

**PEREZ-GUERRERO TRUST FUND FOR ECONOMIC AND TECHNICAL
COOPERATION AMONG DEVELOPING COUNTRIES**

Final Report on

**Overcoming Existing Barriers to Small Hydropower Development in
Southern and Eastern African Countries**



International Center on Small Hydro Power

August 2017, Hangzhou, China

I . Project Overview

1. **Project Title:** Overcoming Existing Barriers to Small Hydropower Development in Southern and Eastern African Countries
2. **Abstract:** This project is designed to help selected countries from Southern and Eastern Africa to overcome main challenges on the way of small hydropower development. The project aims to promote small hydropower for achievement of a higher level of industrialization, broader economic and social growth and maximize the development impact of inclusive and sustainable industrial development.
3. **Background Analysis:** Small hydropower (SHP) is a clean, renewable and predictable energy source, and it can pursuit electrification for sustainable development. SHP is one of the most environmentally benign forms of energy generation available to us today. Southern and eastern Africa has vast potential for hydropower development. However, many people who live in this region still experience lack of electricity, which becomes a great barrier for region-wide inclusive and sustainable development. The majority of these people live in remote rural areas, where national grid is not covered. Therefore, they are still relying on carbon fuels that cause air pollution and climate change. Obviously, SHP is an environmentally friendly energy source that is able to meet both electricity demands of rural communities and greater national needs in a clean, renewable way. Besides, SHP development may also lead to an increase in employment opportunities, an improvement of the local environment and economic growth.

For southern and eastern Africa, especially the countries like Kenya, Zambia, Sudan and Ethiopia, they have vast untapped small hydropower potential but there are a number of barriers which hinder the development of small hydropower. First, the financial aspect remains the major constraint which hinders progress in the development of SHP. Considering the relatively high investment costs for SHP projects, the end user often does not have the financial capacity to support the investment. The lack of resource data also causes the project costs higher. Project developers must often collect data before making decisions about a project. Third, they are lack of vague legislative framework and policies to encourage the SHP development. This region also needs suitable business models to address the investment issues.

Besides, unfamiliar with the technology is also a limiting factor for SHP in this region. Kenya lack of electro-mechanical SHP equipment, and its poor maintenance and management scheme also hinders a healthy development of SHP. Zambia is lack of SHP knowledge and technical capacity. Although Ethiopia has a long history of micro hydropower, local skills to manufacture, operate and

maintain plants are not well developed. Additionally, SHP equipment and components are not available on the local market.

In conclusion, the southern and eastern Africa, especially Kenya, Ethiopia, Sudan and Zambia, share common barriers to SHP development. Among main barriers are lack of SHP knowledge and technical capacity, vague legislative framework, policies and incentives, funding of SHP projects, knowledge on exploiting or upgrading existing water resources and hydropower projects or suitable business models. With the successful experience of SHP development in China, an e-seminar platform with basic SHP knowledge is the most efficient and direct way to help those who urgent to know the information on SHP projects. Besides, technical training and tour study in China provides an opportunity to directly communicate with the experts and manufacturers in China. In addition, on-site training may also help the local owners and technicians to find and solve the practical problems.

II. Implementation

The implementation of this project is divided into five distinct stages, but only first four stages are involved in current project report. The remaining stage is a future strategy, in order to further strengthen the capacity building of technicians on small hydropower development.

- **The first stage** is to collect the related knowledge and information of small hydropower, design the framework of the e-seminar. Meanwhile, the general information on small hydropower is delivered including its status, challenges and benefits.
- In **the second stage**, ICSHP organized a training workshop for the technicians from African countries, including four selected countries of this project, providing trainees with technical knowledge on small hydropower development. The workshop invited the experts and representatives from outstaying equipment manufacturers and design institutes of China to share experience and communicate with participants. The workshop also organized a tour study to visit small hydropower plants, equipment manufacturers, and hydropower development enterprises, to know the SHP status of China and directly communicate with the potential investors.
- **The third stage** is to present more comprehensive information on the development of small hydropower project, covering the process to develop a SHP plant, maintenance and planning a SHP plant.
- **The fourth stage** is to conduct on-site consultations and training by ICSHP experts to address the current technical difficulties, improving the knowledge and awareness on monitoring and SHP maintenance, and analyzing specific barriers for local SHP project implementation.
- As planned, **the fifth stage** represents ongoing strategies in the future that ICSHP will provide more opportunities to African countries, especially the targeted four

countries, for on-job training or internship in China. By working with ICSHP, participants will better understand the development of small hydropower and learn the successful cases.

Beneficiaries:

The primary beneficiary will be the rural communities in Kenya, Ethiopia, Sudan and Zambia. The project will help these countries to overcome existing barriers to SHP development and move away from the reliance on fossil fuels, harness their own energy resources and move away from depending on import, and provide rural areas with electricity. The secondary beneficiaries will be relevant to SHP production institutions and agencies in the selected four countries together with individuals and enterprises that will be provided with stimulating trainings, effective workshop, and necessary knowledge. Furthermore, other COMESA member countries will also benefit from knowledge exchange and capacity building of representatives from COMESA. Besides, relevant Chinese investors and manufactures would gain from their business development possibilities.

III. Completed activities

Activity-1:

Time: May 2016-January 2017

Location: Hangzhou, Zhejiang Province of China

Implementation: First ICSHP collected many information and materials on small hydropower and invited technician to design an e-seminar on the Easygenerator platform. The e-seminar mainly opened to the investors, engineers, technicians and SHP plant owners, but it also welcomed all audiences who are interested in the small hydropower development. In the first phase, the e-seminar mainly gave the general information of small hydropower including definition, benefits, types and components of a SHP plant. Meanwhile, the platform also analyzed the SHP development status of Kenya, Zambia, Ethiopia and Sudan, providing relevant data for future development. In the second phase, more technical content were added, mainly including the process of developing SHP project, planning, maintenance and management, as well as the successful SHP policies and standards of China. A quiz was also designed for the audiences to check their outcomes.

Participants: IC-SHP



Civil Works

Dam

Dam is a structure built across a river in order to raise the level of the water, generally including following types. Based on structure and design, dams can be classified as follows:



Gravity dam

A gravity dam is a dam constructed from concrete or stone masonry and designed to hold back water by primarily utilizing the weight of the material alone to resist the horizontal component of water pressure.



Arch dam

An arch dam is a solid dam made of concrete that is curved upstream in plan. The arch dam is designed so that the force of the water against it, known as hydrostatic

Ethiopia



Ethiopia

Ethiopia, with a tropical monsoon climate and three distinct climate zones, has nine major rivers and 12 big lakes. Lake Tana in the north, for example, is the source of the Blue Nile. However, apart from the big rivers and major tributaries, there is hardly any perennial flow in areas below 1500m.

With a population of almost 100 million and an area of approx. 11 million km², it is Africa's second most populated and 10th largest country. Ethiopia is a member of both, the Common Market for Eastern and Southern Africa (COMESA) and the Eastern African Power Pool (EAPP).

Potential Capacity 2011: 1,500

Flow chart: Steps to be taken



Social Impact Assessment

A social impact assessment is a process of gathering and analysing information that enables the definition of actions to limit negative or enhance positive impacts of a project on the human element.

Some social aspects that can be affected by a policy or project (Source: UNEP):



Policy incentives

- Profit from SHP stations exempted from tax if re-invested in SHP
- Low-interest loans from central and local governments
- Central government grants
- VAT on SHP only 3%
- Income tax on SHP between 0-33% depending on province
- Feed-in-tariff

Standards

- More than 1200 technical standards related to SHP planning, design, materials, equipment, construction, commission and operation
- Applying these standards brings a number of benefits to economy, quality, reliability, speed, operation, safety and environment.



Question

Environmental Impact: Match the events during operation with the corresponding impact priority.

Drag items from the column on the right to the left to match the pairs

Noise from electromechanical equipment	Low
Watercourses damming	High
Flow rate modification	Low

Learn more about the e-seminar, please visit:

<http://elearning.easygenerator.com/5dba73d4-57a5-40ec-8e11-214de3920a6b>

Register first and then start your course.

Activity-2:

Time: June, 2017

Location: Zambia and Kenya

Implementation: ICSHP sent experts to visit Zambia and Kenya to conduct a training workshop and on-site consultation on small hydropower development and management. They visited the officials from the ministries who are responsible for the renewable energy, introducing the successful SHP policies and technologies in China, and also discussing the future potential cooperation. Co-organized with COMESA, ICSHP held a training workshop in Kenya, and also carried out on-site consultation for local technicians and plant owners, providing guidance on site selection, design, construction, maintenance and management. Experts also answered their questions on plant operation.

Participants: IC-SHP, Zambia, Kenya and COMESA counterparts.



Activity-3:

Time: October, 2016

Location: Hangzhou, Zhejiang Province of China

Implementation: ICSHP organized a technical seminar on small hydropower and sustainable development of rural communities for African countries. Participants included technicians, experts and officials on renewable energy including small hydropower from Zambia, South Africa, Ethiopia, Kenya, Sudan, South Africa and Nigeria. The experts from ICSHP and academic institutes gave the lectures covering SHP technology, planning, management and construction. The seminar also arranged the participants to visit Jinhua Base of ICSHP and a small hydropower plant in Zhejiang Province. The expert from Jinhua Base also introduced manufacturing of SHP turbine-generator. At the end of the seminar, a certificate of completion was issued to every participant.

Participants: IC-SHP and local partners.



Activity-4:

Time: December, 2016

Location: Hangzhou, Zhejiang Province of China

Implementation: ICSHP gave training on small hydropower to four engineers from ZESCO, Zambia. The training included site selection, economic assessment, immigration and EIA, equipment selection and hydrological application.

Participants: IC-SHP and ZESCO



Activity-5:

Time: April, 2017

Location: Hangzhou, Zhejiang Province of China

Implementation: Mr. Sindiso Ngwenya (SG of COMESA) and Mr. Mohamedain E. Seif Elnasr visited ICSHP and signed a memorandum on COMESA-ICSHP cooperation on small hydropower. Meanwhile, COMESA-ICSHP Office was inaugurated, aiming at close cooperation on technical transfer, capacity building, policy research and construction of pilot projects.

Participants: ICSHP and COMESA.



IV. Activities costs

Activities costs of this project were strictly based on the financial budget. IC-SHP referred specialized accountants to manage the economic evaluation and review for this project. Project leaders were also responsible for monitoring of cost for each activities regarding to the project and required for submission of periodical report to the Director General of IC-SHP for processing and stage of the project. Details are shown below:

No.	Items	PGTF Fund	ICSHP Fund	Total
1	International travel	16,000 USD	30,000 USD	46,000 USD
2	International consultants	6,000USD	9,000USD	15,000 USD
3	Training workshop	7,500 USD	10,000 USD	17,500USD
4	E-seminar	2,000USD	10,000USD	12,000USD
5	Domestic travels	0 USD	1,800USD	1,800USD
6	On-job training salary (future strategy)	0	0	0
7	Unpaid PGTF Fund	3500USD	19,200 USD	22,700USD
	Total	35,000USD	80,000 USD	115,000USD

V. Project management arrangements

The project is implemented by the International Center on Small Hydropower (IC-SHP). IC-SHP has appointed a project coordinator. All project staff is appointed by IC-SHP. IC-SHP is responsible for producing and submitting a report to the UNDP China Office following allocation of 90% of the budget resources. The IC-SHP Director General (DG) bears the ultimate responsibility for overall management of the project.

IC-SHP has executed the project under UNDP National Execution modality (NEX). As executing agent for the project, IC-SHP is responsible for the reporting and financial requirement foreseen under the UNDP's national execution procedures and guidelines.

Progress monitoring is mastered by the China International Center for Economic and Technical Exchange, Ministry of Commerce. However, any staff from the UNDP or Perez-Guerrero Trust Fund undertakes monitoring activities in line with managerial roles above. All lessons learned will be written into a report after the project has been implemented.

VI. Appendix

The lists of participants and schedules of the training workshops held in Kenya and in Hangzhou are collected as appendixes shown as following:

Appendix-1**Participants list of training workshop in Kenya**

No	Name	Gender	Nationality	Position
1	Mr. Haftom Seyoum	M	Ethiopia	Engineer
2	Mr. Rivoharilala Rasolojaona	M	Madagascar	Engineer
3	Mrs. Roza Mgwadira	F	Malawi	Licensing officer
4	Dr. Joseph K. Njoroge	M	Kenya	Principal Secretary
5	Dr. Fredrick Nyang	M	Kenya	Director
6	Mr. Cornel Okumu	M	Kenya	Project Engineer
7	Ms. Juliet C. Ngeiywa	F	Kenya	Project Engineer
8	Mr. Kipyego Wesley	M	Kenya	Engineer
9	Mr. William Mwangi	M	Kenya	Engineer
10	Ms. Freda Nyambura	F	Kenya	Technical Affairs Engineer
11	Mr. Benson Kimathi	M	Kenya	Technical Officer
12	Mr. Jackson Ntambara	M	Rwanda	Engineer
13	Mrs. Cynthia Alexander	F	Sudan	Principal Officer
14	Mr. Samuel Ngoni Zaranyika	M	Zimbabwe	Senior Engineer

Delegation from China				
1	Mr. DONG Guofeng	M	Chinese	Deputy Chief
2	Mr. TAN Xiangqing	M	Chinese	Deputy Chief Engineer
3	Mr. CHEN Xing	M	Chinese	Senior Program Officer
4	Mr. ZHOU Xiao	M	Chinese	Program Officer
5	Dr. ZHAO Bin	M	Chinese	Assistant General Manager
6	Mr. YU Jie	M	Chinese	Engineer

Appendix-2

Schedule of the training workshop in Kenya

Date	Time	Activities	Speaker/Coordinator Position/Title
20 th June	8:30-10:00	Opening Ceremony	
	10:30-12:00	Lecture 1: The Development Plan of Water Energy Resources and the Site Selection of SHP	Mr. TAN Xiangqing Deputy Chief Engineer /Senior Engineer
	14:00-17:00	Lecture 2: The Calculation of Output and Installed Capacity of Power Station	Mr. TAN Xiangqing Deputy Chief Engineer /Senior Engineer
21 st June	09:00-12:00	Lecture 3: Experiences and Remarks of Rural Electrification on Small Hydro Power in China	Mr. CHEN Xing Senior program officer /Professor
	14:00-17:00	Lecture 4: Hydraulic-machinery Selection (turbine, generator, valve etc.)	Mr. CHEN Xing Senior program officer /Professor
22 nd June	09:00-12:00	Lecture 5: Comprehensive Solutions for Hydropower and Water Conservancy	Mr. ZHAO Bin /Professor
	14:00-17:00	Lecture 6: Intergrated Automation Solution for Small S ized Hydropower Plants	Mr. YU Jie/Project Manager
23 rd June	09:00-12:00	Site visit: Wanjii Small Hydro Power Station	

	14:00-17:00	Lecture 7: Case Study for Shiwang'andu SHP Station in Zambia	Mr. DONG Guofeng Deputy Chief /Senior Engineer
24 th June	08:00-11:30	Introductions of Enterprises and Products & Services from Chinese Delegation	
	13:30-16:30	Country Report from Every African Country Attended and Project Discussions	
	16:30-17:30	Closing Ceremony	

Appendix-3

Participants list of the training workshop in China

No	Name	Gender	Date of Birth	Nationality	Position
1	Ms.Ngonsongan Marthe Roseth Bibiane	F	1980.12.21	Cameroonian	Engineer
2	Mr.Tamnkotii Marien Marvin	M	1983.09.01	Cameroonian	Engineer
3	Mr.Chomba Musenge	M	1983.12.22	Zambian	Advisor
4	Mr.Hamanyanga Hantuli Martin	M	1976.08.14	Zambian	Environmental Specialist
5	Mr.Kamungu Tanelly	M	1963.07.02	Zambian	Senior Engineer
6	Mr.Musukwa Dean Lameck	M	1974.04.27	Zambian	Engineer
7	Mr.Espinheira Faustino Soares	M	1963.04.27	South African	Researcher
8	Mr.Cheddy Pravesh	M	1972.10.09	South African	Researcher
9	Mr.Abebe Mohammed Hassen	M	1964.12.23	Ethiopian	Chief Finance Officer

10	Mr.Ganda Aminu Mohammed	M	1968.06.17	Nigerian	Senior Engineer
11	Ms.Kavu Shorai	F	1979.03.29	Zimbabwean	Researcher
12	Mr.Muraguri Philip Mbitu	M	1982.08.15	Kenyan	Engineer
13	Mr.Omwenga Joe Ariga	M	1983.08.28	Kenyan	Engineer
14	Mr.Mariita Evans Onyancha	M	1983.03.03	Kenyan	Engineer
15	Ms.Irungu Margaret Wanjiru	F	1971.04.11	Kenyan	Engineer
16	Mr. Adu Daniel	M	1980.08.20	Sudanese	Engineer

Appendix-4

Schedule of the training workshop in China

Date	Day	Time	Activities	Speaker/Coordinator Position/Title	Organization of Speaker/Coordinator or	Venue
17 th Oct.	Mon.	All Day	Arrival and Registration	Ms. Hu Xiaobo Unit Chief	ICSHP	ICSHP International Conference Hall
18 th Oct.	Tue.	8:30~9:00	Opening Ceremony	Directors	ICSHP Nanjing Hydraulic Research Institute	ICSHP International Conference Hall
		9:10~10:30	Lecture 1: Water Resources in China	Prof. LIU Heng Professor/Vice President	Nanjing Hydraulic Research Institute	
		10:45~12:00	Lecture 2: The Development Plan of Water Energy Resources and the Site Selection of SHP	Mr. TAN Xiangqing Deputy Chief Engineer /Senior Engineer	ICSHP	
		13:30~15:30	Lecture 3: Powerhouse Design for SHP Station	Mr. LI Zhiwu chief engineer /Senior Engineer with Professor Rank	National Research Institute for Rural Electrification	
		15:45~17:30	Lecture 4: A General Survey of SHP Development and Rural Electrification in China	Prof. CHENG Xialei Professor/ Director General	ICSHP	
		18:30~20:00	Welcoming Dinner	Prof. LIU Deyou Managing Director of ICSHP/Professor	ICSHP	
19 th Oct.	Wed.	8:30~10:00	Lecture 5: Construction and Management for	Prof. LIU Deyou Managing Director of	ICSHP	ICSHP

Date	Day	Time	Activities	Speaker/Coordinator Position/Title	Organization of Speaker/Coordinator	Venue
			SHP Projects	ICSHP/Professor		International Conference Hall
		10:15~12:00	Lecture 6: Construction of Rural Micro Hydropower	Mr. CHEN Xing Senior program officer /Senior Engineer with Professor Rank	ICSHP	
		13:30~15:00	Lecture 7: Case Study for Construction of SHP Project	Mr. DONG Guofeng Deputy Chief /Senior Engineer	ICSHP	
		15:30~18:30	Visit Jinhua Base	Mr. WEI Jianghui Division Chief of Technical Cooperation among Developing Countries Division	ICSHP	Jinhua Wangjiang Hotel
20 th Oct.	Thu.	8:30~11:30	Lecture 8: Manufacturing of SHP Turbine Generator Unit Site Visit of Zhejiang Jinlun Electromechanical Co., Ltd	Mr. ZHANG Liansheng Chief Engineer/Senior Engineer	Zhejiang Jinlun Electromechanical	Jinhua, Zhejiang
		13:30~17:00	Visit Shizhutou SHP plant	Mr. WEI Jianghui Division Chief of Technical Cooperation among Developing Countries Division	ICSHP	
21 st Oct.	Fri.	9:00~12:00	Closing Ceremony	Officials and Directors	ICSHP National Research Institute for Rural Electrification	ICSHP International Conference Hall

Date	Day	Time	Activities	Speaker/Coordinator Position/Title	Organization of Speaker/Coordinator	Venue
		12:00~14:00	Farewell Lunch	Prof. CHENG Xialei Professor/ Director General	ICSHP	Hangzhou Ouxiangju Restaurant
21 st -22 nd Oct.	Fri.-Sat.	All days	Departure	Ms. Hu Xiaobo Unit Chief	ICSHP	Hangzhou Xiaoshan International Airport