PEREZ-GUERRERO TRUST FUND Project

Training, Consultation and Awareness for Small Hydro Power

in Mozambique, Uganda, Nigeria and Zimbabwe

INT/06/K10

Final Report

Submitted by

International Center on Small Hydro Power

136 Nanshan Road 136, P.O. Box 202

Hangzhou 310002, China

G77 PGTF Project Final Report

Introduction

The project “Training, consultation and Awareness for Small Hydro Power in developing Countries”, submitted by IC-SHP and endorsed by Ministry of Commence includes four major elements:

T01. Identification of the Barriers to SHP Development:

T01.1 The 2006 SHP Technology Training Workshop for Africa, Hangzhou, China;

T02. Increased Awareness and Information Exchange between the Public and Private Sectors

T02.1 The Regional Seminar on Small Hydro Power Development for Africa held in Harare, Zimbabwe;

T02.2 The 3rd Global Forum on ”Hydropower for Today”;

T03.Trained Higher level of Expertise in Respective Countries

T03.1On-the-Job training at IC-SHP for three SHP engineers from Nigeria;

T04. Operational SHP Demonstration Station:

T04.1 Technical Consultation and Site selection for the Bundibogyo SHP Pilot Project, Uganda;

T04.2 Field Visit to Four SHP Sites in Mozambique: Rotanda, Maue, Majaue and Kazula;

T04.3 SHP Site Visit and Technical Evaluation in Zimbabwe;

T04.4 Consultation Mission to Nigeria;

T05.Establish Trade Links between China and Africa for SHP Equipment

T05.1 SHP Equipment donation to the Bwindi Micro Hydro Project, Uganda;

T05.2 SHP Equipment Exportation to Nigeria through the National Association of Small/Medium Hydropower Equipment Manufacturers Affiliated to IC-SHP;

T06. To Address the Barriers to Financing Opportunities for SHP:

T06.1 Publication of textbook *Small Hydro Power: China’s Practice (English &*

Chinese, Edition III);
T06.2 Distribution of IN-SHP Newsletter (monthly).
T06.3 “Lighting-up Rural Africa” Project: Small Hydro Power for Enhancing Access and Promoting Productive Uses in Africa

The beneficiaries of the Project are the above mentioned four countries and IN-SHP members globally, which are over 360 members from about 67 countries. So the G77 PGTF Project will stimulate SHP development worldwide and improve rural energy and environment conditions.

The outputs generated by this project are described as below.

T01.1 2006 SHP Technology Training Workshop for Africa, October 10 – November 23 2006, Hangzhou, China

Background

Endowed with significant natural energy resources, Africa is becoming an ever more important development area for Hydro. It is estimated that the continent holds 10% f the worlds hydro potential energy at 1100 tWh most of it in Congo Zaire basin, Zambezi, the Nile, Ruvuma and Rufiji and thousands of smaller streams running down the ranges and mountains of Africa, and that Zaire drainage basin alone holds over 90% of the Africa hydro potential. However, unfortunately, little transformation of those resources from primary to secondary forms has taken place to improve access to modern energy services by the majority of the people. Most of the countries are poorly served with electricity and have a low per capita consumption as low as 80 kWh and the sub Sahara countries averaging 350 kWh compared with 3750 kWh for Europe. The rural areas are have generally been neglected with connection to the national grid averaging more averaging less than 4 % while urban areas average 40% in the four east African countries of Kenya, Uganda, Tanzania and Rwanda. The low rates of connection are a source frustration for many waiting to be connected to national grids. In Kenya, the connection rates grew on average 5.5 % in the last 10 years.

Small hydros, by their very nature of being widely disbursed can be part of the solution to meeting the modern energy needs of many people. It has been identified as one of the most appropriate and environment friendly, renewable energy sources, can provide convenient and uninterrupted energy to off-grid rural villages in Africa. Providing electricity to rural communities can open up an array of opportunities resulting in comprehensive socio-economic development that would facilitate more and improved income generation in the rural setting. The challenges facing SHP exploitation are many and the few bigger ones are: (1) lack of access to appropriate technologies especially in the mini, micro and pico hydro categories; (2) lack of infrastructure for manufacturing, installation and operation; (3) lack of local capacity to design and develop small hydropower schemes for areas sometimes considered too remote. (4) A major challenge to the development the small hydros have been the low electricity consumption associated with the sub-region.

China presents an excellent model for sustainable development through SHP, having effectively exploited a substantial proportion of its energy resources. Over 300 million people in China now enjoy the benefits of electrification through SHP. By the end of 2004 in China ,43,809 SHP stations had been built with a total installed capacity of over 34,661 MW, accounting for 28.9% of the total exploitable potential. These installations produce annually a total of 97.8 billion kWh of electricity, and the above numbers are growing fast each year. This is by far the largest capacity installed in any country. China owes its successful practice of SHP development to the strong support of government preferential policies, the large indigenous manufacturing capacity and fully recognizing the advantages of SHP over Large Hydropower.

In this context, *2006 SHP Technology Training Workshop for Africa, October 10 – November 23 2006* was held at the premises of the International Network on Small Hydro Power (IN-SHP) at Hangzhou, China. This program is designed to facilitate participants from over twenty African countries to participate in a 45-day capacity building programme on small hydro power (SHP). Also through this initiative, IN-SHP's programme on rural electrification

will be further strengthened, building capacity to increase local participation in projects; generating jobs and income through technology transfer for local assembly or manufacture of energy equipment; and promoting productive end-use of energy.

Training Objectives

Through theoretical and practical training, the students are expected to master the basic theories and knowledge of SHP technology, to develop an understanding how SHP plays a key role in easing rural energy shortage and promoting sustainable development and to keep informed on modern SHP technique for rural electrification, which will facilitate SHP exploitation and utilization in their home countries.

Training Content

Technologies and Policies SHP development

Training Methods

Lessons, internship, demonstration, lectures, visit, field trip, discussion and reports

Means of Assessment

The trainer made a comprehensive evaluation on the level of training that the students achieve by their grade in written examination and internship, as well as their performance on the course.

Proposals for Future Cooperation

During the 2006 SHP Technology Training Workshop for Africa, two proposals from IN-SHP concerning Small Hydro Power in Africa were mentioned. They are:

- Lighting Up Rural Africa and
- Go To Africa.

Lighting Up Rural Africa is a scheme in which IN-SHP's 100 units of turbine (Electro-mechanical components with each unit ≤10kW) is going to be donated

to African countries.

IN-SHP is also going to handle the technical aspect, erection of equipment, testing and training of operators and commissioning of the project.
Civil works, distribution and local cost to be covered by country/developer/owners.

Interested developers are to make an application through their national government to the IN-SHP after identifying potential sites. This would be followed by IN-SHP experts' visit to confirm site(s). The second visit by IN-SHP experts will be for the erection of equipment, training and commissioning of the station i.e. after the civil works must have been completed by developer/owner.

Go to Africa is a partnership between the Chinese Government and the local developers. The SHP schemes involved must be ≥500kW per station. It is a business approach in SHP & LHP development and the cost is share by the developer and the Chinese Government at an agreed ratio. This partnership is not limited to SHP projects alone; it can also be in any other sector of the economy in which partnership with the Chinese government can be of mutual benefit to both parties.

Participants of the 2006 SHP Technology Training Workshop for Africa Hangzhou, China (10 OCT - 23 NOV 2006)

No.	Name	Country	Position	Work Unit
1	Mr. Macumu Pierre	Burundi	Excutive Director of YAD; Coordinator of YES	Youth Action for Development and Youth Employment; Summit Network Burundi
2	Mr. Cyprien Simbananiye	Burundi	Director in Department of Hydropower and Energy in Rural Area (DGHER)	Ministry of Energy and Mines

3	Mr. Emile Manirakiza	Burundi	Engineer in Department of Hydropower and Energy in Rural Area (DGHER)	Ministry of Energy and Mines
4	Mr. Boris Merlain Djousse K.	Cameroon	Design, Planning and Follow up Officer, ACREST	African Centre for Renewable Energies and Sustainable Technology
5	Mr. Hycinth Ndikilar Tanto	Cameroon	President-Board of Directors	CC Technologies Group
6	Mr. Matty Fru Fombong	Cameroon	Executive Director	Rural World Resources International
7	Mr. C. A. Kabasele Dikangala	D.R.Congo	Division Chief, Distribution of Electricity	Ministry of Energy
8	Mr. Oscar Bisimwa Mondo	D.R.Congo	Responsible for Energy in South Kivu Province	Government Department of Energy; Program Energy Foundation
9	Mr. Kasindi Lurhakwa Remy	D.R.Congo	Responsible for Operation and Development	Program Energy Foundation
10	Mr. N'Faly Yombouno	Guinea	Chief of Micro Hydropower Section	Division of Renewable Energies, Department of Energy
11	Mr. Alphadio Barry	Guinea	Engineer	Rural Electrification Project, Guinea Government
12	Mr. Abdikadir Hussein Maalin	Somalia	Chairman	MOGAOISHU, Somalia; Somlink Relief and Development Organization
13	Mr. Adama Keita	Mali	Electrical Engineer (Ph.D)	Ministry of Mines, Energy and Waters
14	Mr. Birama Diourte	Mali	Electromechanical Engineer	Ministry of Mines, Energy and Waters
15	Mr. Mohamed Ould Abdel	Mauritania	Principal Engineer	Director of Water Supply Resources, Ministry of

	Khair			Hydropwer, MIR
16	Mr. Burbwa Felix Ter	Nigeria	Mechanical Engineer	UNIDO-RC-SHP in Africa
17	Mr. Ismaila Sulaiman	Nigeria	Mechanical Engineer	UNIDO-RC-SHP in Africa
18	Mr. Nwanokwai Collins	Nigeria	Senior Engineer	UNIDO-RC-SHP in Africa
19	Mr. Bosco Selemani	Tanzania	Senior Research Engineer	Tanzannia Electric Supply Company Limited
20	Mr. D'almeida Dosse	Togo	Electrician	Department of Energy, Ministry of Energy and Mines
21	Mr. Gamedey Koffi Dodji	Togo	Electrician	Department of Energy, Ministry of Energy and Mines
22	Mr. Hichem Mohamed Chaibi	Tunisia	Head electricity sector	Department of Energy, Ministry of Industry, Energy and PME
23	Mr. Wadi El Euch	Tunisia	Electromechanical Engineer; Managing Director	Ministry of Water Resources & Agriculture
24	Mr. Christopher Katwesigye	Uganda	Research Technician	Uganda Industrial Research Institute
25	Mr. Daniel Rea	UK/Zambia	Civil Engineering Project Manager	North West Zambia Development Trust (NWZOT); Ove Arup & Partners, London
26	Mr. Arnold M. Simwaba	Zambia	Senior Electrification Officer	Ministry Of Energy And Water Development
27	Mr. Godwell Simbeya	Zambia	Semior Manager-Plannaing & Projects	Rural Electrification Authority (REA)

28	Mr. Geoffrey Musonda	Zambia	Project Coordinator	UNIDO
29	Mr. Aaron S. Nyirenda	Zambia	Senior Manager – Prp & Generation Projects	ZESCO Limited
30	Mr. David Zimba	Zambia	Chief Civil Engineer	ZESCO Limited

Programs of the 2006 SHP Technology Training Workshop for Africa Hangzhou, China (10 OCT - 23 NOV 2006)

Date	Activity	Lecturer/ Title / Position	Lecturer's Organization
10 OCT 2006 (Tuesday)	Arrival & Registration	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
11 OCT 2006 (Wednesday)	1 . Opening Ceremony 2 . The History, Situation and Experience of SHP Development in China	Prof. TONG Jiandong Director General/Senior Engineer with Professor Rank	IC-SHP
12 OCT 2006 (Thursday)	Hydrological Data Acquisition and Analysis for SHP Projects	Prof. LI Zhiming Chief Engineer/Senior Engineer with Professor Rank	IC-SHP
13 OCT 2006 (Friday)	Economic Evaluation on SHP Projects	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
14 OCT 2006 (Saturday)	Study Visit to IC-SHP Jinhua SHP Equipment Manufacturing Base		
15 OCT 2006 (Sunday)	Site Visit to Xin'anjiang Hydropower Station and One Thousand Islands Lake		
16 OCT 2006 (Monday)	Site Selection and Preparation for SHP Development	Prof. LI Zhiming Chief Engineer/Senior	IC-SHP

		Engineer with Professor Rank	
17 OCT (Tuesday) - 22 OCT 2006 (Sunday) 2006	SHP Automation Technologies & CDM		
23 OCT 2006 (Monday)	Preparation for the group discussion	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
24 OCT 2006 (Tuesday)	Opinion Sharing among Trainees	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
25 OCT 2006 (Wednesday)	Operation, Maintenance and Management for SHP projects	Mr. TAN Xiangqing Division Chief/Senior Engineer	IC-SHP
26 OCT 2006 (Thursday)	Mechanical and Electrical Technologies for SHP projects	Mr. LIU Deyou Managing Director/Professor	IC-SHP
27 OCT 2006 (Friday)	Electric & Control Equipment for SHP Projects	Mr. SUN Li Senior Engineer	IC-SHP
28 OCT 2006 (Saturday)	Sightseeing of West Lake in Hangzhou		
29 OCT 2006 (Sunday)	Visit to Zhejiang Museum and the Former Residence of Mr. Hu Xueyan, a Former Zhejiang Businessman in Qing Dynasty		
30 OCT 2006 (Monday)	A Case Study on Nigeria's SHP Development and Its Community Development Centre (CDC) Building	The On-job Training Staff from Nigeria	IC-SHP
31 OCT 2006	Special Subject: Development and	Mr. Gary Martin	IC-SHP

(Tuesday)	Application of Pico Hydropower in Developing Countries	Program Officer/Engineer	
1 NOV 2006 (Wednesday)	Methods of Feasibility Study on SHP Projects	Prof. LI Zhiming Chief Engineer/Senior Engineer with Professor Rank	IC-SHP
2 NOV 2006 (Thursday)	Special Subject: China's Pilot Hydro-electrification Program for Rural Counties	Mr. ZHENG Xian Ex-Department DG/Senior Engineer	Ministry of Water Resources of P.R.China
3 NOV 2006 (Friday)	Special Subject: NGOs and Renewable Energy Development	Mr. Matt Fombong Enginee	Rural World Resources International, Cameroon
4 NOV 2006 (Saturday)	Study Visit to Linhai Electric Machinery Works and Linhai Machinery Works, Zhejiang Province		
5 NOV 2006 (Sunday)	SHP Site Visit in Lin'an		
6 NOV 2006 (Monday)	Promotion of Rural Environmental Conservation and Sustainable Community Development through SHP Exploitation	Mr. Mikel Claramunt Program Officer/Engineer	IC-SHP
7 NOV 2006 (Tuesday)	Special Subject: China's Replacing Firewood with Electricity Program in Rural Areas	Prof. TONG Jiandong Director General/Senior Engineer with Professor Rank	IC-SHP
8 NOV 2006 (Wednesday)	Special Subject: Domestic Manufacturing of SHP Equipment	Mr. WANG Hangwei Director of IN-SHP Jinhua Base/Senior Engineer	IN-SHP Jinhua Base
9 NOV 2006 (Thursday)	SHP Development in Latin America	Ms. Erika Imhof Program Officer	IC-SHP

10 NOV 2006 (Friday)	Special Subject: China's Sending Electricity to Counties Program in Remote Rural Areas	Mr. WEI Jianghui Deputy Division Chief/Interpreter	IC-SHP
11 NOV 2006 (Saturday)	Tour to Shanghai Pudong Development Zone and Shanghai City		
12 NOV 2006 (Sunday)	Tour to Wuzhen, a Village of Rivers and Lakes		
13 NOV 2006 (Monday)	Special Subject: IC-SHP's Activities in Africa	Prof. TONG Jiandong Director General/Senior Engineer with Professor Rank	IC-SHP
14 NOV 2006 (Tuesday)	Training Test Comment on the Test Paper	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
15 NOV 2006 (Wednesday)	SHP Site Visit in Anji, Zhejiang Province		
16 NOV 2006 (Thursday)	Opinion Sharing among Trainees /Conference Paper Preparation	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
17 NOV 2006 (Friday)	Opinion Sharing among Trainees /Conference Paper Preparation	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
18 NOV 2006 (Saturday)	Visit to Silk Museum		
19 NOV 2006 (Sunday)	Visit to Longjin Village and Zhejiang Tea Museum, Hangzhou		
20 NOV 2006 (Monday)	International Cooperation on SHP	Prof. TONG Jiandong Director General/Senior Engineer with Professor	IC-SHP

		Rank	
21 NOV 2006 (Tuesday)	Country Paper Presentations/ Technology among Trainees	Mr. WANG Yansong Deputy Chief of TCDC Division Chief/Engineer	IC-SHP
22 NOV 2006 (Wednesday)	1 . Discussion on Future Cooperation	Prof. TONG Jiandong Director General/Senior Engineer with Professor Rank	IC-SHP
	2 . Conclusions		
	3 . Closing Ceremony		
23 NOV 2006 (Thursday)	Departure for Home Destinations		

T02.1 The Regional Seminar on Small Hydro Power Development for Africa, November 27 - December 1 2006, Harare, Zimbabwe

Background

Southern Africa Development Community (SADC) region is most backward in exploitation of SHP. Only 2.5% of SHP resources have been identified, with much less being exploited. 95% of rural population has no access to electricity. With increasing electricity demand of the SADC regional grid, the region is running out of generation capacity, and the crisis is expected to peak in 2007. SADC countries are frantically trying to build power stations to meet the deficit, even though it takes between five to ten years to build large hydro or thermal power stations. Given that the deficit is already being felt, and that 2007 is only 15 months away, SADC governments and utilities realized it imperative to embrace SHP development to limit the impact of the deficit as SHP projects take much less time to complete, and are a proven environmentally-clean technology.

However, they are faced with lots of barriers in progress of developing SHP projects, namely limited knowledge of SHP technologies, inadequate capacity to engage in SHP projects, poor institutional and legal environmental framework to encourage SHP development, poor technical and financial skills in implementation SHP projects, inadequate government policy development

on SHP as a poverty alleviation tool.

Under this background, the Governments of Zimbabwe, Mozambique and other 3 countries in the southern Africa region, requested IC-SHP for assistance to provide solutions to above barriers in SHP development. Invited by the above governments, IC-SHP decided to conduct a regional training seminar on SHP Development at Harare, Zimbabwe. The objective of the training seminar is to overcome the shortcoming of SHP development in SADC region using IC-SHP expertise and relevant experience.

IC-SHP's Delegation to the Seminar

The IC-SHP experts who traveled to Harare and gave presentations in the Seminar were Prof. Tong Jiandong, Director General of IC-SHP, Prof. V.K. Damodaran, managing director of IC-SHP, and Mr. Yuan Peisheng, Senior Engineer. The experts of IC-SHP sub-center in Africa also contributed to the seminar.

The Contents of Seminar

Around 40 participants from 6 countries of SADC region, namely Zimbabwe, Mozambique, Zambia, Congo, Madagascar, Angola, attended the seminar. The seminar included a half-day inaugural session, one and half day technical session, and a half-day of site visit. As most of participants are governmental officials and SHP engineers, the IC-SHP experts decided to put the focus on the SHP development policies, case study of successful SHP development, mature technology, etc. The contents of the Seminar can be seen in the following table.

28th Nov	Registration and inauguration
	Technical Session Paper 1: Appropriate And Cost-effective SHP Technology (by Prof.Tong) Paper 2: Indian Experience of SHP Development (by Prof. V.K.Damodaran)
29th Nov	Technical Session:

	Paper 3: China's SHP Policy (by Prof. Tong) Paper 4: IC-SHP Activity in Southern Africa (by Prof. V. K. Damodaran) Paper 5: Preliminary Design of SHP development (by Mr. Yuan Peisheng) Paper 6: Financing Analysis of SHP Project (by Mr. John Miller) Paper 7: The role of African Sub Center (by Mr. Trust Chifamba)
30th Nov	Discussion
1st Dec	Site visit and Closing session

In inaugural Session, the minister of Power & Energy Ministry of Zimbabwe warmly welcomed the IC-SHP delegation, and expressed his deep gratitude for IC-SHP' contribution to the development of Small Hydropower for the Southern African countries, Zimbabwe in particular. He also hoped to strengthen the cooperation with IC-SHP in the further and the bilateral cooperation with China through the effort of IC-SHP.

Prof. Tong Jiandong, on behalf of IC-SHP, also spoke in the inauguration. He expressed his gratitude for the Zimbabwe Government and African Sub Center's effort for this seminar. Then he introduced the activities IC-SHP had done and the pilot SHP stations IC-SHP developed in African Countries, and expressed IC-SHP's willingness to further assist to SHP development in Africa.

In technical session, the IC-SHP delegation made presentations in different aspects of SHP development, which mainly concentrated on solutions to overcome barriers of SHP development in SADC region. Prof. Tong totally made two presentations. The first one with title of "Appropriate And Cost-effective SHP Technology" emphasized the importance to reduce cost and make the technology affordable to backward areas. He introduced some useful measures and strategies, such as small basin development, planning and design optimization, proper economic analysis of SHP installed capacity, developing indigenous manufacturing capacity, simplification and serialization of SHP equipment, etc. He also introduced different cost-effective types of equipment by Chinese manufacturers.

The second presentation is about series of policies and strategies formulated by Chinese government to stimulate SHP development. Prof. Tong detailed explained some most effective policies. For example, “3-Self” policy, namely, Self-construction, Self-management and self-consumption; preferential policies, such as Leadership by example system, Establishment of rural SHP development foundation, Electricity generates electricity; Prof. Tong also introduced some successful examples of SHP development in mountainous and backward areas benefited by the polices.

Prof. V.K. Damodara also made two presentations regarding India SHP development and IC-SHP activities in Southern Africa countries. Prof. Damodaran talked about the experience and achievement India made in SHP development. He also made some comparison between SHP development of India and China. In the second presentation, he mainly introduced the activities IC-SHP had done in African Countries and some further projects IC-SHP will implement.

Mr. Yuan Peisheng’s presentation focused on some basic concepts of SHP development on the technical level. Managing Director of African Sub Center made presentations too. They emphasized the important role that Sub Center will play in the future, and they hoped that the SHP developers of Africa would cooperate with them.

The organizer arranged one day for discussion, which enabled the participants to be more actively involved in the event by asking questions and expressing their own views. Rather than mere accepting, the participants can share with each other their experiences and opinions, which in most cases are very valuable.

Post-training Site Visit

Manyuchi station is about 25km away from Harare. The dam created a reservoir with storage of 30 million m^3. In 2003, the consultants from IC-SHP visited the site and evaluated the proposal to build a SHP at Manyuchi Dam. The initial conclusion is that 2×100 kW can be installed for this project.

However, some modification has to be done for integrating SHP into the existing facilities. The existing spillway should be completed and a gate should be added at the entrance of the penstock. The downstream slope of the dam has obvious erosion problem, which needs to be repaired on matter whether SHP will be added. A long crack was also found on the dam crest at this visit which needs to be further investigated.

As for the time arrangement of the dam repair and the SHP construction, our experts' suggestion is that these two tasks can be done separately. After finishing the spillway and penstock modification, the construction of SHP can be started. Other dam repair works can be done step by step according to the available investment. If it is possible, the beneficiary should be asked to contribute labor and/or materials for dam repair.

The location of the powerhouse can be arranged as the first IC-SHP consultant team had proposed. Once the order of equipment purchase is put, the IC-SHP expert will ask the manufacturer to provide the technical drawings of equipment and the sketch of powerhouse arrangement.

Output of the Mission

From introducing the successful practice, mature technology and polices, the seminar gave the participants a general idea on how to over the barriers of SHP development in their countries. The seminar was a success according to the feedback from the participants. Many participants expressed their hope to cooperate with IC-SHP in the future. Some agreements of developing SHP projects had signed between Southern African countries and IC-SHP. The initial objective is to help the 6 countries to establish 6 pilot SHP stations. IC-SHP would be responsible to give technical consultation and equipment supply. Requested by the government officials, IC-SHP would also give consultation services on their countries SHP policy formulation, and train SHP engineers for them.

T02.2 The 3rd Global Forum on "Hydropower for Today", 12-13 June 2007, Hangzhou, China

The 3rd Global Forum on ‘Hydropower for Today” was held successfully from 12-13 June 2007 at the International Centre on Small Hydro Power (IC-SHP). The Forum had 188 delegates - 66 from 26 countries abroad and 122 from China – and an extensive array of presentations were made. The Forum after discussing various problems faced by most of the developing countries for the speedy development of the most urgent SHP development, looking at various approaches to their solutions form Asia, Africa, Latin America and the Europe and exchanging views on how best the needy regions in Asia and Africa could be best served by the most appropriate small hydro power solutions.

Output of the Conference

The Forum had the benefit of 27 learned presentations from researchers and practitioners of SHP from all over the world in 7 technical sessions, chaired by an International Presidium for each session.

The delegates were given insights into some interesting new technology developments like the further improvements in the updraft free exit flow turbine, giving hope of giving a weight reduction to one third of the normal turbines, cost reduction of 30-60% over conventional axial flow turbines and making it environmentally and fish friendly, avoiding the costly draft tube too. We have, of course, to wait for its commercialization in the near future. The other technological innovation reported was the studies conducted simultaneously in China and Finland on performance prediction of Bulb turbines by flow simulation and bringing prediction and reality to closer distance.

Further, the presentations at the Forum brought out clearly the regional/country status of hydropower development and the policy structures prevailing in the countries represented here, highlighting success, failures and lessons learned with the impacts of policies in focus. Many developing country presentations were concerned realizing the Millennium Development Goals of poverty alleviation and employment generation through provision of energy to rural areas. Also highlighted were, the need to upgrade the traditionally built hydropower plants and the water mills in Africa which are used for grain

grinding (200,000 in India alone) and take up more hydropower projects – small and micro/pico hydro power. These would go in line with the proposed massive project on Lighting up Africa and would help in creating and maintaining energy markets in developing countries, especially in the rural communities.

The papers presented extended further to a variety of other technical and managerial issues specific to small hydropower, such as voltage stability, combining energy efficiency efforts, use of LED lighting, legal issues covering a broad spectrum of hydropower activities including power sector reforms.

All the members of the Presidium, authors and the institutions and the respective governments involved, as well as the organizers viz. the International Network on Small Hydro Power (IN-SHP) did an excellent job in getting so many countries and other stakeholders to participate and to have a wide spectrum of issues discussed at the Forum.

IN-SHP declared their intention to actively participate in the Lighting Up Africa programme and announced the re-naming of IN-SHP to International Association for Small Hydro Power for registration within China, the structure and office bearers remaining the same.

Hang Zhou Declaration on Asia and African Cooperation on SHP

Adopted by the Third Global Forum on "Hydropower for Today"
Held at Hang Zhou, P. R. China, from 12 to 13 June 2007

Preamble

The focus of the 2007 forum is Africa and Asia SHP cooperation. The two continents both have great SHP potentials, huge electricity demands but the development scenarios are quite different. Topics of why there is such a difference and how the development gap can be narrowed have been discussed at the forum by the high-level government officers, policy makers,

SHP experts and engineers.

Declaration

1. The participants to the Third Global Forum on Hydropower for Today acknowledge the efforts of Peoples Republic of China in the sustained development of hydropower including small hydropower, and appreciate the joint initiatives in co-organizing this discussion forum by the International Center on Small Hydro Power (ICSHP), United Nations Industrial Development Organization (UNIDO), CANMET Energy Technology Centre (Canada) and the China International Center for Economic & Technical Exchange (CICETE).
2. The Forum recognizes the need to integrate hydropower development with other demands on water resources such as drinking water supply, irrigation, flood prevention, pollution abatement, tourism, environmental protection, regional biodiversity maintenance, and other local economic development needs and requests all concerned to develop innovative methods for realizing this opportunity.
3. The Forum appreciates the need for development of hydropower potential in moderation and the need to have an effective governmental framework to achieve these objectives, as it is governments that should draw up national plans for hydro-energy generation and mandate the amount of river runoff that must be maintained free and to build capacity to manage this critical resource for the benefit of society as a whole.
4. The Forum also recognizes the roles of international agencies in promoting global hydropower development and calls for developing multilateral channel cooperation, and to optimize and ensure maximal use of water resources for the common benefit, through new and revised policies that reflect issues of ecological balance and social equity.
5. The Forum takes note of the fact that the hydro power project inputs are based on impact of submergence and river re-direction as well as on the potential carbon dioxide emissions, and this is inadequate. The Forum recommends that all hydro projects should be covered under the CDM and reasonable mitigation of the impacts built into the project budgets.

However, higher compensation will upset the project viability and it is recommended that the international agencies involved in promoting hydro power agree on sustainable guidelines and come up with reasonable cost structures for evaluating the impacts and benefits of hydropower projects, so they can be constructed at reasonable cost.

6. In view of the very low percentage of electrification in Africa and the abundance of hydro resources in the African continent, the Forum considers it appropriate to focus more on environmentally-friendly and economically-viable hydropower development in Africa during the next decade to help in global reduction of GHG emissions.
7. The Forum further calls upon all agencies related to hydropower, to support the promotion of replicable and sustainable models of small hydropower projects, backing income generating activities, non-formal education and training in skills in rural areas of developing countries, and especially in sub-Saharan Africa.

This Third Forum on Hydropower for Today has re-kindled the hope of promoting further, the development of hydropower globally on a new note of high environment compliance and increased social responsibility and pledges itself to the realization of increased role for hydropower in the energy scenario of the World.

Programs of the 3rd Global Forum on "Hydropower for Today"
12-13 June 2007, Hangzhou, China

June 10~11, 2007 Sunday/Monday

- Airport pickup
- Registration at IC-SHP lobby & escorting to hotel

June 12, 2007 Tuesday

0800~0900 Registration

0900~1015 Opening Ceremony

1100~1200 Plenary Session I : Small Hydropower Development—Various Experiences

1330~1500 Plenary Session II：Small Hydropower Development—Engineering Practice

1515~1700 Plenary Session III：Small Hydropower Development—Technology Development

1800 Banquet at Lou-wai-lou Restaurant(Interpreter: Ms. Wang Xianlai)

June 13, 2007 Wednesday

0830~1000 Plenary Session IV: Small Hydropower Development in Asia

1015~1200 Plenary Session V：Small Hydropower Development in Africa

1330~1515 Plenary Session VI：International Cooperation on SHP

1530~1645 Plenary Session VII：Introduction of Cooperation Project Proposals

1700~1800 Closing Ceremony

1815 Banquet at Hong-Ni-Sha-Guo Restaurant

June 13, 2007 Thursday

Study Tour

- Tibet (June 14~17)
- Three Gorges Project (June 14~17)
- Jinhua—One-thousand-island Lake(June 14~15)
- Hangzhou city tour (June 14)

Participants of the 3rd Global Forum on "Hydropower for Today"
12-13 June 2007, Hangzhou, China

No.	Name	Position	Country	Organization
1	Mr. Goran Stojmirovic	Group Manager, Hydropower and Major Projects	Australia	Hydro Tasmania
2	Ms. Tammy Chu	Hydropower Engineer	Australia	Hydro Tasmania
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5	Mr. Bharat Tamang	Energy Specialist	Bhutan	Department of Energy
6	Mr. Sonam Tshering	Director General	Bhutan	Department of Energy
7	Dr. Prof. Geraldo Tiago	Executive Secretary	Brazil	National Center of Reference in SHP
8	Ms. Elizabeth Monti Bacha Tiago	Accompanying wife, Pharmaceutical	Brazil	
9	Dr. Jinxing Huang	Senior Advisor	Canada	CETC-Ottawa
10	Mr. Carlos Canales Castañer	Chief Technical Advisor	Chile	Project CHI/00/G32 UNDP - GEF
11	Mr. Mekonnen Ayalew	First Secretary	Ethiopia	Embassy of The Federal Democratic Republic of Ethiopia in Beijing
12	Mr. Davison H. Banda	First Secretary	Zambia	Embassy of the Republic of Zambia
13	Mr. Kabasele Dikangala Camille Augustin	Civil Servant	D.R. Congo	Ministry of Energy
14	Mr. Ahmed Wareth	Civil Engineer	Egypt	Hydro-Power Plants Executive Authority
15	Mr. Ahlamy Ahamd	General Manager of Informarion Centre	Egypt	Hydro-Power Plants Executive Authority
16	Mr. Keletigui Guilavogui	National Director	Guinea	Department of Hydraulic and Energy, Ministry of Energy and Hydraulic
17	Mr. Arun Sharma	Managing Director	India	A. Power Himalayas Limited
18	Mr. Abhay Sharma	Sr. Executive	India	A. Power Himalayas Limited
19	Mr. Asish Bose	Vice President-HYDAL	India	Assam Roofing Limited
20	Mr. Kadayattu Madhavan Dharesan Unnithan	Director	India	Energy Management Centre, Power Department, Government Of Kerala

21	Dr. Anil Joshi	Founder Director	India	Himalayan Environmental Studies And Conservation Organisation (HESCO)
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23	Mr. Sunil Aggarwal	Managing Director	India	Madkini Hydro Power Private Limited
24	Prof. Damodaran Vadakke Kunnummal	Energy Consultant	India	MD, IN-SHP
25	Mr. Balan Aasari Koroth	Minister for Electricity	India	Power Department, Government Of Kerala
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27	Mr. Ankur Aggarwal	Sr. Executive	India	Regency Aquaelectro & Motelresorts Limited
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29	Mr. Ramaswamy Venkateswaran	CEO/Director	India	Rightlinx (India)Limited
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50	Prof. Priyantha Cabral Wijayatunga	Director General	Sri Lanka	Public Utility Commission of Sri Lanka

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60	Mr. Geoffrey Musonda	Project Co-ordinator	Zambia	GRZ/UNIDO/GEF Project
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63	Mr. Trust Chifamba	Managing Director/ Principal Engineer	Zimbabwe	H.T. Power & Industrial Engineering
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65	Mr. Nasidi Abdullahi	Secretary	Nigeria	Independent Power Programme (IPP) Committee， Kano State Government，Nigeria
66	Mr. Vincent Ndoungtio Kitio	Energy Adviser	Kenya	UN-HABITAT

T03.1 On-the-Job Training at IC-SHP for Three SHP Engineers from Nigeria

Participants

Mr. Burbwa Felix Ter,
Mr. Ismaila Sulaiman
Mr. Nwanokwai Collins
They are three staff of Lower Benue River Basin Development Authority, Nigeria.

Training Duration

October 2006 to April 2007 at the International Network on Small Hydro Power headquarters in Hangzhou, People's Republic of China.

Training Content

The training course covered various aspects of small hydropower development, such as: Small Hydropower: China's Practice (Strategies and Policies), Small Hydraulic Turbines, Civil works, Electrical Technologies, Technical/Sites Visits to SHP Stations and Companies, SHP Project Proposal Documentation, Preparing SHP-base CDM Project Document, Case Study.

T04.1 Technical Consultation and Site Selection for the Bundibogyo SHP Pilot Project, Uganda

Invited by Ministry of Energy and Mineral Development of Uganda, a team of three members from International Center on SHP, Mr. Wang Yansong, IC-SHP program officer, Mr. Yuan Peisheng, senior engineer and Mr. Deng Simao, SHP engineer, paid a field visit to the Bundibogyo SHP Pilot Project

Basic Information

Bundibugyo District is located at the southwest part of Uganda, neighboring Congo. The proposed site for SHP pilot project is at the foot of Rwenzori

Mountains. It takes 7 hours drive from Kampala to the nearest town to the village. The road that vehicle can access ends about 4 kilometers ahead of the weir site and about 1.5 kilometers ahead of the powerhouse site.

This SHP site is located at a heavily forested area. There are also some plantations and houses along the channel. There is no existing road available to the site. To sum up, the traffic condition for project construction is very poor. Moreover, the mountain slope is very steep and the earth layer is loose, which will aggravate the difficulties in project construction.

There are about 17,300 people living in 5 villages in the project area, who are supposed to get electricity from this project. The farthest one is about 12 km away from the powerhouse. There is no electricity supply in this area right now. However, a power grid extension to the project area is being planned by the government.

The catchment area above the weir site is about 32 km2. The runoff in the river comes from two sources: the snow thawing and rainfall. The current flow in the river is about 0.7~0.8 m3/s which will decrease about one half during dry season.

The Evaluation of the Site Selection

The layout of the project was suggested by the previous mission to the site. The delegation followed the proposed canal route before reaching the weir site. The selection of the main structures is basically reasonable. However, the IC-SHP experts suggested do further investigation on the following three issues:

1) The weir site. The experts found that the current weir site will leave very limited space for accommodating the intake and sluice gate. The storage of the pond will be also very small. Moreover, the chance of bypass leakage of the weir abutment is quite big since fractures are observed on the rock on both sides and there will be no easy remedies for stopping this leakage. To this end, IC-SHP experts suggested that an alternative weir site should be

investigated for comparison. The one about 50 meters downstream from the current site can be an alternate and the IC-SHP experts had told this to the MoE engineer who companioned them.

2) The canal route. An aqueduct is suggested for very steep, rocky areas where excavation will be very difficult. Adopting an aqueduct will minimize the excavation.
3) The forebay. The forebay area seems to be a now settled land slide area. The stability of the forebay foundation needs to be further studied.

The Installed Capacity

This site is initially proposed for a 500 kW SHP project. But the available flow in the river is enough for a larger capacity. Given the catchment area and the rainfall above the weir site, it is suggested that 1000 kW should be installed. Although the investment for 500 kW scheme will be lower, but the per kW investment will be much higher, since no matter how small the installed capacity is, the investment will not come down in proportion with the capacity in terms of civil construction & penstock costs. Moreover, a larger capacity will have more commercial value.

The Investment

The IC-SHP experts found that the material and transportation cost in the project area is very high, which directly contributes to the high cost of this project. The total investment of the 1000 kW scheme will be US$2.77 million (including equipment cost of another 3 sets of 250 kW unit) and that for a 500 kW scheme will be US$2.48 million (including equipment cost of another 250 kW unit). The per kWh investment will be about US$0.554 for 1000 kW scheme and that for 500 kW scheme will be US$0.71. The breakdown of the total investment for 500 kW scheme is attached herewith. In Uganda, the power generation and distribution has already been privatized with government controlling only the power transmission of higher than 33 kV. So it is important to find a commercial partner to develop and run this project. According to MoE, the tariff for the electricity from this project can be as high as US$0.10/kWh (including the subsidy from the government). If this tariff can be guaranteed, then the commercial value of the 1000 kW scheme is very

obvious.

International Center on Small Hydro Power will keep committing itself to provide possible assistance in order to complete this project as soon as possible.

T04.2 Field Visit to Four SHP Sites in Mozambique: Rotanda, Maue, Majaue and Kazula

Mozambique is a country in southern Africa with increasing energy demand and large SHP potential. Many rivers originating in neighbouring countries pass through Mozambique before flowing into the Indian Ocean. These rivers are rich in hydraulic resources. In the mountainous areas, many potential SHP sites remain untapped, while a handful of SHP stations are discarded due to either war damage or bad management. On the other hand, only 15 percent of the population in Mozambique has access to electricity and most of them live in cities. Almost all rural areas are non-electrified. SHP can play a key role in rural electrification in Mozambique, leading to poverty alleviation and social change.

The consultation delegation consisting of three experts from the International Network on Small Hydro Power (IN-SHP), Mr. Wang Yansong, Program Officer, Mr. He Zhicheng, Chief Egineer and Mr. Qiu Dale, SHP engineer as well as two engineers from M/s Powermate International, where the Sub-center of IN-SHP for Africa is functioning, covered four sites in Mozambique and the team was guided by Ministry of Energy and Ministry of Industry of Mozambique. The sites visited were in the order of visit, Rotanda, Maue, Majaue and Kazula.

1. ROTANDA

The power distribution grid has already been set up in the town of Rotanda, which is only 7 km away from Mozambique-Zimbabwe border. There is a hospital, a school and some retail shops in the town. The construction of a 70 kW diesel generation powerhouse is almost complete. There are 4260 people as part of 885 families living in the area. Initially, the town and 45 families only

will get electricity, according to the local administrator. Due to the high price of diesel, a SHP station is planned as the main power source and the diesel generator is expected to remain as the standby.

The proposed location for the SHP station is about 3.5 km from the town. There is a maze mill now with grinder driven by a Pelton turbine. A 17 cm diameter metal pipe of 165 m length connects the turbine with a pond on the mountain, which serves as a forebay. A 5 km long canal diverts water from the river to the pond with most of the water being released for irrigation purposes along the way.

The IC-SHP experts suggested that a 30 kW micro hydro unit be installed at this site using the existing forebay and pipeline. Our measurement indicates that about 80 m water head will be available. Other suggestions are:

1) The current powerhouse together with the equipment inside should be removed, because the powerhouse is in bad shape and the tail water canal is not big enough.
2) The whole penstock should be thoroughly checked and the rusted portions should be replaced, ensuring that there is no leakage. It should be ensured that the wall thickness of the pipe is not less than 6 mm. Anchor blocks should be added where the penstock bends. And the whole penstock should be properly supported.
3) The canal from the river intake to the fore bay needs rehabilitation. 0.063m^3/s water is needed for a 30 kW turbine to function.
4) The cross section of the canal is as shown in the following sketch.

The material suggested for the canal is rubble masonry in cement lined with cement mortar of 1.5 cm thick for preventing seepage. The longitudinal slope of the canal should be ensured not to be less than 1:1000, in order to guarantee enough water flow and speed.

The existing forebay needs to be cleaned and any leakage from the forebay plugged. Before the penstock inlet, a trash rack should be added.

2. MAUE

Generally the civil works are in good condition and it would not be difficult to restore the power station to its original capacity. The slope of the existing canal is insufficient - approximately 35 cm over the 750 m length and the penstock is quite small, with 800 mm diameter only. With some minor improvements, the capacity could be increased to 280 kW. The improvement suggested are: increasing the area of the trash rack; or moving it and increasing the dam crest and canal walls in the vicinity of the dam, to increase the effective canal slope. The capacity of the transformer would also need to be upgraded.

It is observed that the powerhouse has flooded twice in the past 20 years. Therefore, the flood prevention for the powerhouse should be a key issue to be considered while refurbishing the station. Flood protection measures should also be included - such as blocking the low level windows and raising the elevation of the door. Waterproof door and windows can be used. However, this is subject to checking the strength of the building and making sure that it can withstand the flood pressure. Enough drainage equipment and reliable standby power supply should be available during the flood season.

Because of the limited size of the canal and penstock diameter, increasing the capacity beyond 300 kW would require more extensive canal modifications and the use of a larger penstock. For example, the original 200 kW plant required a flow of 1.3 m^3/s with an assumed head loss of 1.3 m. If we double the flow, the head loss would increase to 5 m or 25% of the gross head available will be lost, resulting in only a 320 kW capacity, suggesting that there is no corresponding increase in power.

Given the conditions at the site, the IC-SHP experts would propose to complete a detailed survey and develop a restoration plan without delay. The existing transformer can be either replaced or altered appropriately.

As discussed with the EDM and Ministry staff at the site, bush clearing below the flood line in the proximity of the power station would lower the flood levels

and it is an inexpensive and uncomplicated exercise before restoration planning.

The diesel backup would not be required as the grid connection from Malawi can be used for emergency back up purposes.

LONG TERM PLANS FOR MAUE

The watershed appears to have great variation in flow. This could be getting worse, if there is much environmental degradation upstream. A long-term strategy would be to begin a process of flow monitoring with a view to constructing a storage reservoir upstream.

Based on site observations of the existing conditions, the following preliminary calculations were made, all of which are subject to modification after a detailed site survey and hydrologic investigation is over:

Max plant flow: 2.0 m^3/s
Capacity: 280 kW
Gross Head: 20 m
Net Head: 17 m
Turbine: Horizontal Francis of 650 mm dia runner

It would not be complicated exercise to replace the penstock with a larger diameter one and to increase the canal height in the event of a higher capacity being required. This would still be a much cheaper option than the construction of a new generating station.

3. MAJAUE

This former generating station provides an excellent opportunity to incorporate a Rural Electrification Project while offsetting current power imports for the town of Milange. The civil works are in good shape and some minor improvements can be made to improve capacity to, perhaps 1 MW. The powerhouse appears to be sound and the penstock is in good condition, perhaps only requiring a coat of paint and replacement of the expansion seals.

The access road will require improvement before equipment can be brought to site.

The supply from Malawi appears to be very erratic, so it appears advisable to construct this as an isolated system where the Malawi side is connected only when long term shut down of the hydro station is encountered.

The experts proposed a 33 kV transmission line from the site to Milange with intermediate step-down transformers along the line for the local villages, schools and shops. This line would be approximately 60 km long, linking with the existing distribution lines in Milange.

The Dept of Energy in conjunction with the local EDM staff should advise on what current is the demand and IN-SHP can then advise on the most appropriate size, factoring in the proposed increased demand from the new line and future growth in demand.

Local knowledge suggests that flow levels are quite low in October. So, additional civil works may be required at that time to ensure that all of the low flow is diverted into the intake.

Civil works improvements would include a course trash rack at the intake and a gate to permit drainage of the canal. The existing trash rack, as well as the existing gates and valves require replacement. The powerhouse appears structurally sound, but will require some restoration work.

Based on site observations, the following preliminary calculations are made, all of which are subject to modification after a detailed site survey and hydrologic investigation is completed:

Max plant flow: 7 m^3/s
Capacity: 1.0 MW
Gross Head: 20 m

Net Head: 18.3 m

Turbine: Horizontal Francis of 1.2 m dia. runner & scroll case 4.2m high

The penstock intake will have to be checked for adequate submergence for the proposed increased flow

4. KAZULA

Kazula is an ideal site for “hydro for rural electrification”. The team visited two sites for the proposed 30 kW micro hydropower site. Of them, the one where there used to be a small dam is considered the best.

A small dam can be built at the same place where the old damaged dam stands. The fore bay shall be constructed on the left side hill, where a relatively plain terrain is available, and as close to the dam as possible. A canal then will divert water from dam site to the fore bay. The powerhouse shall be constructed on the downstream of the waterfall, but not far from it. The flood level at both the dam and powerhouse sites should be ascertained by consulting with local people, to take necessary measures for protecting the intake and the powerhouse. Water head of about 50 meters can be had.

The same cross section for the canal of the Rotanda site can be applied to this case also, and the slope of the canal should not be more gentle than 1/1000.

The penstock diameter shall be 20 cm.

Topographic maps and aerial photos would be the best means to develop this concept further, followed by a detailed topographic survey based on the concept drawings.

The gravel road access to the site is in good condition.

SUMMARY

All the four sites visited offer good opportunities for small hydro station

development in rural Mozambique, each with slightly different conditions and benefits. The two former generating stations can be restored reasonably quickly, as very little civil works are required. The other two sites (Rotanda and Kazula) can also be constructed quickly due to its small size.

The recommended capacities of the sites are as shown below:

- Maue 280 kW
- Majaue 1000 kW
- Rotanda 30 kW
- Kazula 30 kW

The most glaring conclusion from this field trip is the need to validate the appropriate size of other proposed sites, as data on the two available (Maue and Majaue) were extremely off the mark.

Hydrological information appears to be very sketchy on these sites and the IC-SHP experts assumed that it is so generally throughout Mozambique. A long-term goal should be to establish a network of flow gauges to establish reliable flow data to develop watershed utilisation plans as per the Chinese model. In the short term, the lack of hydrological data will mean that the determination of most economical plant size will be less accurate, than would normally be possible and desired.

The IN-SHP Sub-Centre in Africa at Powermate International is capable of conducting the required further studies and to undertake construction and management of the recommended SHP sites. The Nyafaru Project completed by Powermate in Zimbabwe about ten years ago, is still in good condition and is benefiting the local people. The IN-SHP headquarters can be a back up institution to offer any assistance to the speedy implementation of the recommended activities, if the government so desires. This arrangement will also make it possible for completing the projects in a reasonable time, with guaranteed quality and at the lowest cost possible.

THE FOLLOW-UP ACTIVITIES

1) First of all, the Mozambique government should decide upon the capacity of the different sites. For Rotanda, the capacity can go up to 70 kW, but larger and longer canal is needed in such a case. And penstock should also need to be changed. Therefore, the expense could be much higher than the 30 kW scheme.
2) Once the capacity is finalized, the process of equipment purchase can be started. The equipment supplier will provide necessary data for civil construction, like the powerhouse dimension, etc.
3) Local counterparts can start civil construction with professional supervision or a qualified contractor should be employed for civil construction. The IN-SHP Sub-Centre can undertake the work, if so needed.
4) Once the civil structure is ready, the equipment supplier will send people to install the equipment, if this is needed. The training of operators can be carried out at this time.

T04.3 SHP Site Visit and Technical Evaluation in Zimbabwe

Invited by Ministry of Energy and Power Development and Powermate International, a team of four members from IC-SHP, Mr. Wang Yansong, Program Officer, Mr. He Zhicheng, Chief Egineer and Mr. Qiu Dale, SHP engineer, visited some proposed small hydro sites in Zimbabwe.

The task of the visit is to provide consultation and other technical assistance in identifying/evaluating several SHP sites as well as carrying out the master plan of the national SHP development of Zimbabwe. Through this TCDC mission, it is expected that the close relation will be established between stakeholders in Zimbabwe and IC-SHP, and through IC-SHP, with other IN-SHP members. This is critical to SHP development in Zimbabwe as there is a lack of awareness, technology and expertise in SHP development in this country.

Zimbabwe is a country endowed with plentiful SHP resources in some regions while a lot of people living in remote areas still suffer from no access to electricity. Totally 40% of its population is not electrified. A serial of problems

remain impossible to solve because of no electricity. For example, in the remote areas, the lack of facilities to freeze vaccines has prevented successful implementation of the immunity program. The rural economy development has also been hindered by poor power supply.

1. KYLE DAM

The surface area of Kyle Dam reservoir is 91 km^2 and the storage is 1.332 billion m^3. More hydrological data, such as catchment area, rainfall, evaporation and more importantly, the daily irrigation flow and water level to decide the installed capacity and equipment selection.

There are two embedded pipes in the dam for water discharge with diameter about 50 cm. When deciding the installed capacity of SHP in the future, the diameter of the penstock should be taken into consideration. Other elements such as trash rack, gate should be added if the current pipes are used as penstock for power generation.

The powerhouse can be located at both sides of the river. If it is on the left side, the arrangement of penstock will be easier than the right side. But the spill flow is also on the left side, which will have more direct effect on the powerhouse. In either case, the effect of water mist created by water discharge from spillway on powerhouse, substation and transmission lines should be checked to avoid any problem in the future.

2. MANYUCHI DAM

Two pipes are embedded for irrigation discharge with diameter about 120 cm. There is a branch on the right pipe which is originally for power generation with diameter about 80 cm.

The reservoir was constructed mainly for sugarcane field irrigation. The irrigation flow throughout a year and water level in the reservoir should be the key factor when deciding the installed capacity of this project. To this end, the IC-SHP experts hope the management body of the Manyuchi Dam will be able to provide the detailed daily record of flow and water level for them to decide a

optimum equipment scenario.

It is recommended one of the now irrigation pipes should be used as the penstock if the installed capacity is 1400 kW. If the branch pipe is used, the friction loss inside the pipe will be too big. If the installed capacity is less than 1000 kW, the branch pipe can be used as the penstock.

As there is no flood issue for the powerhouse, it should be located as close as possible to the dam. This will not only save cost on penstock, lessen head loss but will also alleviate the water hammer pressure in the penstock. The precondition is that the construction of the powerhouse should not affect the dam safety. It is found there are big boulders in the downstream riverbed.

The wall thickness of the pipes should be checked if it is used as penstock since the pressure will be different from the case when it is just for irrigation.

The number of units for Manyuchi Dam project should be decided according to the variation magnitude of irrigation flow throughout a year. Too many units may make it more difficult for arranging powerhouse.

3. MOKORSI DAM

This project is still under construction. It is good for the Ministry of Energy and Power Development to get involved at this stage for adding power generation facility to the site. It is easier to construct a powerhouse and other structures now than the time when the dam is completed. Moreover, if the power station can be put into operation sooner, it will generate more benefits.

4. DURU SITE

The flow in the creek when the delegation visited the dam is about 0.8 m^3/s, part of it is diverted for irrigation. According to our observation, the total catchment area above the water fall is very restricted. The water head is very high, 350m over 2km distance according to the instruction, created mainly by two waterfalls.

The project area is heavily inhabited but there is no power supply. It is suggested that Duru SHP project should be considered as an isolated system for supplying power to local communities. The installed capacity should be decided according to the current demands. The IC-SHP experts suggested the whole river basin can be divided into several cascades for SHP development in order to start a project as soon as possible.

5. ITDG MICRO HYDROPOWER SITE

ITDG micro hydropower project has not been in operation for quite a while. It seems there is no big problem for the equipment and it must be repairable. The DN200 penstock, however, were not well anchored on the slope and at the bending part. The penstock is loose in several locations and there are leakages, too. The anchorage block should be added every 15 meters and at every bending point. The channel, being short of maintenance, is not functioning at this time therefore needs to be cleaned and lined to guarantee adequate water into the penstock.

The powerhouse was constructed in the middle of the mountain slope, which has 40~50m height difference with the river. It is quite easy to construct another 30 kW micro hydropower station by utilizing the tail water of ITDG project. It is suggested that the ITDG project should be rehabilitated before constructing the new one. After that, the tail water and water head can be measured and the penstock and equipment type for the second micro hydropower project can be finalized.

The powerhouse size of ITDG project is rather small, making equipment maintenance and operation inconvenient.

6. GAIREZI SITE

The flow in the river is quite big when the delegation visited the site. Two drops which are not far from each other collect most of water heads for the site. The right bank is quite plain which is an idea terrain for canal.

7. TSANGA SITE & MUDZORO SITES

Both sites have high water falls and the flow in the river is quite stable according to the introduction. They are idea sites for SHP projects.

SUMMARY

Our stay in Zimbabwe is rather short in contrast with the time needed for field visit in order to do SHP development planning for a river basin. The information collected from the field visit, combining with China's experiences in SHP sites development, enable the IC-SHP experts to sum up the following suggestions:

1) For the dam sites such as Kyle and Manyuchi, their dominant function is water supply and power generation is determined by the irrigation flow. Therefore, the water release plan and the practical daily irrigation discharge record and reservoir water level is very important to determine the capacity and equipment selection of SHPs.
2) For other sites like Duru, Gairezi, Tsanga and Mudzoro, we suggest that a SHP development master plan for the whole river should be carried out. The purpose of river planning is to have the maximum benefit from the whole river, instead of just one site. The possibility of cascade development should be studied. With the master plan being done, the developers can select the most suitable site to develop according to the power demand, budget, technical difficulties, etc and the negative impact for developing other sites in the future can be avoided.
3) Reliable hydrological data is very important for hydropower projects. Even short period reliable hydrological data is very useful to determine the project capacity. Hydrological gauge stations should be established at key river sections. There should be specific departments/persons in charge of observation and data recording.

T04.4 Consultation Mission to Nigeria

Background

In order to carry out the implementation of "Lighting-up Rural Africa" project, IC-SHP organized a technical mission to Nigeria. The two SHP experts of the

mission are Mr. WANG Yansong, Deputy Division Head of South-south Cooperation Division and Mr. HE Xinqun, Senior Engineer of IC-SHP.

Task of Mission

The tasks of this mission are designed to identify demonstration sites and secure the cooperation and support of local government for “Lighting-up Rural Africa” project, including,

- To carry out task of site selection, including geological survey, hydrological data collection, water head and flow measuring
- To meet with local partner and sort out the technical arrangement of the project implementation
- To promote TCDC/ECDC with three countries
- To provide electricity through a renewable energy resource to a remote rural areas for the socio-economic development of the surrounding areas.
- Give suggestions to local government for further cooperation on SHP development

Site Visit to Waya Dam & Kiri Dam

After a meeting with the local project developer, the site visits were arranged to the two sites proposed to be the demonstration projects under the “Lighting Up Rural Africa” Project in Nigeria, namely the Waya Dam and Kiri Dam. IC-SHP consultants visited these two potential sites and collected as much as possible information which is to be studied later concerning the construction for these two demonstration projects. The local project developer hopes that with the help and involvement of IC-SHP, they could secure PPA sooner and start raising necessary investment for the project.

The ***Waya Dam*** is about 25km away from Bauchi. The dam created a reservoir with storage of 30 million m3. In 2003, the consultants from IC-SHP visited the site and evaluated the proposal to build a SHP at Waya Dam. The initial conclusion is that 2×100 kW can be installed for this project. However, some modification has to be done for integrating SHP into the existing facilities. The

existing spillway should be completed and a gate should be added at the entrance of the penstock. The downstream slope of the dam has obvious erosion problem, which needs to be repaired on matter whether SHP will be added. A long crack was also found on the dam crest at this visit which needs to be further investigated.

As for the time arrangement of the dam repair and the SHP construction, the experts' suggestion is that these two tasks can be done separately. After finishing the spillway and penstock modification, the construction of SHP can be started. Other dam repair works can be done step by step according to the available investment. If it is possible, the beneficiary should be asked to contribute labor and/or materials for dam repair.

The location of the powerhouse can be arranged as the first IC-SHP consultant team had proposed. Once the order of equipment purchase is put, the Chinese manufacturer will provide the technical drawings of equipment and the sketch of powerhouse arrangement.

The ***Kiri Dam*** reservoir has 615 million m^3 storage capacity which can provide enough water for SHP if it was constructed. The project manager of Kiri Dam proposed to add a SHP station by connecting penstocks to the existing scouring gates. Since the original design of the dam did not take the electricity generation into consideration, there are some technical issues needing to be studied in this proposal of adding a SHP, such as how to arrange the powerhouse, how much water can be taken from the reservoir for power generation, whether the sediments will effect SHP operation, etc. To this end, a feasibility study should be done before moving to the next step with this proposal. And IC-SHP can provide expertise in this regard.

T05.1 SHP Equipment Donation to a Micro Hydro Project in Bwindi, Uganda

The proposed site for a micro hydro power in Biwindi, Uganda is found that it is quite easy to construct a 20~30 kW station near the ICT center. The

transportation and geological conditions are favorable and the river has adequate flow throughout a year. There are some villages and tourist camps near the project location, which can also benefit from this project, as no electricity is available for them at present. The total cost for this project will be around US$55,000.

Taking the financial problem of this proposed demonstration project into consideration, the International Centre on Small Hydro Power donated a 26kW turbine generator with all the necessary accessories, manufactured by Zhejiang Yueqing Machinery Plant Co. Ltd., for setting up a micro hydro power system at the Impenetrable National Park in Bwindi. This donation is intended to jump start the Small Hydro Power activities in Sub Saharan Africa, especially in the remote rural off grid areas of the region. This donation will positively help IN-SHP to set up a model Small Hydro Power System for demonstration purposes which can be replicated in many other parts of the country and the region. Also this donation will go a long way to alleviate the energy poverty in many impoverished regions of Africa in general and Uganda in particular.

T05.2 SHP Equipment Exportation to Nigeria through the National Association of Small/Medium Hydropower Equipment Manufacturers Affiliated to IC-SHP

No	Installed Capacity	Turbine Type	Generator Type	Manufacturer	Validity Term of Purchase Contract
1	1×30KW	HL130-WJ-35	SFW30-6	Fujian Zhengh Qixing Turbine Co. Ltd.	26 SEP – 30 DEC 2006
2	2×75KW	HLA551-WJ-35	SFW75-6		

T06.1 Publishing the textbook of "Small Hydro Power: China's Practice" *(English & Chinese, Edition III)*

This book comprehensively introduces the whole information on the small Hydro Power in China. With its rapid development of China's SHP, more and more people want to learn more Chinese experience on SHP.

This textbook includes the survey of SHP development in China, an important sustainable energy source, SHP based rural electrification, planning and development, cost-effective SHP technology, operations and management, international co-operations for SHP development and the future development of SHP industry. In this book, many ideas/experiences of successful practice could be borrowed by China's on-going electricity industry reformation.

The following categories explain the detailed contents of the book.

Chapter One A Development History

1.1 Rise, Fall and Resurgence of SHP in China

1. From Humble Beginning to a People's Movement
2. Rural Electrification with a Different Yardstick
3. A Reform to Deregulate the Rural Electricity Market

1.2 Small Hydro Power in China Now

1. A Variety of Actions Leading to Rural Self-sufficiency
2. How and Why of the Fast Development of SHP in China
3. An International Network for SHP is Born

1.3 Case Study: Inspiration from Yongchun County

Chapter Two Features and Policies

2.1 Unique Features of SHP Development in China

1. County Based Decentralized Management Mechanism
2. Preferential Policies and Strategies Adopted in China
3. Multi-channel Fund Raising System
4. County Primary Rural Electrification Achieved through SHP Development
5. Cost-Effective Indigenous SHP Technology
6. Formation of SHP Local Grids

2.2 Case study: Development of Local Grids in SHP Supply Areas

Chapter Three SHP as an Important Sustainable Energy Source

3.1 SHP Potential in China

1. Definitions and Classifications
2. The Distribution and Features of SHP Potential

3.2 SHP - An Important Rural Energy Source in China

1. High Efficiency Commercial Energy Source in Rural Areas
2. An Appropriate, Proven & Clean Renewable Energy Source
3. Locally Available Energy Source Suitable for Cost-effective Development

3.3 Developing Rural Electricity Market for SHP

1. Situations and Features of Rural Electricity Consumption in China
2. High Rate of Increase in Electricity Demand and Supply
3. High Rate of Increase in Electricity Coverage Areas
4. Rapid Change in the Constitution of Rural Electricity Consumption
5. Rapid Rise in per capita Electricity Consumption
6. Rapid Increase in Per Capita Installed Capacity
7. Case Study: Developing SHP oriented Mountain Economics

Chapter Four SHP Development and Characteristics

4.1 SHP-based Rural Electrification

1. The Primary Rural Electrification Construction in Trial Counties
2. Special Policies and Measures
3. The Results and Experience
4. Features of Rural Electrification Construction in China

4.2 Send Electricity to Villages

1. The Need for Social Development in Remote Areas
2. The Initiative for Mountain Economy Development
3. Case Study: Send SHP to “Holy Land in Snow”

4.3 Replacing Fuel wood with SHP

1. The Environmental Concern Stimulates Ecology Oriented SHP Development
2. To Realize Clean Generation in Rural Areas
3. Case Study: SHP Protects the Hometown of the Giant Pandas

4.4 Deregulation and Small IPPs Development

1. Deregulation Promotes the Commercialization of SHP Development
2. Case Study: Promoting SHP Construction under Large Grid Covered Areas

Chapter Five SHP Planning and Development

5.1 SHP Development and Rural Electrification Planning

1. Small River Cascade Development
2. Small River Basin Transit Development
3. Irrigation Canal System Development
4. SHP-based Rural Electrification Planning

5.2 Site Survey and Design

1. Small River Planning and Site Selection.
2. Preliminary Design.
3. Working Drawings.
4. Reconnaissance and Surveying Work.

5.3 Project Approval and Construction

1. SHP Project Evaluation
2. Project Approval
3. Project Construction

Chapter Six Appropriate and Cost-effective Technology

6.1 Features of SHP Technology

1. The Need for Specialization in SHP Industry
2. Appropriate SHP Technology for Local Conditions

6.2 Site Specific Civil Works

1. Small Dams
2. Other Civil Works

6.3 Standardization and Automation of Equipment

1. Small Hydraulic Turbine
2. Generator
3. Governor
4. Inlet Valve
5. Micro Integrated Generating Unit

6.4 Application of New Electro-Mechanical Technology

1. Pressure- Relieving Valve
2. Wicket Gate Actuator
3. Automatic Control Systems
4. Dead Weight Operating Valve
5. Energy Saving Transformer
6. New Panels

7. SF_6 Circuit Breaker
8. 10 kV Pole-Mounted Oil Re-closers
9. Centralized Control Table
10. Gearbox
11. Automatic Trash Rack Cleaner

6.5 Case Study: Developing Indigenous Equipment Manufacturing

Chapter Seven Promote International Cooperation

7.1 SHP Development Becomes a New Tendency

1. Environmental Concerns
2. The Success of the Primary Rural Electrification County Program in China
3. Power Source Development is Tending Towards Small-scaled and Decentralized
4. Increasing Demand for SHP in Developing Countries.

7.2 Strategies for Promoting Global SHP Development

1. Develop Multi-lateral Co-operation Channels of IN-SHP
2. Promote SHP Technology Transfer
3. Develop Export-oriented Economy
4. Strengthen Capacity Building

7.3 Case Study : Promote SHP Development in the World

Chapter Eight Overcoming the Growth Barriers of SHP

8.1 Problems and Common Flaws

1. Managerial Problems
2. Technical Problems

8.2 Minimize the SHP Disadvantages by Improving the Benefits

1. Promoting the Reliability of SHP Electricity Supply by Local Grid
2. Improving the Operation and Management of SHP Stations
3. Technology Innovation and Upgrading of Equipment
4. Form the New SHP Development and Management Mechanism

Chapter Nine Future Development of SHP

9.1 Main Tasks for Future SHP Development

1. Realize Decentralized SHP-based Rural Electrification.

2. Send Electricity to Villages.
3. Replace Firewood with Electricity.
4. Independent Development for Higher Economic Benefits
5. Adopt the “Going out” Strategy .
6. SHP Promote Deregulation, Development and Management.
7. The Establishment of the International Center on SHP for Worldwide Service.
8. Innovations in SHP Industry.

9.2 Prospects for Future SHP Development

1. Stabilize and Develop Rural Electricity Market in SHP Supply Area
2. Developing SHP-oriented Economy in Mountainous Areas

T06.2 Publishing “IN-SHP Newsletter” (English, monthly)

China has the biggest potential and installed capacity in term of SHP on the earth, and it has got great achievement on SHP. In order to introduce its experience and exchange the information concerning the latest SHP news and activities among the members, IN-SHP edits the monthly Newsletter and distributes it among IN-SHP members and other interests. The newsletter covers IN-SHP news, China’s SHP information, membership news, and Conference information, etc.

T06.3 Initiation of the “Lighting-up Rural Africa” Project: Small Hydro Power for Enhancing Access and Promoting Productive Uses in Africa

Background

The “Light-up Rural Africa” Project to promote small hydropower sources for productive uses in selected countries in Africa has been officially kicked off at the 3rd Global Forum on “Hydropower for Today” in June 2007 at Hangzhou, China. As part of the forum, the participants discussed the barriers in small hydropower development in developing countries, and exchanged ideas for providing appropriate SHP technology and financing opportunities for Africa. The Forum concluded with a declaration adopted by all participants requesting IN-SHP and other cooperating agencies to develop a regional programme to promote SHP in Africa. This project builds on the earlier SHP activities

undertaken and experience gained by IC-SHP in Africa, and would aim at setting-up 100 On/Off-grid SHP systems linked with productive uses in rural Africa.

Energy sector in Africa is characterized by lack of access (especially in rural areas), low purchasing power and over-dependence on the traditional biomass for meeting basic energy needs. Since access to affordable energy is the central determinant of economic growth and poverty reduction efforts, Africa continues to face critical challenges related to its energy sector. As a follow-up to this discussions and also keeping in view several requests received from member states in Africa, as well as in consultations with the national counterparts and IC-SHP in China, this project is jointly developed by IC-SHP and G77 PGTF Project to promote small hydropower sources for productive uses in selected countries in Africa.

Contents

The main contents of “Light-up Rural Africa” project is to install about 100 PICO hydro units in remote rural areas to demonstrate how electricity will improve people’s life there. Depending on the individual site situation, the PICO unit will be donated free of total charge or partial charge. The project will be implemented from 2007~2009.

The project primarily aims at promoting small hydropower systems for rural electrification and productive uses in selected countries in Africa. The project would focus on those countries in the Africa region, which have abundant small hydropower resource, and at the same time, have large rural populations, which are yet to be connected with the power grids. The project would use the expertise available at IC-SHP for identifying potential SHP sites, preparing feasibility studies and implementing SHP systems for productive uses in selected countries in Africa. In particular, the project would address the need for a wider adoption of SHP systems in enhancing energy security in Africa, especially in off-grid areas. In addition, the Project would help in building capacities at the local / national level in selected countries in Africa for implementation, maintenance and replication of SHP systems on a wider

scale.

To begin with, the project would mainly focus on ten countries in the Africa region for implementation of 100 mini/micro/pico small hydropower systems for augmenting rural electrification in remote rural areas, and linking energy services to promote productive uses and income generation activities. The participating countries will be selected on the basis of high level of national ownership, availability of small hydro resources, willingness of local communities to support SHP's systems and potential for productive uses in and around SHP systems.

Project Development Process

To gather more attention and access funding resources for the "Lighting-up Rural Africa" Project, IC-SHP has made great efforts in this regard through meetings and negotiations with different governmental institutions, international organizations, project developers and equipment manufacturers. Below are the activities IC-SHP recently made:

1) High-level Meeting and Discussion on the "Lighting-up Rural Africa" Project held between IC-SHP and Ambassadors of Seven African countries, to seek the local support to "Lighting-up Rural Africa" project from the governmental level of the objective countries, August 2007, .Beijing, China. The ambassadors/high-level diplomats from embassies of Sudan, Liberia, Nigeria, Sierra Leone, Uganda, Mozambique and Kenya, and Officers from UN organizations in Beijing attended the meeting and acknowledged their support to boost the SHP cooperation between China and Africa. It is to his understanding that the future of bilateral cooperation is very bright and the cooperation on commercial level should be especially encouraged.

2) Meeting with the Ministry of Commence, Ministry of Water Resources of People's Republic of China, to obtain governmental support to the bilateral and multilateral cooperation in renewable energy field from the Chinese Government, July 2007, Beijing, China. The related governmental officers

promised their support to the “Lighting-up Rural Africa” Project, and it is to their understanding that the future of bilateral cooperation is very bright and the cooperation on commercial level should be especially encouraged.

3) Discussion with other International institutions, such as UNIDO, World Bank, IEA, ESHA etc, to get the help and involvement through their joint cooperation. In May 2007, Prof. TONG Jiandong, Director of General of IC-SHP traveled to Vienna, Austria, to meet with Officers from these organizations above mentioned for the financial support. The participants appreciated IN-SHP’s consistent efforts in promoting SHP in Africa and committed to provide technical assistance along the way to implement the “Lighting-up Rural Africa” Project.

4) Negotiation with local Chinese manufactures and SHP developers, to seek funding opportunities and equipment & technology transfer issues. IC-SHP held a meeting with the International Industrial Commodities Purchasing Base, September 2007, Chongqing, China, to discuss funding resources in many channels. Also meetings with National Association of Small Hydro Power Equipment Manufacturers were arranged for equipment donation and exportation issues.

Enclosed Breakdown of Expenditure