Edited by Hangzhou Regional(Asia-Pacific)
Center for Small Hydropower

Rural Hydropower and Electrification in China

中国水利水电出版社
China WaterPower Press

Rural Hydropower and Electrification in China

Edited by Hangzhou Regional(Asia-Pacific)
Center for Small Hydropower

中国水利水电出版社
www.waterpub.com.cn

图书在版编目（CIP）数据

中国农村水电及电气化=Rural Hydropower and Electrification in China / 杭州（亚太地区）小水电研究培训中心编著. —北京：中国水利水电出版社，2004
ISBN 7-5084-1905-7

Ⅰ.中… Ⅱ.杭… Ⅲ.①农村－水力发电工程－概况－中国－英文②农业电气化－概况－中国－英文
Ⅳ.①TV752②S24

中国版本图书馆CIP数据核字（2004）第004115号

书　　名	**Rural Hydropower and Electrification in China**
作　　者	Edited by Hangzhou Regional (Asia-Pacific) Center for Small Hydropower
出版　发行	中国水利水电出版社(北京市三里河路6号　100044) 网址：www. waterpub. com. cn E-mail：sales @ waterpub. com. cn 电话：(010)63202266(总机)、68331835(营销中心)
经　　售	全国各地新华书店和相关出版物销售网点
排　　版	中国水利水电出版社微机排版中心
印　　刷	北京市兴怀印刷厂
规　　格	787mm×1092mm　16开本　10.75印张　362千字　8插页
版　　次	2004年3月第1版　2004年3月第1次印刷
印　　数	0001—1000册
定　　价	**39.00**元

凡购买我社图书，如有缺页、倒页、脱页的，本社营销中心负责调换

ACRONYMS

Currency

1 Yuan =1 Yuan Ren Min Bi (RMB) = 100 fen; 1 USD = 8.28 RMB (Oct. 2003)

1 Mu =1/15 hectare = 666.7 m^2

Electrical units

kW	kilo Watt
MW	Mega Watt (1000 kW)
kW • h	kilo Watt hour
MW • h	Mega Watt hour (1000 kW • h)
GW • h	Giga Watt hour (1000000 kW • h)
TW • h	Tera Watt hour (1000 million kW • h)

Organizations

APEC	Asia-Pacific Economic Co-operation
CPC	Communist Party of China
HRC	Hangzhou Regional (Asia-Pacific) Center for Small Hydropower
ITDG	Intermediate Technology Development Group
MOFTEC	Ministry of Foreign Trade & Economic Cooperation, now merged into the Ministry of Commerce
MWR	Ministry of Water Resources
MWREP	Ministry of Water Resources and Electric Power
SHP	Small Hydropower, defined as less than 50 MW installed capacity
UNDP	United Nations Development Programme

Preface

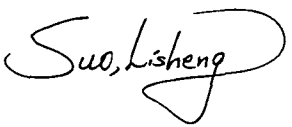
Since the founding of the People's Republic of China over 50 years ago, and particularly since the country's opening up and reform period, the Chinese government has been stressing the development of SHP, small hydropower——a clean, renewable energy which plays a significant role in supplying energy for both rural production and daily life, poverty alleviation, environmental improvement, promotion of the local economy and social progress.

In the past 20 years, the attention given to hydropower and rural electrification by the world community has also been increasing. A number of international conferences, including the World Summit on Sustainable Development held in Johannesburg, South Africa in 2002 and the Third World Water Forum held in Kyoto, Japan in March 2003, have appealed for more utilization of all renewable energy sources, including hydropower. A new era of greater development for this thriving green energy has come.

Co-sponsored by the Ministry of Water Resources of China, Ministry of Foreign Trade and Economic Cooperation of China, and UNDP/UNIDO, the Hangzhou Regional (Asia-Pacific) Center for Small Hydropower (HRC for short) located in Hangzhou was set up in 1981, with the main aim of promoting SHP international exchange and cooperation in the Region. Through great efforts over the past 20 years or so, HRC has contributed much to SHP training, R&D, consultation and information dissemination, and has been praised and appreciated by the world community. Rural Hydropower and Electrifica-

tion in China, edited by the Center, gives a comprehensive introduction to the main experience and technology of rural hydropower and electrification in China, as a reference for global colleagues working in the hydropower sector and a valuable attempt in international SHP exchange. Therefore, I am very happy to write this preface for the book.

There is a saying both in China and overseas that teaching someone how to fish is better than giving that person some fish. I hope that the publication of this book will have the effect of teaching how to fish.



Dr. Suo Lisheng
Vice Minister
Ministry of Water Resources, PRC

Foreword

With strong governmental policy support, outstanding achievements have been made in the development of rural hydropower and electrification in China during the past 50 years, especially during the last 20 years. By the end of 2001, 43 027 SHP stations were in operation, with a total installed capacity of 26 262 MW. Half of the land, one third of the counties (cities) and one quarter of the population have access to rural hydropower. The achievements and experience gained in China have been recognized and highly evaluated by the world community.

After the world energy crisis in the 1970s, SHP, as the most realistic form of renewable energy, was revived in many countries in the world. Thanks to the active role that SHP plays in the supply of rural energy, alleviation of poverty, improvement of the environment and promotion of the rural economy, quite a number of countries have worked out plans to develop it actively in the past 20 or 30 years. The installed capacity in many countries has leapt from a few hundred kW to tens or even hundreds of MW.

UNIDO organized the First International SHP Seminar in Kathmandu, Nepal in 1979, which was followed by the Second International SHP Seminar in Hangzhou, China and Manila, Philippines in 1980. The "Kathmandu Declaration" and "Hangzhou-Manila Declaration" were adopted, and stressed the significance of SHP international cooperation and exchange of SHP experience. Under the sponsorship of UNDP /UNIDO and the Chinese government, Hangzhou Regional (Asia-Pacific) Center for Small Hydro Power (HRC for short),

located in Hangzhou, was set up in 1981, with the main aims of conducting international cooperation on SHP by training, information exchange, R&D and consultation, and of promoting SHP development in the Region.

Through great efforts over the past 20 years or so, HRC has fulfilled all the missions entrusted to it by the UN and the Chinese government. At the beginning of the new century, HRC was given the award of "Model of South-South Cooperation" by MOFTEC. The contributions of HRC have been widely recognized by the world community. In a speech delivered at Zhejiang University in mid-October 2002, United Nations Secretary-General K. Annan pointed out: "Right here in Hangzhou, China, you have made use of the Regional Center where you share your valuable rich experience in the field of renewable energy with those from numerous developing countries in the world. China is playing a pioneering role in the regional technical cooperation with developing countries. You developed a lot of cooperative projects not only in foreign countries, but also you have generously implemented training workshops for those from the developing countries."

The appeal of green energy has run high in the world during the past 20 years. Actions and resolutions have been adopted by the international institutions and important conferences. For instance, the World Energy Conference Committee pointed out in its report "1990～2020 Opportunities and Obstacles for Renewable Energy" that: "SHP is advantageous and will be paid attention to. If it is supported by policies on renewable energy in the related countries, SHP will have 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 in March 2003, affirmative and motivational resolutions were adopted towards renewable energy including SHP.

The macro international environment favours SHP and the energy situation is encouraging. Therefore, it is currently an important task for the SHP

sector to further conduct international exchange and cooperation on SHP.

As a member of the global SHP family, China has the commitment and responsibility to summarize its SHP experience and exchange it worldwide. The earliest books on SHP in China were *Small Hydro Power In China : A Survey* prepared by HRC in 1985 and published by UK's ITDG; and "SHP Series" No. 3 *Chinese Experiences in Mini-Hydropower Generation* which was organized by UNIDO and written by Chinese experts. As SHP practice has continued during the past 20 years, China's rural hydro and electrification experience has gone through a process of continual growth, gaining extensive experience with the following characteristics:

- Unique management mechanism: planned by the central government and implemented by the locals.
- Setting up SHP-based rural electrification counties, simultaneously leading to a booming rural economy.
- Promoting poverty-alleviation by SHP construction.
- Putting up SHP-based local grids with their own supply areas.
- Development of medium and small hydropower as an important part of the river treatment work, and an inseparable part of water resources sector.
- Paying attention to environmental benefits and conducting SHP ecological substitution for firewood fuels.
- Multi-layer fund-raising channels, mainly building state-owned SHP stations in combination with a multi-ownership system for SHP stations.
- Developing the corresponding equipment manufacturers for medium and small hydropower, conducting timely training, with self-reliance in solving technical problems.
- Coordinating all parties concerned, adjusting and updating promotional and protective policies.

In order to provide a comprehensive and in-depth introduction to the experience and technology in the rural hydro and electrification drive with unique Chinese features, we have updated this book as a reference tool for our SHP colleagues throughout the world. It could also be used as a part of the teaching material for the international SHP training courses currently being conducted by HRC.

During the compilation of this book, the related strategy, principles and policy towards rural hydropower in China are based on the documents of the Chinese Ministry of Water Resources and the work of some senior officials, especially that of Mr. Cheng Huizhou, Director of Rural Hydropower and Electrification Bureau. Meanwhile, the experience and summaries of SHP experts in other relevant provinces and cities have also been drawn upon so as to enrich and consolidate the content of this book.

The compilers include: Zhu Xiaozhang, Cheng Xialei, Pan Daqing, Lou Hongping, Zhang Guansong, Zhao Jianda, Lin Ning and Shen Xuequn. The book has been organized and checked by HRC's Honorary Director, Mr. Zhu Xiaozhang and HRC's Deputy Director, Ms. Cheng Xialei. Director of HRC, Dr. Chen Shengshui finalized the book. Special thanks should be given to our editorial consultant, Dr. Eugene Chang (contact e-mail: echang@a-1.net.cn), for his work on the English text.

Any comments or suggestions to the book are welcome. (Contact e-mail: secretariat@hrcshp.org).

Hangzhou Regional (Asia-Pacific) Center for SHP
P. O. Box 1206
Hangzhou, China
October 2003
http: //www. hrcshp. org

CONTENTS

Chapter

1

A Survey of SHP Development in China

- The three phases of development
- The Ecological Protection Programme to Replace Firewood with SHP
- Facing new challenges

1.1 The three phases of development

Rural hydro in China has developed in step with the overall social and economic progress in China. The development of rural hydro can be divided into three phases.

(1) The first phase: SHP is mainly used for domestic lighting (1950s~1970s).

In this period from the founding of the People's Republic of China in 1949 to the primary period of reform and opening up, rural hydro was mainly developed as a solution for domestic lighting for rural, hilly and poor areas. SHP, small hydropower, was essentially developed under the mode of a planned economy. With the guidance and encouragement of government policy, the local government and rural population were motivated to build up SHP, thereby making possible substantial developments in rural hydro.

Before 1949, the exploitation of SHP was rather backward in China. The earliest SHP station was the Guishan SHP Station at the Danshui River tributary in Taiwan in 1904 with an installed capacity of 500 kW. In mainland China, the first SHP station was Shilongba SHP Station near Kunming in Yunnan province. Up to 1949, the installed capacity of all the hydro power stations in China was o-

ver 360 MW, and the installed capacity per capita was less than 1 W, with an annual power generation of 1.2 billion kW · h. There were only 52 SHP stations each with an installed capacity below 500 kW, totaling 5916 kW in all.

After 1949, with the development of agriculture and rural hydro projects, SHP advanced quickly. The National Agricultural Development Programme issued in the 1950s pointed out, "Wherever appropriate to develop hydro projects, try every possible way to construct medium and small hydropower stations so as to gradually solve the problem of rural energy supply." Since the 1950s, a large number of SHP stations were built nationwide. By the end of 1960, 8 975 SHP stations had been built, with installed capacity of 252 MW. The 1950s were the initial period of rural hydro and electrification. Its features were mainly to supply energy for domestic lighting and agricultural by-products processing. The local population called rural hydropower a "night pearl". At that time, the installed capacity of the SHP stations was very small, with an average of 28 kW only, and most of them were in isolated operation. The equipment was simple, mainly adopting wooden or wood-iron turbines produced by agricultural machinery factories. These were run by the local people, and financially and technically aided by the government. Some SHP stations of bigger installed capacity were essentially invested and built by local governments.

During the 1960s, the State (national) grid developed rapidly, and extended to the suburbs and rural areas. Some isolated SHP stations were substituted by the State grid and others were abandoned; the total installed capacity and rate of development of SHP therefore decreased. However, there was still a large potential for development, owing to the demands of industrial and agricultural growth and improvement in people's living standards. The annual average installed capacity reached 58 MW, and the definition of SHP was upgraded to refer to hydropower stations with installed capacity of 3000 kW.

In 1969, the State Planning Commission held a meeting on SHP projects for the hilly areas in south China in Yongchun county, Fujian province. Some policies were worked out including "Mainly small-scale, run by the local people and with locally-made equipment", together with the incentive policy of State assis-

tance in funding and materials for SHP development. Thus, SHP exploitation was formally listed in the national development plan. The implementation programme of small basin development and coordinated distribution of local equipment manufacturing were proposed, thereby promoting the large-scale development of SHP. Afterwards, the State set timely measures to protect and assist SHP with funds, technology, key materials, and so mobilizing everybody's initiative in constructing SHP stations.

Then, in 1975, 1978, 1979 and 1980, national meetings on SHP were conducted respectively in Guangzhou, Wuchang, Beijing and Chengdu to summarize the experience and problems in various phases, thus pushing forward SHP development. The definition of SHP was upgraded to 12 MW, and the average annual increase in installed capacity was 580 MW, with a maximum of 1 120 MW in 1979. In this period, SHP supply was used for domestic lighting, processing, drainage, irrigation and township enterprises. In the whole country, there were over 60 turbine and complete package manufacturers with an annual production capacity of 1 million kW. Serialization of the turbine products from 250 kW to 12 000 kW was prepared. Automatic regulation of turbine speed could be performed in key stations. Some counties with fast SHP development formed local SHP-based 35 kV grids. SHP stations developed from isolated operation to connected operation with unified dispatching. During this period, overall surveys and investigations were carried out for SHP resources, essentially clarifying the exploitable SHP potential in China.

After some 30 years of SHP exploitation since 1949, SHP supplied power to over half of the territory for domestic lighting, thereby solving the electricity supply problem for 300 million people.

(2) The second phase: SHP is mainly used for poverty-relief in poor areas (1980s & 1990s).

Since the wide application in China in 1980 of the contract system of responsibility linked with production, tremendous changes took place in the rural economy and great achievements were made. Electricity demand increased with economic development, living standards improved and there was a boom in

township enterprises. This led to a sharp imbalance between power demand and supply. The severe shortage of electricity became the main obstacle to the development of the rural economy. In order to meet the needs of rural development and to quicken the pace of poverty-relief in the rural areas, the State decided to speed up the rural electrification programme, and to include it in the two key strategies of national agricultural modernization and national energy construction.

In Nov. 1982, with the personal support of Deng Xiaoping, the central authorities proposed that wherever SHP is available, SHP should be developed, putting the rural electrification programme at the core of resolving the poverty-relief issue in remote, minority, old revolutionary and hilly areas. The State Council issued a document to publicize the 100 counties for primary rural electrification. In all, 100 million Yuan was allocated for subsidies every year and the 100 counties for rural electrification were to be completed by 1990. SHP development started to be included in the rural electrification programme. After years of efforts, the progress of the pilot counties for rural electrification was swift. By the end of 1988, 48 counties reached the target in advance and passed inspection. By the end of 1990, the first batch of 109 counties had passed inspection for primary rural electrification.

With the advancement of rural electrification counties, the rural hydropower scope increased and more key SHP stations appeared. The definition of SHP was increased as well, from installed capacity of 12 MW to 25 MW. Local grids were established, with around 78% of the capacity in connected operation. The previous defect of isolated operation was overcome and unified dispatching set up at the county level. Furthermore, reservoirs were built at many cascade stations, thus increasing regulating capacity. The management system and equipment were improved constantly. Generally speaking, local SHP corporations at the county level were created and efficiency increased. By the end of 1988, the installed capacity of SHP in the whole country reached 11790 MW, with annual power generation 31.6 billion kW · h and 683600 km of high voltage transmission lines, 1.52 million km of low voltage transmission lines and total transformer capacity of 44.413 million kVA. In the whole country, 717 counties were