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

Final Report on

Regional Database System Promoting Program for Small Hydro Power

(SHP) Development in Africa

International Center on Small Hydro Power

October 2018, Hangzhou, China

Ⅰ. Project Overview

1. **Project Title:** Regional Database System Promoting Program for Small Hydro Power (SHP) Development in Africa

2. **Abstract:** This initiative program will target at African countries to carry out unprecedented practices and actions in the field of small hydro power with focus on extensive survey & report, analysis & research, consultation & training, information & communication, capacity building & project construction, technology & finance etc, aiming to promote the widespread utilization and regional development of small hydro power as well as achieving sustainable development of renewable energy and effective solution to climate change.

3. **Background Analysis:** Small hydropower (SHP), as a potentially clean and environmentally benign form of renewable energy, is regarded as an indispensable component in the global renewable energy mix. In response to the severe challenges from energy consumption, environment protection and mitigation of climate change, governments return to the development of the conventional small hydropower energy because of its low cost, proven technology and zero environment impact in comparison to other forms of renewable energy. Besides, small hydropower has been listed as one of the top priorities for promotion of renewable energy in many countries, in order to meet the growing demand of energy required by rapid social and economic development as well as to effectively mitigate the negative impacts caused by the climate change. Governments also stipulated relevant regulations and policies to support the development of small hydropower as an indispensable component of their national strategy of renewable energy.

   However, due to many barriers of knowledge in information, awareness, technology, expertise, finance and policies, the development of global small hydropower emerged in an unbalanced nature between developed and developing countries and between continents and regions. SHP fundamental data in many regions and countries are insufficient or even vacant and unclassified leaving much potential space for improvement. For instance, most African countries are lack of basic records or documents of hydrological and geologic data, which directly limits those countries who possess abundant of small hydropower potential to develop this clean and cost-effective energy, and even impedes the optimization of the whole energy mix. Although some existing SHP databases and reports are available, they are still limited in their use to be universally referenced because they may only focus on national or regional levels. Additionally, some barriers are generally existed which hinder the development of global SHP and directly lead to insufficient support from governments and investors. These barriers include differences in definition of SHP among regions and countries, lack of publicity on SHP awareness for its positive functions and merits, lack of universal database

reference and global platforms for SHP information sharing, and lack of political, technical and financial support.

So far, many universal database platforms were established by international organizations for information sharing and exchange. However, there is no such a regional database on SHP for all Africa. Thus, this project aims to create a regional database concerning information, policy and barriers of SHP and following-up actions of capacity building will also be essential components of this project to achieve sustainable development of SHP renewable energy.

Ⅱ. Implementation

The implementation of this project is divided into five distinct stages among which the first four stages are relevant to this current project report, with the remaining stage representing ongoing long-term strategies regarding future updates of the program.

- **The first stage** was preparation of SHP data information. Through the past cooperation experience and exchange visits with African countries, especially three target countries and region, ICSHP firstly understood the urgent needs and challenges of African countries for SHP development. We made a draft outline for the Regional Report, and then collected the relevant data and conducted research and analysis upon it. Meanwhile, we kept close contact with three target countries and region, exchanged ideas regularly to confirm the accuracy and effectiveness of the collected data.
- In **the second stage**, upon the research and analysis on the collected data, the outline framework of the Regional Report was finally established through analysis and research on the collected data. ICSHP invited experts to draft the Report. The whole process was lasting one and half a year, from drafting to peering review. The primary regional SHP database was firstly established by compilation of the Report.
- In **the third stage,** ICSHP provided consultancy to Zambia, Kenya and ECREEE countries. ICSHP and target countries sent experts and technical personnel to visit each other, and exchanged experience and ideas, further improving the data of the Regional Report. We further explored the practical application of database in the pre-project preparation stage. Meanwhile, ICSHP established and practical application in the pre-project preparation. At the same time, ICSHP has established contact with the ECREEE. They have organized officials and technicians from their member countries to visit and study in China. Both sides have reached agreement on the sharing and release of database. ICSHP and ECREEE would shall the data information of small hydropower and co-publish the Regional Report through the platforms of both sides.
- In the **fourth stage**, through previous communication, it is finally agreed that the Regional Report will be issued at 8th Hydropower for Today Forum, which will be held on November 6 and 7, 2018, in Lusaka, Zambia. Meanwhile, ECREEE and COMESA will also use their platforms to disseminate and promote the Report and

database, so as to bring maximum benefits.

- As planned, **the fifth stage is a remaining strategy.** ICSHP will continue to work with target countries and relevant institutions to carry out training and capacity building, further disseminating and updating the data information. On this basis, ICSHP will continue to provide consulting, technology transfer and engineering services on small hydropower development.

Beneficiaries:

This program aims to achieve widespread utilization and development of small hydro (SHP) power for African countries. By implementing the initiative practices and actions, the program will positively encourage active cooperation among governments on small hydro power and create a regional platform for the popularization of SHP technology as well as dissemination of managing experiences. Furthermore, it is expected that the program will promote improvement in the energy utilization efficiency of SHP, mitigation of environment impacts and a reduction of fossil energy consumption in order to help governments realize energy saving and emissions reduction for the sustainable development of renewable energy and provide an effective solution to climate change.

Ⅲ. Completed activities

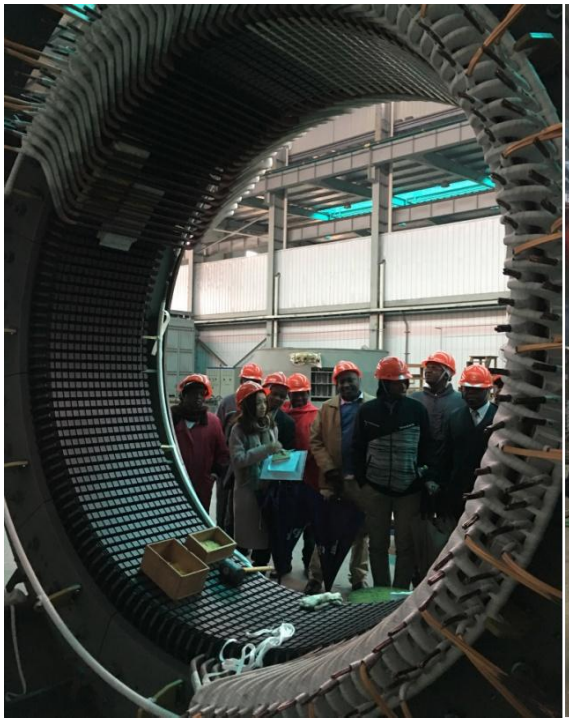
Activity-1:

Time：March, 2017

Location：Hangzhou，Chengdu, Lanzhou of China

Implementation: In March 2017 governmental officials from Ministries of Energy of East Africa and Nigeria went on a training to explore best practices and lessons learned from solar-, biogas and small hydropower projects for productive use at the industry level. The training included site visits, presentations as well as discussions and was organized by the International Centre on Small Hydropower (ICSHP). They visited ICSHP and small hydropower plants near Hangzhou, Biogas Institute of Ministry of Agriculture in Chengdu and International Solar Energy Center for Technology Promotion and Transfer in Lanzhou. Please see the Annex 1 for the list of participants.

Participants: ICSHP, ECREEE member countries, BIOMA and ISEC.




Activity-2:
Time: June, 2017
Location: Zambia
Implementation: ICSHP sent experts to give consultancy on small hydropower to ZESCO, Zambia. The consultation included site selection, economic assessment, immigration and EIA, equipment selection and hydrological application. Meanwhile, ICSHP and ZESCO reached agreement on sharing the SHP data information.
Participants: ICSHP and ZESCO.

Activity-3:
Time: August, 2017
Location: Hangzhou, Zhejiang Province of China
Implementation: Mr. Biririza Emmanuel Gabriel Michael, an adviser to the African Development Bank's Renewable Energy Department, visited ICSHP. Michael pointed out that Africa has rich renewable energy to be exploited. Two sides agreed to introduce Chinese equipment, technology and capital through the establishment of cooperative

partnership in the future to create favorable conditions for Chinese enterprises to conduct investment, production capacity cooperation and economic and trade cooperation in African countries. Both sides also made agreement to share small hydropower data information for sustainable development small hydropower in Africa.
Implementation: ICSHP organized a technical seminar on small hydropower and sustainable development of rural communities for African countries.
Participants: IC-SHP and AFDB.

Activity-4:
Time: May, 2018
Location: Lusaka, Zambia
Implementation: ICSHP organized experts to conduct technical training for ZESCO in Lusaka, Zambia. The training mainly focused on the development planning, operation management, economic evaluation of SHP, environmental impact assessment, risk analysis and development financing mode of SHP, and discussion with the technical personnel on actual case studies. A total of 25 technicians from ZESCO participated in the training.
Participants: IC-SHP and ZESCO

Activity-5:
Time: July, 2018
Location：Abuja, Nigeria
Implementation: “Seminar on Construction and Management of Water Conservancy and Hydropower Project for Nigeria”, organized by ICSHP, was successfully held in

Abuja, Nigeria. A total of 61 officials from Ministry of Science and Technology, Ministry of Water Resources, Ministry of Electricity of Nigeria. The training courses included planning, site selection, investment, construction, management and policy of small hydropower. Please see the Annex 2 and Annex 3 for the list of participants and training content.
Participants: ICSHP and Nigerian counterparts.




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 ICSHP for processing and stage of the project. Details are shown below:

No.	**Items**	**PGTF Fund**	**ICSHP Fund**	**Total**
1	International travel	15,000 USD	60,000 USD	75,000 USD
2	International consultants	6,000 USD	10,000 USD	16,000 USD
3	National experts	6,000 USD	10,000 USD	16,000 USD
4	Workshop organization	5,000 USD	60,000 USD	65,000 USD
5	Regional Report	1,000 USD	5,000 USD	6,000 USD
6	Domestic travels	0 USD	15,000 USD	15,000 USD
	Total	**33,000USD**	**160,000 USD**	**193,000USD**

Ⅴ. Project management arrangements

The project is implemented by the International Center on Small Hydropower (ICSHP). ICSHP has appointed a project coordinator. All project staff is appointed by ICSHP. ICSHP is responsible for producing and submitting a report to the UNDP China Office following allocation of 90% of the budget resources. The ICSHP 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, ICSHP 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 ECREEE study tour

Country	Surname	Name	Position	Organization
Burundi	Makuwa	Moise	Advisor	Cabinet of the Ministry of Energy and Mines
Burundi	Bigirimana	Desire	Technical Advisor	General Directorate of
Kenya	Kasanga	Samson Makau	Assistant Director	Renewable Energy Directorate in the Ministry of Energy and Petroleum
Kenya	Kirui	Elijah Kibett	Principal Renewable Energy Officer	Ministry of Energy and Petroleum
Kenya	Mukofu	Larry Muhanji	Research Scientist	Kenya Industrial Research and Development Institute (KIRDI)
Kenya	Ms. Kwach	Sarah	Research Scientist	Kenya Industrial Research and Development Institute (KIRDI)

Nigeria	Saidu	Garba	Chief Technical Officer and Electrical Head of Solar Photovoltaic Unit	Sokoto Energy Research Center, Usman Danfodiyo University, Sokoto
Nigeria	Inalegwu	Acheme Paul	Scientific Officer	Energy Commission Nigeria
Rwanda	Habineza	Valens	Biogas Engineer	REGLTD (Rwanda Energy Group)
South Sudan	Manase	Loboso Cosmas	Director General	Regional Electricity Coordination
Tanzania	Kigully	Cosmas Leonard	Energy Engineer	Ministry of Energy and Minerals, Renewable Energy Section
Tanzania	Kashushura	Stephan Laurean	Energy Engineer	Ministry of Energy and Minerals, Renewable Energy Section
Uganda	Okure	Makacy Akoori Ecuman	Associate Professor	College of Engineering, Design, Art and Technology Makerere University
Uganda	Ahimbisibwe	Michael	EACREEE Focal Point, Senior Energy Officer	Ministry of Energy and Mineral
Uganda	Kiza	Michael	EACREEE Programme Management Expert	College of Engineering, Design, Art and Technology Makerere University

Appendix-2

Participants list of training workshop in Nigeria

S/N	NAMES	ORGANISATION	DESIGNATION
1	MR. FASHINA ADESANYA YUSUF	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SCIENTIFIC OFFICER
2	MR. NDUKWU MAGNUS	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SCIENTIFIC OFFICER
3	MR. SHITTU ABDULBAQI	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	ASSISTANT CHIEF SCIENTIFIC OFFICER
4	MR. ATIBERE SIMEON	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	POLICY ANALYST
5	MR. ABIOGWU	FEDERAL MINISTRY OF	SCIENTIFIC OFFICER

	MAGNUS	SCIENCE &TECHNOLOGY (FMST)	
6	MR. ALIYU IBRAHIM	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SCIENTIFIC OFFICER
7	Ms. EZEUNARA JULIET	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SCIENTIFIC OFFICER
8	MR. ENEJO VICTOR SULE	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SCIENTIFIC OFFICER
9	MR. CHUKWU FRANKLIN	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SCIENTIFIC OFFICER
10	MR. AMORAN ADEKUNLE	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	PRINCIPAL SCIENTIFIC OFFICER
11	MR. TSUTSU ORSEER	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	SENIOR SCIENTIFIC OFFICER
12	MR. FALANA FOLARANMI	FEDERAL MINISTRY OF SCIENCE &TECHNOLOGY (FMST)	ENGINEER
13	MR. MOHAMMED SULAIMAN NMA	FEDERAL MINISTRY OF WATER RESOURCES (FMWR)	CHIEF CIVIL ENGINEER
14	MR. OKORAFOR CHIKAODIRI	FEDERAL MINISTRY OF WATER RESOURCES (FMWR)	SENIOR GEOLOGIST
15	MRS. EMAYOMI BERNADETTE	FEDERAL CAPITAL DEVELOPMENT AUTHORITY (FCDA)	BIOTECH & ANALYTICAL
16	Ms. JEMISENIA RUTH	FEDERAL CAPITAL DEVELOPMENT AUTHORITY (FCDA)	ASSISTANT. CHIEF CHEMICAL ENGINEER
17	MRS. ABDULRAHMAN FATIMAH	FEDERAL CAPITAL DEVELOPMENT AUTHORITY (FCDA)	ASSISTANT CHIEF CHEMICAL ENGINEER
18	DR. MRS. ADEYEMI KAFAYAT	UNIVERSITY OF ABUJA	LECTURER
19	DR. ZARMAI MUSA	UNIVERSITY OF ABUJA	SENIOR LECTURER
20	MR. IBRAHIM AMINU HAMISU	PROJECT DEVELOPMENT INSTITUTE (PRODA)	SENIOR ENGINEER
21	MR. MOHAMMAD GANDA	ENERGY COMMISION OF NIGERIA (ECN)	LECTURER

22	ENGR DR OFUALAGBA GODSWILL	FEDERAL UNIVERSITY OF PETROLEUM RESOURCES (FUPRE)	LECTURER
23	ENGR DR OTANOCHO OMONIGHO BENEDICT	FEDERAL UNIVERSITY OF PETROLEUM RESOURCES (FUPRE)	LECTURER
24	ENGR DR UZEDHE GODWIN	FEDERAL UNIVERSITY OF PETROLEUM RESOURCES (FUPRE)	SENIOR LECTURER
25	MR. MSHELIA SUNDAY GANA	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	ENGINEER
26	MR. FAJINMI OLUFEMI	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	ENGINEER
27	ENGR. MISS. AYODELE BABAPELUMI EBUN	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	SENIOR ENGINEER
28	MR. IBRAHIM USMAN AUWAL	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	SC IENTIFIC OFFICER
29	MR. KWAJAFA BOYI JESSY	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	ENGINEER
30	MR. SALAMI ALABA NASIRUDEEN	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	SENIOR ENGINEER
31	MR. SULEIMAN MEJIDI	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	PRINCIPAL ENIGINEER
32	MR. ABDULLAHI MUSA ALHAJI	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	SENIOR RESEARCH AND DEVELOPMENT OFFICER
33	MR. YUSUF ABDULMAJEED	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	ENGINEER
34	MR. SHUAIBU ALIYU	NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE (NASENI)	ENGINEER
35	MR. KOLAWOLE JAMES	FEDERAL MINISTRY OF ENVIRONMENT	ENVIRONMENTAL SCIENTIST
36	MR. LAWAL MAGAJI	ABUJA GEOGRAPHIC	DATA MANAGEMENT

		INFORMATION SYSTEM	SYSTEM OFFICER
37	ENGR. TIAMIYU SIKIRU OLUBUSOLA	NIGERIAN INTEGRATED WATER RESOURCES MANAGEMENT COMMISSION (NIWRMC)	CATCHMENT MANAGEMENT OFFICER
38	MISS. GREMA MUSTAPHA AMINA	FEDERAL MINISTRY OF WORKS	CIVIL SERVANT
39	MISS. KWAJAFFA HAMSATU	ENERGY COMMISION OF NIGERIA (ECN)	PRINCIPAL TECHNICAL OFFICER
40	MR. OLOKEDE OLUWAGBEMIGA	ENERGY COMMISION OF NIGERIA (ECN)	SENIOR SCIENTIFIC OFFICER
41	MR. IBRAHEEM TAOREED BAYO	ENERGY COMMISION OF NIGERIA (ECN)	PRINCIPAL SCIENTIFIC OFFICER
42	MR. UCHEGBU KINGSLEY	DEPARTMENT. OF RENEWEABLE. ENERGY AKWA IBOM	CIVIL SERVANT
43	MR. JARIGBE ALI	CROSS RIVER STATE GOV'T	ENGINEER
44	MR. JARIGBE IJANYI	CROSS RIVER STATE GOV'T	PERSONNEL ASSISTANCE
45	MR. PATRICK OTU	AWKA IBOM STATE GOV'T	CIVIL ENGINEER
46	MR. IBU AUSTIN	CROSS RIVER STATE GOV'T	TECHNICAL ASSISTANT
47	MR. DONATUS MONDAY	MINISTRY OF POWER	CIVIL SERVANT
48	MR. AGBOR LAWRENCE OTUOKWA	MINISTRY OF HOUSING CALABAR	CIVIL SERVANT
49	MR. IDIKA CHUKWUMA GEORGE	MINISTRY OF HOUSING CALABAR	CIVIL SERVANT
50	MR. AKPUENIKA ANTHONY NNAMDI	AKWA IBOM STATE GOV'T	PRINCIPAL OFFICER
51	MR. AKPUENIKA INNOCENT	AKWA IBOM STATE GOV'T	RESEARCH ENGINEER
52	BLDR. NJAYO MIKAILU JANDI	MINISTRY OF LAND AND HOUSING	CIVIL SERVANT
53	MR. HEBERT CHUKWUEMEK A ANDY	FEDERAL MINISTRY OF POWER WORKS & HOUSING (FMPWH)	ENGINEER
54	ENGR. AROWOSEBE ADEYEMI MUYIWA	NIGERIAN INTEGRATED WATER RESOURCES MANAGEMENT COMMISSION (NIWRMC)	SENIOR CIVIL ENGINEER
55	MR. SADIQ KAIMI	FEDERAL MINISTRY OF POWER	SENIOR ELECTRICAL

	MAINA	WORKS & HOUSING (FMWPH)	ENGINEER
56	MR. IGBA MATHIAS AHANGBA	FEDERAL MINISTRY OF POWER WORKS & HOUSING. (FMWPH)	CIVIL SERVANT
57	MR. NJOKU THANKGOD ANTHONY	FEDERAL MINISTRY OF POWER WORKS & HOUSING (FMPWH)	CIVIL SERVANT
58	ENGR. MRS. SERIKI OLUWATOYIN LANRE	RURAL ELECTRIFICATION AGENCY	PUBLIC SERVANT
59	MR. EWORO ECHENG	RURAL ELECTRIFICATION AGENCY	CIVIL SERVANT
60	MR. YARO RICHARD	RURAL ELECTRIFICATION AGENCY	PUBLIC SERVANT
61	MR. EZEH CHIBUEZE KENECHUKWU	MINISTRY OF HOUSING CALABAR –CROSS RIVER STATE	CIVIL SERVANT

Appendix-3
Schedule of the training workshop in Nigeria

Date	Time	Activities	Speaker/Coordinator Position/Title
14th July	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：Experiences and Remarks of Rural Electrification on Small Hydro Power in China	Mr. FU Zilong Deputy Director of ICSHP
15th July	09:00-12:00	Lecture 3：The Calculation of Output and Installed Capacity of Power Station	Mr. TAN Xiangqing Deputy Chief Engineer /Senior Engineer
	14:00-17:00	Lecture 4：Hydraulic-machinery Selection (turbine, generator, valve etc.)	Mr. FU Zilong Deputy Director of ICSHP
16th July	09:00-12:00	Lecture 5： Intergrated Automation Solution for Small S ized Hydropower Plants	Mr. YU Jie/Project Manager
	14:00-17:00	Lecture 6： Comprehensive Solutions for Hydropower a nd Water Conservancy	Mr. ZHAO Bin /Professor
17th July	09:00-12:00	Site visit：Usuma Dam on the Gulala River	
	14:00-17:00	Lecture 7：Case Study for Shiwang'andu SHP Station in Zambia	Mr. DONG Guofeng Deputy Chief /Senior Engineer

18th July	09:00-12:00	Lecture 8： Hydraulic Structure	Mr. LI Zhiwu Chief Engineer
	14:00-17:00	Lecture 9：Green Small Hydro Construction in China	Mr. OU Chuanqi Deputy Chief/Senior Engineer
19th July	09:00-12:00	Lecture 10： Project management, risk management and economic evaluation	Mr. WANG Xin Manager
	14:00-17:00	Lecture 11：Hydraulic Machinery	Mr. CHEN Xing Senior Engineer
20th July	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	

International Center on Small Hydro Power (ICSHP)

Regional Report on African Small Hydropower Development

September 2018

Hangzhou, China

(Executive Summary)

Overview

SHP in Africa can be characterized as having a relatively low level of installed capacity but with considerable potential for development. Climatic and topographic characteristics vary tremendously, resulting in a large variance of SHP potential in the north and south as compared to the east and west of the continent.

The total SHP installed capacity for Africa is 580 MW and the total estimated potential is 12,197 MW. This indicates that approximately 5 per cent has so far been developed.

Eastern Africa has the highest installed capacity and potential for SHP in the continent, followed by the Western and Middle Africa regions. Northern Africa has the highest electrification rate, but due to climatic conditions, it has low potential for hydropower. Southern Africa has the lowest installed capacity, the vast majority of which is located in South Africa. Of the 45 countries in the region, many have some form of renewable energy policy, while 10 countries have established FITs relating to SHP.

1. Eastern Africa

Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Réunion, Rwanda, Sudan South, Tanzania, Uganda, Zambia and Zimbabwe

The Eastern Africa region has the highest overall potential for SHP in the African continent. It is home to the Great Lakes region as well as the White Nile basin, the Congo River basin, among others. In Burundi, Ethiopia, Malawi, Mozambique, Uganda and Zambia, large hydropower provides the vast majority of national electricity generation.

Of the total SHP potential of 6,759 MW, the combined SHP installed capacity in the region is only 216 MW. Uganda has the highest installed capacity, with 35 MW, while South Sudan currently has no installed capacity. With only 3 per cent of SHP potential having been developed, countries such as Kenya and Ethiopia have significant potential estimated at 3,000 MW and 1,500 MW respectively. Most countries in the region are member states of the Common Market for Eastern and Southern Africa (COMESA), several are participating members of the East African Power Pool (EAPP). Renewable energy policies are either already in place or being implemented in the near future. Ethiopia and Malawi are expected to implement FITs while Kenya, Mauritius, Rwanda, Tanzania and Uganda have FITs in place, marking Eastern Africa as the sub-region with the most FIT policies.

SHP development has been relatively slow. So far, Madagascar, Mauritius, Mozambique, Tanzania, Uganda and Zimbabwe have moderately increased their share of SHP in the generation mix. More extensive hydrological data and feasibility studies are needed in several countries, including Burundi, Tanzania and Zambia. In collaboration with the World Bank, Madagascar will publish a hydropower atlas by the end of 2016.

Barriers to SHP development include the costs of infrastructure development, including transmission lines and roads to SHP sites; lack of long-term financial solutions from local banks; and a need for capacity building in regard to maintenance and operation of SHP plants.

2. Middle Africa

Angola, Cameroon, Central African Republic (CAR), Democratic Republic of the Congo (DRC), Congo, Equatorial Guinea, Gabon and Sao Tome and Principe

Like much of the African continent, the Middle Africa region has a large amount of undeveloped SHP potential. The Democratic Republic of the Congo has the highest installed SHP capacity at 56 MW, or over half of its potential, although further feasibility studies should reflect the increase of the number of potential sites.

Angola has the highest SHP potential at approximately 860 MW, yet less than 2 per cent has been developed. While Equatorial Guinea and Gabon are likely to have considerable potential, accurate data are unavailable, giving the false impression that there is no SHP left to develop in the country. Overall, about 6 per cent of the regional SHP has been developed, marking a decrease in percentage from WSHPDR 2013, largely due to the increase in SHP potential in Angola.

The overall hydropower resources of Middle Africa are enough to supply the entire continent, and progress is being made to develop large-scale hydropower resources in several countries.

However, all the countries in the region have very low electrification rates, which are significantly lower in the rural areas, with inefficient transmission networks compounding the issue. Moreover, most countries in the region lack formal policies for developing the SHP sector, hindering not only the construction of SHP projects but also progress in rural electrification.

More data are needed for the Central African Republic, Congo, Equatorial Guinea and Gabon to accurately determine their SHP potentials. More crucial to the overall renewable energy development is the need to establish transparent legal frameworks for investment in the energy sectors of most countries in the region.

3. Northern Africa

Algeria, Egypt, Morocco, Sudan and Tunisia

Partly attributable to the dry climate and limited water resources in Northern Africa, hydropower in general is not a primary source for generation, particularly in Algeria and Tunisia, where hydropower represents about 1 per cent of overall generation. The estimated SHP potential in Northern Africa is limited at 225 MW, one of the lowest in the world, with 112 MW already developed. This indicates that approximately half of the potential is considered developed. It should be noted that this percentage is lower than that indicated in the WSHPDR 2013, due to the SHP potential increases in Egypt and Sudan.

Morocco is the only country in the region with robust policies regarding SHP development and is currently constructing an SHP project of 15 MW. Conversely, due to climatic conditions and water shortages, Algeria has planned to cease hydroelectric generation in favour of utilizing all water resources for irrigation and water supply. Most countries of the region have opted for wind and solar power as alternatives to fossil fuels.

Southern Africa

Botswana, Lesotho, Namibia, South Africa and Swaziland

SHP in Southern Africa is dominated by South Africa, which comprises 80 per cent of the region's combined installed capacity and 63 per cent of the estimated potential. Aside from South Africa, which has had a considerable effect on the regional development of the sector, SHP potential is rather limited. The combined installed capacity of the region is 62.5 MW and potential is 392 MW. This indicates that 16 per cent has so far been developed. Swaziland has so far developed half of its SHP potential. In doing so, it had the largest increase in installed capacity, while Botswana still has no SHP. In Lesotho and Namibia, SHP capacity has remained unchanged.

Coal and large hydropower remain the chief sources of electricity generation in the region, while solar has the most abundant potential of small-scale renewable sources. Renewable energy policies and national plans reflect this, and large hydropower and solar power will continue to be dominant renewable energy sources for several of the countries in the region. As such, the SHP sector is relatively underdeveloped with the exception of South Africa.

Western Africa

Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea, Liberia, Mali, Nigeria, Senegal, Sierra Leone and Togo

As with much of the African continent, Western Africa can be characterized as having considerable SHP potential but with limited development. Ghana and Nigeria, for example, have estimated potential capacities of 1,245 MW and 735 MW respectively. However, only 6 per cent of the potential in Nigeria has so far been developed, and there is currently no SHP in Ghana.

The region has the second-highest SHP potential in the continent, at 3,113 MW. Yet the installed capacity is the second lowest, with only 86.1 MW in operation. This indicates that 3 per cent of the total potential has been developed overall.

Nigeria has the highest installed capacity, at 45 MW, while Sierra Leone has demonstrated the largest increase. If current long-term SHP projects are carried out, the region stands to triple its installed capacity of SHP.

Although the region has witnessed slower growth in the SHP sector compared with other regions in Africa, Western Africa has the second-largest potential in Africa. Combined with the planned projects and development goals set forth by the Economic Community of West African States (ECOWAS), the region could very well see an upswing in SHP development.