of SHP can be economically develop, taking China as an example the theoretical SHP is about 150 GW in which about 70 GW can be economically developed, the Chinese government gives many preferential policies for developing SHP stations, this open policies provided by the Chinese government attracted the local investors which make China presently No 1 in the world with total No of about 4000 SHP station scattered all over china, and has been successfully managed. In Nigeria up to today there is no clear open policy with regards to SHP development. ■

Letter from HRC

Dear participants of TCDC workshops,

In the auspicious Chinese Year of Rooster, we would like to extend you and your family our heartfelt wishes for happiness and prosperity.

Entrusted by the Ministry of Commerce of P. R. China, by now HRC (Hangzhou Regional Center for Small Hydro Power) has already hosted 38 TCDC international training workshops on SHP, and nearly 700 international engineers or technicians from around 70 countries participated. It is believed your stay in China offered you valuable experience through the classroom presentation, discussions, study tours and various contacts with the local friendly Chinese people. It is meanwhile expected that we could continuously carry out all-round exchange and cooperation in the field mutually concerned.

Thereby, HRC's homepage ***(www.hrcshp.org)*** was set up years ago for dissemination of SHP information, and it has already been browsed by hundreds of thousands of SHP professionals for it is informative, applicable and rewarding. Now a new column called ***"HRC Alumni"*** is open especially for the participants of TCDC SHP training workshops, inside which the personal details of each former TCDC participant will be online, and participants can also log-in for raising any comments or suggestions, as well as get acquainted with other friends for exchanging experience and technology to consolidate friendship and SHP cooperation. In such a way, all of us can work closely with each other, regardless of the geographical distance, and share valuable information and further strengthen cooperation among us. You, as our friends, are expected to timely provide us the SHP-related information in your countries (such as policies & regulations, project cooperation, project bidding, international meetings, training and etc.) by means of giving introductions, reports, brief news, business opportunities or with vivid pictures. We will put the relevant information on HRC's homepage, and possibly select some to distribute internationally through our periodical ***"SHP NEWS"***.

Besides, should there be any change of your personal contact details or other information concerned, never hesitate to contact us directly, since HRC, as the family of global SHP, is the home for all of you.

Thank you for your attention. Looking forward to hearing from you.

Yours faithfully

Dr. Chen Shengshui, Director of HRC

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