Review of Foreign-aid Training Programs and International Cooperation on Small Hydropower under the Belt and Road Initiative

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Abstract: *HRC has long been engaged in foreign-aid training, international cooperation and technical exchange on small hydropower and other renewable energy with remarkable achievements. Its foreign-aid training programs have realized five strides: the training venue has been extended from domestic to both domestic and overseas, the training forms expanded from multilateral to both multilateral and bilateral, the working language ranges from monolingual to multilingual such as English, French, Russian and Vietnamese, the training level ranges from technical training, seminar to ministerial workshop, training content extended from small hydropower technology to water conservancy, hydropower, renewable energy, climate change and other areas. With the strong support from Chinese government and the international organizations, HRC carries out joint research and development, technology transfer, project demonstration, etc. The setting-up of overseas technical transfer, research and training centers in the countries along the Belt and Road effectively promote the development of clean energy and the construction of rural electrification in developing countries, thus benefiting the local people. With a positive spillover effects of the centers, the technologies on SHP and other renewable energy are being developed in other developing countries, which gives rise to the exploitation and utilization of the energy resources and promotes the sustainable energy development in the world.*

Key words: *The Belt and Road, Small Hydropower, Foreign-aid Training, International Cooperation*

National Research Institute for Rural Electrification (NRIRE), Ministry of Water Resources, also called Hangzhou Regional Center (Asia - Pacific) for Small Hydro Power (HRC), is an international organization jointly sponsored and established by the Chinese government, the United Nations Development Programme

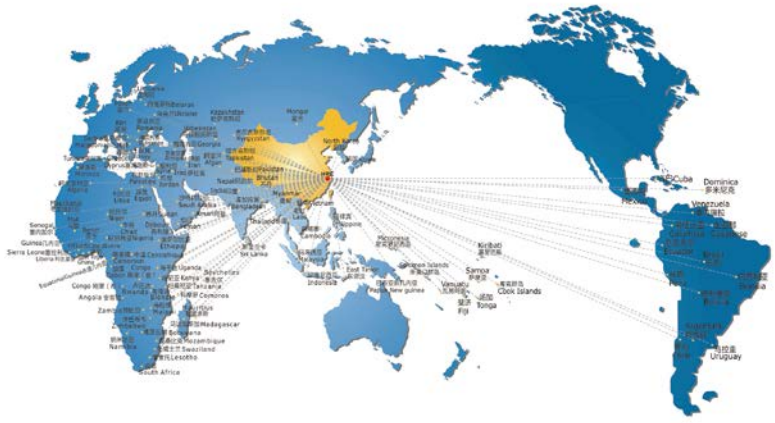

Figure 1. Distribution of training participants

(UNDP) and the United Nations Industrial Development Organization (UNIDO) in Hangzhou in November 1981, dedicating to SHP research, training and information consultancy in Asia-pacific region and worldwide. HRC serves as an important window of international cooperation with other countries in the field of SHP, and is the only rural hydropower and electrification research institute in China. It is also the Research Center on Rural Hydropower Engineering of Chinese Ministry of Water Resources (MWR), the MWR designated training unit, and the International S & T Cooperation Base of Renewable Energy and Rural Electrification in Zhejiang Province. Internationally, HRC enjoys a good reputation in the field of small hydropower and renewable energy. Focusing on the countries along the Belt and Road, HRC persistently carries out foreign-aid training programs, joint research, technology transfer, and project demonstration in the field of renewable energy, rural electrification and so on. Through in-depth cooperation and exchange, HRC gets remarkable success in promoting technical progress and facilities the construction of SHP and the development of other renewable energy.

I.Organizing the Foreign-aid Training and Providing Capacity-building Services

With the development of China's reform and opening up, HRC has given full play to its professional advantages since its establishment. Relying on Chinese Government's foreign-aid policies and funds, HRC carries out training courses of renewable energy and rural electrification for developing countries, and helps the countries along the Belt and Road promote the capacity building. So far, HRC has successfully organized 106 foreign-aid training programs on water resources management, small hydropower development, rural electrification, climate change and other related topics. A total of more than 2,000 participants from 113 countries were trained. The distribution of participants is shown in Figure 1.

In recent years, HRC has conducted trainings and seminars in major countries and regions of the "Belt and Road" according to their requirements. For ASEAN countries, technical seminars on hydropower and dam safety management, and hybrid power generation of renewable energy were carried out for Laos; bilateral training of senior management personnel in water and power systems was held for Cambodia; bilateral seminars on small hydropower financing were carried out for Vietnam. Jointly organized with the ASEAN Secretariat, the ASEAN Training Workshop on Small Hydropower and Solar Energy System for Rural Electrification funded by the China-ASEAN Cooperation Fund and the Seminar on Small Hydropower and Rural Electrification for ASEAN Countries supported by UNDP were held respectively in Hangzhou, China and Bandung, Indonesia. More than 300 senior managerial and technical personnel in the field of small hydropower and other renewable energy from ASEAN countries participated in these training programs. For African countries, Training Course on Small Hydropower Technology for Rwanda has been held annually for the last 4 years since 2015; Seminar on Renewable Energy and Off-grid Hybrid Power Generation System for East African Countries was held in Addis Ababa in 2017; Training Course on Small Hydropower Technology for Ethiopia was held in Addis Ababa in 2018 for the first time. A total of 23 multilateral and bilateral training programs were conducted for African countries, with the attendance of 1806

Fig. 2 Distribution of 4 Overseas Centers to be built by HRC

government officials and technical personnel in the field of water conservancy and energy from 46 African countries.

After years of development and practice, the foreign-aid training has realized five strides: the training venue has been extended from domestic to both domestic and overseas, the training forms expanded from multilateral to both multilateral and bilateral, the working language ranges from monolingual to multilingual such as English, French, Russian and Vietnamese, the training level ranges from technical training, seminar to ministerial workshop, training content extended from small hydropower technology to water conservancy, hydropower, renewable energy, climate change and other areas. On the basis of foreign-aid training programs, HRC has established a database of participants' information. Through regular visits to former participants, their return visit to HRC, remote technical consultation, and sharing the E-journal *SHP News*, the follow-up exchange has been strengthened, thus deepening the friendship and promoting the cooperation.

II. Establishing Technology Transfer Centers and Conducting Joint Research

Over the years, HRC has maintained close exchange and cooperation with the countries along the "Belt and Road", and continuously expanded the communication channels. Recommended or witnessed by governmental agencies or high-level officials, HRC signed MOUs with relevant universities and scientific research institutes for further increasing the political mutual trust and laying a good cooperation foundation. With the great support of Chinese Ministry of Water Resources, the Ministry of Commerce, the Ministry of Science and Technology and Chinese embassies abroad, HRC has carried out joint research and technology transfer with Pakistan, Indonesia, Ethiopia, Serbia and other countries and regions, and has established four overseas centers, shown in Figure 2.

1. China-Pakistan Joint R&D Center on Key Technology of Small Hydropower and Rural Electrification

With the cooperation of Pakistan Council of Renewable Energy Technology (PCRET), HRC established China-Pakistan Joint Research Center for Small Hydropower Technology. On April 20th, 2015, Chinese President Xi Jinping paid a visit to Pakistan, and launched China-Pakistan Joint Research Center for Small Hydropower and other 7 China-Pakistan Cooperative Projects. HRC is now implementing a Key Project of Strategic International S&T Innovation Cooperation to further enhance the technological innovation capability of Pakistan in the fields of renewable energy development including small hydropower and rural electrification construction through mutual exchange and cooperation. The establishment of the joint R&D center will promote small hydropower development and rural electrification construction in South Asian countries.

2. China-Africa Technology Transfer, Research & Training Center on Clean Energies & Rural Electrification

In 2017, with support of the Mission of the People's Republic of China to the African Union, HRC established the "China-Africa Technology Transfer, Research & Training Center on Clean Energies & Rural Electrification" in cooperation with Addis Ababa Science and Technology Uni-

versity (AASTU) in Ethiopia. Under the framework of the Center, HRC is working together with AASTU on clean energy discipline construction, teaching materials compilation, faculty cultivation and joint master degree education, which makes preparations for setting up the China-Africa Friendship Institute of Rural Electrification in AASTU. Besides, HRC is cooperating with African countries like Uganda, Rwanda, and etc. in developing the solar water-pumping systems and containerized hydropower plant, providing the technical services of hydropower development planning, site identification and etc. and vigorously promoting the application of Chinese SHP standards. The "China-Africa Technology Transfer, Research & Training Center on Clean Energy & Rural Electrification" is becoming a cooperation platform for serving China-Africa clean energy and rural electrification industry, laying a good foundation for green energy exploitation and promoting the green and sustainable development in Africa.

3. China-ASEAN Technical Transfer and Training Center on Renewable Energy and Rural Electrification

The Southeast Asia is one of the most dynamic regions for world economic growth but with an imbalance of clean energy development in different countries. In 2017, HRC implemented the project called China-Indonesia Joint Research Center for Rural Electrification Based on Hydropower. With the participation of Brawijaya University and PT PLN (Persero) Pusharlis, HRC carried out technical R&D, trial equipment manufacturing, project demonstration and personnel training on hydropower based hybrid power-generation system. On this basis, HRC and ASEAN Center for Energy (ACE) take the lead in cooperation with universities, research institutes and enterprises engaged in renewable energy in China and ASEAN countries, and established the China-ASEAN Technical Transfer and Training Center on Renewable Energy and Rural Electrification. The activities of capacity building, joint research and technology demonstration promote renewable energy and rural electrification technology, enhance energy cooperation between China and ASEAN countries, and develop an integrated industrial chain of energy resources.

4.SHP Technology & Equipment Development Base for West Asia, East Europe and Caucasian Regions

In May of 2017, HRC signed the MOU with the University of Belgrade of Serbia, and discussed the technology and project demonstration of small hydropower and other renewable energies. In the same year, HRC started to implement the Key Project of China-Serbia Intergovernmental Scientific and Technical Innovation called *Joint Research on the Development Technology of Low-head Run-of-the-river Hydropower*. Through joint assessment and planning of hydropower resources of a typical river in Serbia and the research on simulation technology of low-head run-of-the-river hydropower development, the project aims to develop the methods and strategies for tapping low-head river water resources and renewable energy, and promote the application of rural electrification mode based on hydropower. By means of capacity building and project demonstration,

the relevant proven technologies and equipment are expected to be extensively popularized in East Europe Region. The multilateral scientific and technical cooperation and exchange platform, called SHP Technology & Equipment Development Base for West Asia, East Europe and Caucasian Regions is being built.

III. Carrying out Project Demonstration and Promoting the Global Production-capacity Cooperation

Over the years, supported by the South-South Cooperation Assistance Fund, China-Africa Cooperative Fund, Foreign-aid Project Fund of Chinese Government, and Perez-Guerrero Trust Fund (PGTF) of the United Nations Development Programme, and based on the current status and actual demands of different countries, HRC has widely carried out demonstrative project cooperation such as hydropower development planning, hydro-wind-solar hybrid power generation system, low-head power plant, containerized mini hydropower plant, solar water-pumping system, solar water-purification system and etc. Under the framework of the four overseas technical transfer centers, HRC has successfully undertook SHP electromechanical equipment supply, installation, consultation and design services for hundreds of projects in over 50 countries such as Vietnam, Indonesia, Turkey, Peru, Kenya and Angola, etc. Through the project cooperation and demonstration, the technologies on renewable energy development have been applied and demonstrated, creating the favorable economic and social benefits for those project countries. In addition, HRC is playing a leading role in formulating and revising national & industrial standards so as to popularize abroad China's SHP standards regarding project planning, design, consultation, operation and management, construction, equipment manufacturing and etc.

IV. Prospect

Following the Reform and Opening up, HRC has been engaged in SHP international training and cooperation exchange for nearly 40 years. In the next step, HRC will unswervingly adhere to the working principle of"Capacity Building- Joint Research-Production Capacity Cooperation", provide personnel training and technical services for countries along the Belt and Road in the field of water resources, small hydropower, clean energy, climate change and etc., jointly conduct technical research and project demonstration, boost the technology transfer and localization of equipment production, promote the internationalization of China's SHP standards, and facilitate the international cooperation of clean energy and rural electrification. HRC will contribute to realize rural electrification in countries along the Belt and Road, jointly address the global challenges such as energy shortage, environmental pollution and climate change, and improve the well-being of people in the world.

About the author

Prof. Dr. Xu Jincai, born in 1969, Professor Senior Engineer, Director General of National Research Institute for Rural Electrification (NRIRE) and Hangzhou Regional Center (Asia - Pacific) for Small Hydro Power (HRC), has been engaged in the research on small hydropower and other renewable energy development technologies and the related policies, committed to the foreign-aid training and international cooperation and exchange of China's small hydropower technology under the "Belt and Road" Initiative.