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SMALL HYDRO POWER

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SMALL HYORO POWER NEWS

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The Belt and Road Initiative VS Clean Energy & Rural Electrification

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC)

Zhao Jianda, Pan Daqing

Currently, an estimated 1.1 billion population around the world are still living without access to electricity, half of which are Africans. *The UN Sustainable Development Goals for 2030 (2015-2030)* released in June 2015 included 17 goals to be achieved by 2030, with one of them being that the whole population can access to affordable, reliable modern energy. In November 2016, the UN Security Council unanimously agreed to support the *"Belt and Road Initiative"* and the role it plays in enhancing regional economic cooperation and maintaining regional stability and development. Not only has the *"Belt and Road Initiative"* been written in the UN documents, but it has also become an important platform to realize the *UN Sustainable Development Goals for 2030*.

Poverty and poor economic development is a common problem confronted by the developing countries, and energy shortage has become the main cause. However, poverty and poor economic development has blocked energy development. Most countries along the Belt and Road abound in clean and renewable energy such as hydro, wind and solar energy, but the production of energy and power supply is still far from sufficient to satisfy the demand for economic and social development.

Currently, clean and renewable energy has surpassed the conventional types in economic benefits in many regions and countries, and the energy structure is undergoing revolutionary changes. In the past 5 years, the cost for wind power development has dropped by 20% on a global basis, while the cost for photovoltaic development has dropped by 60%.

In the long run, the countries using conventional energies are bound to have a transition. The countries along the Belt and Road are important areas for renewable energy development and renewable energy transformation with a big market and plenty of opportunities. The countries along *the Belt and Road* are mostly at a stage of rapid increase in energy demand and confronted with the same question that what kind of energy system shall be set up. Countries including Oman, Qatar, UAE, Saudi Arabia, etc. all have formulated corresponding planning on new energy development, clearly stating certain amount of power generation from the renewable energy shall be hit.

In the rising photovoltaic market, countries in the Southeast Asia such as Thailand, India, the Philippines etc. are blessed with sufficient sunshine as well as power incentives. In Australia, there is the tradable green certificate system. In America, despite of the high threshold, the dollar assets keep the value well. In the Middle East, and North Africa, there are rich sunshine and new policies on energy. In UAE, there is a record low PV power price of 2.42 cents per kWh in the world, far less than thermal power.

China has been in cooperation with more than 80 countries globally in the field of hydro, photovoltaic, wind, solar water heater etc. On the premise of mutual benefits and double wins, the Chinese government encourages Chinese enterprises with technologic

advantages to keep enhancing the cooperation in technology and industry chain, and jointly promote technological industrialization and demonstration projects construction in solar energy generation, accumulation of energy, smart grid, advanced wind generators etc. to reduce the development cost and promote the application of technologies in large scale in an effort to push the global transformation in energy structure.

China has done a lot in renewable energy development, contributing a lot to the reduction of renewable energy cost globally. There is a solar and hydro complementary project of 1 GW in Qinghai, China. In Africa, the solar and hydro power plants are able to maintain the stable power supply for some regions. China is willing to cooperate with countries and organizations around the globe who have done well in renewable energy development to promote the development of clean and renewable energy in the countries along the Belt and Road. In 2017, China will focus on the cooperation in clean and renewable energy in Morocco, African regions, and South America, etc.

As the most reliable, mature, stable clean energy, hydropower takes up the biggest share in clean energy system, and the global installed capacity of conventional hydropower is about 1 billion kW with annual generation of 4000 billion kWh. The development rate globally reaches 26% (by power generation amount), with Europe, North America, South America, Asia, and Africa respectively being 54%, 39%, 26%, 20% and 9%. The developed countries boast a higher

development rate, with Switzerland, France, Italy, Germany, Japan, and America respectively being 92%, 88%, 86%, 74%, 73 % and 67%, while the developing countries are generally low in hydropower development rate. The development of hydropower in the years to come will mainly happen in those developing countries with low development rate and high power demand, for instance, Asia, Africa, South America, etc. and it is estimated that the global hydro installed capacity will reach 2.05 billion kW (2050GW) by 2050.

China's hydropower development rate has reached 37% (by power generation amount) and the hydro installed capacity has reached 0.32 billion kW, accounting for 27% of the global total, ranking the first in the world. The small hydropower installed capacity in China accounts for half of the global total. In recent years, China has advanced by leaps and bounds in hydropower industry, becoming a "pacemaker" instead of a "follower". As a country of fast hydropower development and high hydropower technology, China has been strong in its overall capacity in hydropower industry including design, planning, construction, manufacturing, transmission etc. *The 13th Five-Year Plan (2016-2020) for Hydropower Development* clearly states that international cooperation shall be enhanced based on the mode of open development. Guided by the *"Belt and Road Initiative"*, the international cooperation in equipment, technology, standards, project service, etc. shall be further promoted.

As a green, renewable, distributed and clean energy, small hydropower will be an important area of cooperation on energy and infrastructure between China and the countries along *the Belt and Road*. In the developing countries, especially those along *the Belt and Road*, the potential of small hydropower development and cooperation is enormous and small hydropower with its mature and applicable technology holds great attraction to the developing countries. The developing countries

along *the Belt and Road* are rich in hydropower resources, but small hydropower development policies and power market system differ greatly in those countries. Besides, with low rate of hydropower development and utilization, poor management, slow electrification process, those countries especially the African ones are in an urgent need to boost the application of small hydropower in promoting industrialization, infrastructure etc..

To put infrastructure in the first place is China's experience obtained in the 30 years' practice of opening up and reform policy. As important public infrastructure and facilities in the rural areas, small hydropower has mainly served in power supply to promote the rural economy. Confronted by many constraints including technology, capital, talent, equipment, etc., small hydropower has blazed a new trail in those areas with rich hydropower resources. The local people created an innovative and effective mode of development on their own based on practical experience, contributing a lot to China's electrification process. In addition, small hydropower has also made achievements in rural economy development, targeted poverty alleviation, improvement of livelihood, treatment of small and medium-sized rivers, etc. China's success in rural electrification has set up a good example for the countries around the world especially those developing countries in rural electrification, which has been evaluated highly of by international organizations including the UN and received wide attention from around the world. China's technology and experience in small hydropower is also being popularized in the developing countries. As the biggest developing country in the world, China has been enlightening and demonstrative in technology and experience in small hydropower to those countries in face of shortage of energy and power. The path of opening up and reform and rural electrification China has taken has served as a good reference to the other developing countries, facilitating them in solving the problems in the course of development.

"China hydro" and *"China's small hydro"* have been a striking signature card of China, which promotes China's technology, standard, manufacture and culture to go global. Small hydro is an important bearer and player in the *"Belt and Road Initiative"*, sharing China's experience in small hydropower with the rest of the world for mutual benefits and double wins.

"The Belt and Road Initiative" originates from China but belongs to the world. The pursuit of clean energy especially small hydropower on a global basis would be a mutual dream, while realizing the Chinese Dream, for which small hydropower is a good media and is a great cause for us to pursue.

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Intensifying Foreign-aid Training on Small Hydropower and Promoting Capacity-building of Developing Countries

——Dedicated to 20 years' involvement of HRC in South-South Cooperation

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC)

Lin Ning, Zhang Hua

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (briefed as HRC) is a regional organization established in Hangzhou in November, 1981 under the joint sponsorships of the Chinese government, United Nations Development Program (UNDP) and United Nations Industrial Development Organization (UNIDO). It is the one committed to research, training, information sharing and consultation in terms of small hydropower (SHP) in the Asia-Pacific region and even the world. Since its establishment, HRC has completed 80 training workshops and seminars in the field of water resources, SHP technology and rural electrification, which are entrusted by Ministry of Commerce, Ministry of Foreign Affairs, Ministry of Science and Technology, the ASEAN Secretariat, and the UN organizations, etc.. The participants of these workshops and seminars include around 2000 government officials and technicians from 113 countries. Besides, HRC is also one of the first centers that start to undertake the foreign-aid training program under the Ministry of Commerce from 1993, and 95 training workshops have been accomplished to this day.

The foreign-aid training program is an important part to the South-South Cooperation, playing a vital role in enhancing friendship and promoting economic and technical cooperation between China and other countries. Over the past 20 years, HRC has been unswervingly adhering to the mission of strengthening foreign-aid training on SHP and promoting the capacity-building of developing countries. Moreover, HRC has been accumulating experience and exploring new possibilities in implementing foreign-aid training programs. Improvements in both training mode and performance bear witness to the remarkable achievements that have been scored in several aspects.

I Exploring Various Training Modes

Over a long time, HRC has been innovating the training modes and seeking for further improvements. Great achievements have been made in several aspects including diversification of training language, expansion of training content, extension of training venue to countries other than China, upgrading of training level, etc.

1 Diversification of training language

In 1993, HRC organized a foreign-aid training workshop with English as its working language for the first time. In 2005, a training workshop on SHP technology for French-speaking African countries with French as its working language was organized by HRC, but in 2006, another training workshop on SHP technology for central Asian countries with Russian as its working language was organized. Over the past years, HRC has successfully improved the training program in terms of working language from single language (*English*) to multiple languages (*English, French, Russian*), expanding the beneficiary countries of the training program from English-speaking countries to French and Russian-speaking countries.

2 Extension of training venue to countries other than China

In response to the "*going out*" policy from the Ministry of Commerce, HRC has carried out several training workshops on SHP technology in countries other than China. In May, 1999, training workshops were conducted in Turkey and Greece. In December, 2014, a training workshop on SHP technology for southeastern Asian countries, a *Perez-Guerrero Trust Fund (PGTF)* project, was conducted in Indonesia. In July, 2015, a 20-day training course on SHP technology was successfully held in Rwanda, which was welcomed and appreciated by the local government, partners and the Economic and Commercial Counselor's Office of Chinese Embassy, and in 2016 another training course plans to be organized in Rwanda again. Up to now, HRC has made a successful shift in training mode from "bringing-in the participants" to a combination of "bringing-in the participants" and "organizing training workshops abroad". This very expansion offers more training opportunities to grass-rooted technicians, further boosting the influence of HRC and China's foreign-aid training program in the world.

3 Upgrading of training level from engineers to officials and ministers

To meet the training demand of different levels, the training has been upgraded from technology-oriented courses intended for engineers to seminars and ministerial-level workshops intended for officials and ministers. Besides the training workshop on SHP technology and rural electrification held every year, as the one and only organization that is entitled to hold ministerial seminar on water resources, HRC once conducted *"Ministerial Workshop on Water Resources and Small Hydropower for Developing Countries"* and *"Workshop on Water Resources Management and Planning for Developing Countries"* respectively in 2011 and 2015. On the workshops, about 50 ministers and high-level officials in the field of hydropower and energy from Asian, African and Latin American countries had in-depth discussion and idea exchange with each other, leading to significant effect and great achievement.

4 Expansion of training content to rural electrification and renewable energy

The training workshops conducted by HRC in earlier time are largely themed on SHP. Along with the construction of SHP-based rural electrification, and based on HRC's research findings in hydro, solar and wind hybrid power-generating system, the training subjects and contents are continuously renewed and enriched. To this day, HRC has expanded its training content to the field of rural electrification, not only to include the experience in rural electrification development, but also to cover solar and wind power-generation technology and hydro, solar and wind hybrid power-generation technology, as well as water resources management, agricultural water resource utilization, sustainable development of rural communities, etc..

II Shifting from TCDC to ECDC and Inter-governmental Cooperation

Since the participants of HRC's training workshops are great in number and wide in distribution, HRC has taken this opportunity to further promote economic cooperation between China and other countries with varied forms and widened areas. Under the inter-governmental cooperation framework, HRC has undertaken to carry out joint research in the field of renewable energies including SHP, joint trial-manufacture of advanced equipment as well as transfer of applicable technologies. Up to now, several inter-governmental cooperative sci-tech projects have been realized with great performance and demonstration effect, including *Sino-Pakistan Joint Research Centre on Small Hydropower Technology, Research on Emergency-supporting Technology for Rural Hydropower* against Disasters Caused by Climate Change, Sharing of Clean Energy-based Rural Electrification Mode and Technology, Hydro-energy Evaluation of Island in ASEAN Countries. In April, 2015, Chinese President Mr. Xi Jinping, on his visit to Pakistan, attended the unveiling ceremony for 8 joint sci-tech projects between China and Pakistan including the *Sino-Pakistan Joint Research Centre on Small Hydropower Technology* as the lead.

Besides, through the foreign-aid training, HRC's advantages in

renewable energy planning and technical application have been brought into full play, thus promoting the business of engineering design, consultation, electro-mechanical equipment export, etc., which result in good economic benefits. To sum up, HRC gets started from organizing foreign-aid training workshops, adheres to the new concept of South-South Cooperation, and seeks to expand new business areas, thus making the shift from promoting *"Technical Cooperation among Developing Countries" (TCDC)* to stimulating *"Economic Cooperation among Developing Countries" (ECDC)* and inter-governmental sci-tech cooperation among developing countries, which features sustainable development.

III Substantial Achievements of South-South Cooperation

Years of efforts have produced great yields. With great leaps in foreign-aid training, HRC has cultivated a bunch of participants who have deep attachment to China. Mr. Hoang Van Thang, former participant from Vietnam Institute for Water Resources Research, has been promoted as Vice Minister of Ministry of Agriculture and Rural Development. Mr. Sinava, former participant from the Power Department of Ministry of Industry of Laos, has been promoted as Vice Minister of Ministry of Energy and Mines. Mr. Ateye, former participant from Egypt, has been promoted as ministerial-level leader in Ministry of Power and Energy. Mr. Masanja, former participant from the Ministry of Energy and Mines of Tanzania, has been promoted as Chief Engineer of the Ministry. All the participants mentioned or not mentioned here serve as bridge of friendship between China and their own countries, and they are all indispensable and close friends to China. Besides, they function as advocates and propeller to the technical and economic cooperation in terms of SHP and rural electrification technology between China and other developing countries.

HRC's foreign-aid training, on one hand, advertises to the world China's advanced technology and successful experience in the field of small hydropower and rural electrification, and on the other, promotes project demonstration and production cooperation, pushing the export of renewable energy technology and related E/M equipment. With the help of the old participants of the training workshops, HRC has taken an active part in overseas business market for SHP planning, design & consultation, E/M equipment export, installation and commissioning, etc.. Up to today, HRC has supplied services including engineering design, consultation, equipment supply, installation, etc. with the contract volume amounting to over hundred million US dollars, to more than 100 hydropower stations in over 50 countries and regions including Philippines, Vietnam, Indonesia, Papua New Guinea, Sri Lanka, Peru, Fiji, Turkey, Macedonia, Pakistan, Angola, Kenya, etc.. Among all the projects, 45 hydropower plants whose scope of supply only includes equipment and installation have been put into operation with total installed capacity reaching over 800MW. Apart from making enormous economic profits for project owners, the implementation of these projects has pushed HRC to move further on a market-oriented route, forming a new mechanism featuring government guidance, technical support and enterprise participation, sharing the great achievements of South-South Cooperation.

For a long run, HRC has been reputed as "The Family of SHP in the World" by the international community for its capability in SHP technology, and "The Model of South-South Cooperation" by Ministry of Commerce for its high quality and effective foreign-aid training work. Besides, the former Director General of HRC Ms. Cheng Xialei was once awarded "Special Contribution to China's Foreign Aid" by Ministry of Commerce. Just as Mr. Kofi Atta Annan, former Secretary General of the United Nations, put it, HRC has shared its great experience in the field of renewable energy with developing countries. HRC will keep improving foreign-aid trainings and deepening technical and economic cooperation among developing countries based on its strength in SHP technology and talents, thus promoting capacity-building of developing countries and embracing more fruitful achievements of South-South Cooperation in SHP.

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China Taking the World Lead on Renewable Energy

The Trump administration believes that the climate change mantra is a "hoax" peddled by some countries, including China. It also argues that it is a waste of money and threatens US jobs.

Non-adherence to the Paris Agreement on climate change may not affect the already-rich countries but China, as a developing country, has to undertake peaceful development and ensure a safe and prosperous future for Chinese citizens together with taking the strategic opportunity to develop alternative clean technologies.

President Xi Jinping said at the recent World Economic Forum in Davos that the Paris Agreement on Climate Change was hard won and therefore all signatories should stick by it.

A report released by the Ohio-based Institute of Energy Economics and Financial Analysis said China — given its domestic investment in renewable energy sectors — is now a world leader. The report also said China is going global: last year (2016) it invested US$32 billion in large overseas deals involving renewable energy.

China has chalked out a plan for a greenhouse gas "cap and trade" program, calling for the government to tax domestic companies that generate large amounts of carbon dioxide.

Domestic issues as well as a sense of global responsibility — such as acute pollution problems, particularly in the air and water, together with health hazards posed by increased carbon emissions, pollution and rising temperatures — are shaping China's response to the global climate change challenge.

Additionally, scientific advances have afforded economic opportunities to curtail carbon emissions in lieu of clean and renewable technologies.

Solar and wind energy are now major policy priorities. Already, China has started limiting coal consumption in three largest cities — following adverse effects on the environment. Given these commitments, China may be able to control level of carbon emissions by 2025 — five years ahead of its stated goals of 2030.

US President Donald Trump labels climate change a hoax — ignoring the world population will hit 8.5 billion by 2030 from 7.5 billion now, increasing pressure on ever-more-stressed clean water, energy and air resources.

Timely choice

That China has taken the initiative on acquiring clean technologies is quite timely. Its new industries are manufacturing electric cars, batteries, nuclear power and wind, solar and geo-thermal technologies. As an illustration, nearly 200 million electric vehicles have been sold in China already and this trend may be catching up in other countries soon.

Already, coal is difficult to exploit as fracking technology is expensive, albeit involving low labor. Even in coal-rich US states such as West Virginia the proportion of the workforce employed in coal mining is as low as 5 per cent.

Trump's appeal and promise to coal miners and the coal industry played an important role in his election. But clean energy consciousness is growing in progressive states such as New York and California as they make plans for clean and efficient use of energy.

In fact, the Obama administration had already taken some steps to reduce the $C0_2$ emissions by 2025, to one quarter below 2005 levels. Should this happen, many European, Middle Eastern and South Asian countries could follow suit.

Thus, China could become a global leader in low-carbon technologies by taking a major role in building renewable and eco-friendly energy technologies, such as solar and wind, should the US and other rich countries renege on Paris.

(*Source:* China Daily) ■

A Ministerial Workshop on Water Resources Management & Planning for Developing Countries Held in Hangzhou

Entrusted by the Ministry of Commerce and Ministry of Water Sources, organized by National Research Institute for Rural Electrification (HRC) of Ministry of Water Resources (MWR), *2015 Workshop on Water Resources Management & Planning for Developing Countries* was held successfully in Hangzhou in October 19-25, 2015. Mr. Jiao Yong, Vice Minister of Water Resources was present at the opening ceremony and delivered the keynote speech. Mr. Huang Xuming, Vice Governor, the People's Government of Zhejiang Province, Mr. Huang Dengping, Vice President, Academy for International Business Officials, Ministry of Commerce, P.R. China attended the opening ceremony and delivered speeches. The opening ceremony is hosted by Prof. Zhang Jianyun, Academician of Chinese Academy of Engineering, President of Nanjing Hydraulic Research Institute. Leaders from Department of International Cooperation, Science and Technology of MWR, Department of Water Resources of Zhejiang Province, Taihu Basin Authority of MWR, International Center for Small Hydropower were present at the opening ceremony. 21 ministers and senior officers from Afghanistan, Ecuador, Ethiopia, Egypt, Ghana, Uganda, Zimbabwe, Malawi and Panama took part in the one-week workshop.

Mr. Jiao Yong pointed out in his speech that in recent years, with the impact from the in-depth development of industrialization, urbanization and global climate change, water shortages, water ecological deterioration, environmental pollution problems cropped up increasingly, becoming the bottleneck of restricting economic and social development. Therefore, the Chinese government vigorously carried out water conservancy construction, determined the working policy of *"water-saving priority, spatial equilibrium, systematic treatment and two-hands holding"* in the new era, and carried out fruitful work. He hoped that by means of a good platform of this workshop, the participants could gain a comprehensive understanding of the development of China and the Chinese Water Conservancy and build a bridge with China to carry out exchanges and cooperation in water

conservancy. He hoped that with the cooperation of all the developing countries, we can make joint efforts to improve the water resources development, utilization and management level, in order to bring more benefits to the people of the world, and to promote the realization of sustainable development goals of the United Nations in 2030.

During the workshop, Mr. Jiao Yong delivered a keynote speech named *Taking New Cooperative Opportunity & Seeking Common Development*, which gave a comprehensive introduction of water conservancy development in China in terms of *China's Basic Water Conditions, Achievements of Water Construction and Management, Main Measures and Prospectus of Water Reform and Development*, giving answers to the questions about sediment regulation, operation and maintenance of hydraulic projects, forecasting technology for flood control and disaster mitigation and water consumption standard, etc.

Prof. Zhang Jianyun, president of NHRI, academician of the Chinese Academy of Engineering, Mr. Liu Heng, Director-General of International Center for Small Hydropower, Prof. Shao Jiannan, Deputy Division Chief, General Institute of Water Resources and Hydropower Planning and Design of MWR, Ms. Cheng Xialei, Director-General, National Research Institute for Rural Electrification (HRC) of MWR, Mr. Wang Hai, Director of Operation Department, Construction And Operation Administrative Bureau Of Three Gorges Complex, Mr. Wu Haoyun, Deputy Director-General, Taihu Basin Authority of MWR, respectively gave presentations of *Water Resources and Impacts of Climate Change in China, Water Management and Policies in China, Water Resources Planning in China, Development & Utilization of Small Hydropower in China, Three Gorges Project & Water Resource Development on Yangtze River and Management of Water Resources in Taihu Basin.*

During the Workshop, officials paid on-site visits to *Caoejiang Water Conservancy Project, Water Environment Regulation Engineering of West Lake, Three-Gorge Project, Suzhou River Tidal Sluice* and other hydraulic projects, and also visited *China National Water Museum*. HRC invited domestic established corporations such as China Energy Engineering Corporation Ltd, The Three Gorges Corporation to conduct economic and technological exchange with all the officials, organizing the officials and relevant industry departments to study, discuss and share successful experience regarding case study and technical route of "management and development planning of water resources". These activities undoubtedly promoted the cooperation between China and other developing countries in this field.

On the afternoon of October 25, the workshop was concluded in Shanghai. Mr. MOSTAFA ABDEL-KHALEK ABU-ZEID, Vice Minister of Egyptian Ministry of Water Resources and Irrigation commented in his speech at the closing ceremony: "We are gathered here again this evening, in your wonderful country, after 7 unforgettable days. These types of knowledge skills are a celebration of humanity, and together we have experienced many strong emotions. We have shared the grief of a dream cut short. The memory of this cooperation will always be with us. We are in the developing countries looking forward to great cooperation and projects. We are sure that China will lead the world in the next 10 years. Thank you to the all of our Chinese volunteers. Your competency, your kindness and your smiles are worthy of a gold medal! This was excellent and very friendly Workshop!"

This workshop has received strong support and conscientious guidance from Ministry of Commerce, Ministry of Water Resources, Zhejiang Provincial Government, and gained great support from associated departments and other organizations. The success of the workshop has strengthened the communication between China and other developing countries in the field of water resources management and development planning, shared the successful experience, advanced technology, enhanced the development and management capability of water resources of the participating countries, promoted the effective utilization and standardized administration of local water resources, thus laying a solid foundation for future cooperation in these fields.

This workshop is the 79th foreign-aid training program HRC implemented since its establishment. And it is another Ministerial Workshop HRC hosted since 2011.

(*Source:* HRC) ■

Seminar on Climate Change for the Countries along the Belt and Road Held in Hangzhou

Sponsored by Department of Climate Change of National Development and Reform Commission (NDRC), and undertaken by Department of International Cooperation of NDRC, the Zhejiang Program for the *Seminar on Climate Change for the Countries along the Belt and Road* commenced on April 23, 2017 in Hangzhou Low Carbon Science & Technology Museum, China. As the undertaker of the Zhejiang Program, and provincial representative of scientific research institution, Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (briefed as HRC) was present at the Exhibition of Low Carbon Products & Technology in Zhejiang and Negotiation Conference of Projects Cooperation on the Belt and Road held on the afternoon of April 23. Mr. Xu Jincai, Director General of HRC, addressed the opening ceremony.

The seminar includes in total 29 participants, mostly officials and experts in the field of climate change, from 17 countries including United Arab Emirates, Ethiopia, Pakistan, the Philippines, Georgia, Cambodia, Laos, Myanmar, Tajikistan, Thailand, Kazakhstan, Malaysia, etc. The Zhejiang Program of the seminar lasts 7 days, focusing on green and low carbon development in Zhejiang province, including policies and measures, energy development, agriculture and forestry development, environmental protection, etc. Mr. Lin Ning, Division Chief of Foreign Affairs and Training of HRC, delivered a report entitled *"South-to-South Cooperation and Prospectus of HRC"* on the theme of energy development. Besides, study tours for green and low carbon development were also arranged and the destinations included Yucun village in Anji, Laoshikan hydro power station, Yangdu Research and Innovation Base of Zhejiang Academy of Agricultural Science, Alibaba group, etc. In addition, international communication and discussion were conducted with the purpose of sharing China's experience and knowledge in countering the climate change with the other countries along the Belt and Road, and establishing the link between countries for long-term contact and concrete cooperation.

HRC's efforts in organizing the seminar in Zhejiang were unanimously acclaimed. This very experience in organizing the seminar in Zhejiang enhanced the cooperation between HRC and the relevant departments from National Development and Reform Commission, and Zhejiang Provincial Development and Reform Commission.

Mr. Xu Jincai, Director General of HRC, addressed the opening ceremony

Mr. Lin Ning, Division Chief of Foreign Affairs and Training of HRC, delivered a report

Visit to Yucun village, a typical case for ecology-friendly development

(*Source:* HRC) ■

2016 Rural Hydropower 10 Major Events in China

1 National rural hydropower generation exceeded 250 billion kWh

In 2016, the newly added installed capacity of rural hydropower was 2 million kilowatts, the total installed capacity more than 77 million kilowatts, the generation more than 250 billion kWh, equivalent to saving 78 million tons of standard coal and more than 200 million tons of carbon dioxide emissions.

2 MWR issued to promote the development of green small hydropower

2016 No.1 document from Central government made a major deployment of green small hydropower. In December, the Ministry of Water Resources (MWR) issued *"Guidelines on the promotion of green small hydropower development"*, confirming the approaches, goals, tasks and initiatives of developing the green small hydropower.

3 The central government demanded to strongly support the poverty-stricken areas by developing rural hydropower

Small hydropower is an important clean renewable energy related to water conservancy infrastructure and the people's livelihood, the issued *"Economic and Social Development The 13th Five-Year Plan"* and *"the CPC Central Committee and State Council on the fight against poverty"* in 2016 demanded to vigorously support the development of rural hydropower in poverty-stricken areas, and support the development of rural hydropower in the old, revolutionary areas.

4 The hydropower resources development planning of over 2300 small and medium-sized rivers passed review or approval

Since the beginning of 2012, the initial results have been scored for the current round of national unified review and compilation of the development planning for small and medium river hydropower resources, the planning report of the more than 3,200 rivers in the country's 25 provinces has been completed, more than 2,300 rivers planning has passed review or approval.

5 Efficiency-increase and capacity-expansion for rural hydropower in "The 13th Five-Year Plan" fully implemented

Ministry of Finance, Ministry of Water Resources jointly issued a notice, in the condition of unchanged financial capital support standards, with the river as a unit and with focus to ecological restoration, carried out the efficiency-increase and capacity-expansion for rural hydropower in the *"The 13th Five-Year Plan"* and with the total investment 12 billion yuan. Ministry of Water Resources introduced a guideline for efficiency-increase, capacity-expansion and ecological restoration. Rivers of dehydrated or decreased flow over 2,000

kilometers would be repaired. The installed capacity and annual power generation will increase by 25.3% and 42.1% respectively after the restoration.

6 Poverty-relief pilot project of rural hydropower project initiated

The National Development and Reform Commission and the Ministry of Water Resources implemented poverty-relief pilot project of rural hydropower project by setting up archives and checking the cash income as the goal of the pilot project in Hunan and other 6 provinces (municipalities) crack down on the issues of stability of state-owned assets, precise poverty-relief and construction of long-term mechanism. The experience can be copied, be promoted and the construction effectiveness highly praised by the parties concerned.

7 Tasks over fulfilled for constructing safety production standardization on 1000 sets of rural hydropower pilot station

Ministry of Water Resources in 2014 officially launched the safety production standardization pilot construction for rural hydropower. As of the end of 2016, over 1,100 rural hydropower pilot plants for safety production standardization in the country were actually completed, exceeding the set target. Through the pilot construction, the safety production level for rural hydropower stations was greatly improved.

8 The 7th "Hydropower Forum Today" held in Hangzhou

On November 2, the seventh *"Hydropower Forum Today"* opened in Hangzhou. Minister Chen Lei attended and made a keynote speech. Nearly 300 international organizations, government officials, experts and scholars from 36 countries participated in the forum, which is the highest in rank and in number. During the forum, the *"Development Report on World Small Hydropower 2016"* was released.

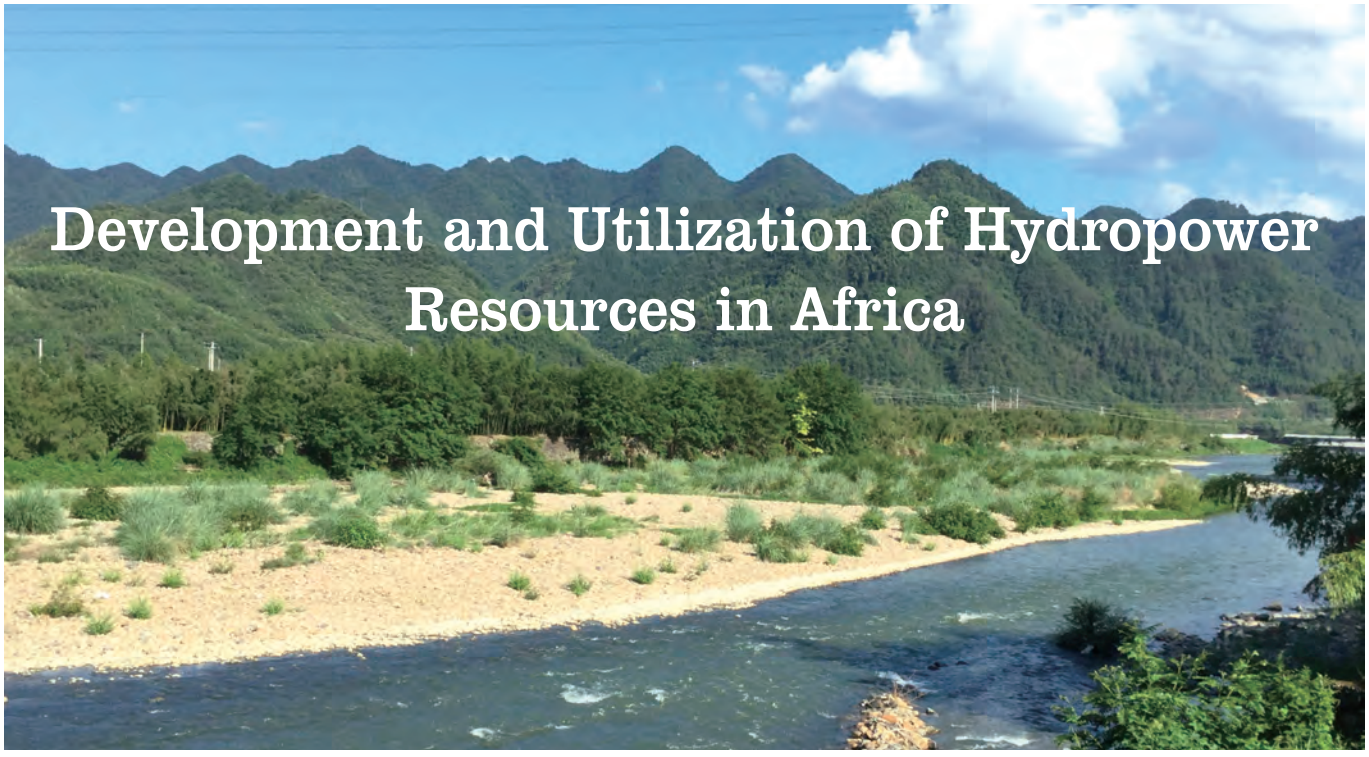
9 International influence of China's small hydropower continues to increase

On July 9, UN Secretary-General Mr Ban Ki-moon visited the International Small Hydropower Center, fully affirmed the contribution of China's small hydropower to climate change and the development of small hydropower in the world, and highly praised the important role that small hydropower played in international cooperation. On June 13, the Ministry of Water Resources and the United Nations Industrial Development Organization (UNIDO) applied for the implementation of the SHP efficiency-increase and capacity-expansion project in China with the formal approval from the Global Environment Facility (GEF).

10 Actively carry out small hydropower practical exploration for transformation and upgrading

Various areas actively implemented the instructions from Central and the Ministry of Water Resources to develop green hydropower, adjust the development structures and boldly practice to explore. Zhejiang province took measures to implement for constructing the rural hydropower ecological demonstration area; Fujian province carried out rural hydropower ecological restoration through the *"limiting, changing, transforming and withdrawing"* and etc. to restore the river ecology; Shaanxi province lead the scientific and rational development of rural water resources via planning; Jiangxi province actively explored experimental sites of monitoring small Hydropower minimum discharge and joint dispatch for cascade hydropower station. All these practice and experience would have a positive reference to the transformation for the rural hydropower across the country.

(*Source:* HRC) ■



Development and Utilization of Hydropower Resources in Africa

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC)

Zhao Jianda, Pan Daqing

At present, about 630 million people in the African continent have no reliable electricity supply, less than 15% of the population with access of electricity, and most of the rural population mainly rely on firewood, charcoal or crop waste as cooking and other living energy. According to the report released by the International Energy Agency in 2016, the average rate of electrification in the African continent is 45%, with urban electrification rates much higher than rural areas, with an average of 71% in urban areas and 28% in rural areas. Africa's electricity coverage is low in the world level. In the context of the global response to climate change and efforts to develop the economy, African countries have a huge potential for clean and renewable energy.

Africa is very rich in water resources. The International Energy Agency believes that hydroelectric power is the most important component of electricity systems in many African countries and is the most widely used renewable energy resource (excluding biomass). The International Energy Agency's assessment of the potential for hydropower in Africa is 283 GW, with an average annual generating capacity of 1,200 TWh, which accounts for 8% of the world's exploitable hydropower resource, but the overall water use efficiency of the continent is still Low, the current actual development rate is only 9%, and most of them are concentrated in Central Africa and eastern Africa, especially concentrated in Cameroon, Congo (Brazzaville), Congo (Kinshasa), Ethiopia and other countries. Some countries in Africa have also developed large-scale hydropower resources, such as Angola, Madagascar, Mozambique and South Africa, in southern Africa, Guinea, Nigeria and Senegal in western Africa.

Hydropower development in major African rivers (Zambezi River, Congo River, Nile River, Niger River, etc.) can meet the growing demand for electricity. The Congo River, located

in the Democratic Republic of the Congo, has more than 100,000 MW of hydroelectric potential sufficient to meet the electricity needs of the entire southern African continent. The Zambezi River also has as much as 100,000 MW of water potential, while Ethiopia and Nigeria have 30,000 MW and 20,000 MW of hydropower potential respectively.

At present, about 82% of the hydropower stations are located in a few relatively peaceful countries of northern and southern parts of Africa. The development of hydropower resources has always been the most important issue of the Congo (DRC) government. The installed capacity of the Inga III project is 1.8 GW, and when it is fully completed, the total installed capacity of the hydropower project will reach 44 GW. There are other hydropower projects that are also being implemented in an orderly manner, such as the Mphanda Nkuwa dam under construction in Mozambique. At the same time, small hydropower projects are being developed steadily in sub-Saharan Africa.

Mozambique, Congo (DRC), Uganda and Kenya, these countries rely mainly on hydropower, and only 10% of the technically exploitable potential is now developed.

Although Africa's natural resources and development conditions are blessed, the level of development of the energy industry, especially the power industry, is still very low due to the relatively backwardness of ideas and technologies, especially lacking in funds. At present, in Africa for the economically exploitable hydropower resources, there are still many obstacles. Including the huge amount of funds in the early stage, the lack of communication between countries, the absence of electricity export opportunities; seasonal climate issues; environmental and social problems, the impact of hydropower stations on water resources and water environment; some countries lack the necessary development technology and so on.

Some of the African countries along the Belt and Road are rich in water resources, small hydropower theoretical reserves huge, but the development rate very low, the general coverage rate not high, the development prospect bright. Such as: the theoretical reserves of small hydropower resources in Ethiopia and Kenya were 1500 MW and 3300 MW, the installed capacity was only 6.16 MW and 33 MW respectively, the power coverage rate was less than 30%. In Sudan, the power coverage rate is only 5%, Uganda only 10%.

1 Southern Africa

At present, the southern African countries has a total installed capacity of 58 GW, hydropower now accounts for 22% of the region's total electricity generation. South Africa's total installed capacity is 46 GW, of which the installed capacity of hydro power installed capacity of South Africa is 5% of the total. Excluding South Africa, the remaining 2/3 population in southern Africa has only 12 GW of installed capacity, of which hydropower installed capacity accounted for half. At present, some countries in southern Africa, hydropower resources development is still very little, but it has great development potential, especially in the Zambian River Basin like Mozambique, Angola, Zambia and Zimbabwe and other countries. It is expected that by 2040, the installed capacity of hydropower in southern Africa will reach 29 GW.

2 West Africa

In 2012, hydropower installed capacity in western Africa reached 20 GW, accounting for 20% of the total installed capacity of the region. Previously, hydropower has been the main source of electricity in the region, but since the 20th century, with the development of installed capacity in fossil energy by leaps and bounds, the increase of hydropower installed capacity significantly decreased. It is estimated that by 2040, the installed capacity of hydropower in western Africa will reach 24.4 GW, of which Nigeria's installed capacity will reach 15 GW.

3 Central Africa

Central Africa is the most abundant region of water resources in Africa and is the region with the highest hydropower development potential in sub-Saharan Africa. At present, hydropower installed capacity accounted for 65% of the total installed capacity of Central Africa. Countries such as Congo (DRC), Cameroon and the Congo (Brazzaville), whose electricity sources rely mainly on hydroelectric power generation. It is expected that by 2040, the installed capacity of hydropower in Central Africa will

increase from the current 2.6 GW to 20 GW.

4 Eastern Africa

In eastern Africa, the total installed capacity is 8.1 GW, of which hydropower installed capacity exceeds half. Ethiopia occupies a leading position, known as the " Water Tower in East African ", with abundant water resources, and almost all of Ethiopia's electricity comes from hydroelectric power due to the lack of fossil fuels.

At present, there are many hydropower projects under construction in eastern Africa. The Merowe dam of Sudan, built in 2009, has an installed capacity of 1250 MW and accounts for 15% of the total electricity generation in Eastern Africa. Ethiopia's hydropower project, Beles II (installed capacity of 460 MW) and Gilgel Gibe Phase II (installed capacity of 420 MW), were completed and put into operation in 2010. Kyrgyz Gibo III (installed capacity of 1870 MW) was also completed in 2016, all units put into operation. The Grand Renaissance Dam is under construction and has a capacity of 6,000 MW after completion, making it the largest hydroelectric power station in Africa.

The Merowe hydropower dam of Sudan

Ethiopia's Gilgel Gibe hydropower project (1870MW)

Uganda's hydropower installed capacity is also increasing. At present, Uganda's energy is dominated by bio fuels, consuming 93% of total energy, a serious shortage of electricity, representing only 1% of total energy. The nation's electricity supply capacity is only 350 MW, one of the lowest per capita electricity consumption in Africa. Uganda is full of rain and abundant in water resources with an average annual rainfall of 1174mm. It has the world's second largest freshwater lake - Victoria Lake, and the Nile River and other rivers and lakes, more rapids and waterfalls, suitable for hydropower development and construction. The national hydropower reserves are about 2300 MW. Hydropower has been the main source of power supply, the installed capacity of hydropower installation from Nile River in Uganda is 380 MW, but the actual power capacity for generation around 200 MW. The built hydropower stations consist of 200 MW Chieira hydropower station and 180 MW Naruoba hydropower station. In recent years, the Ugandan government has been focused on the development of large, medium and small hydropower stations to ease the serious shortage of electricity. Those under construction or in planning include 7 big projects:

(1) Bujacari hydropower station (installed capacity of 250 MW);

(2) Karumah Hydropower Station (installed capacity of 600 MW);

(3) Calgara hydropower station (installed capacity of 450 MW);

(4) AyiakkoBei Hydropower Station (installed capacity of 300 MW);

(5) Aya Gannan Hydropower Station (installed capacity of 250 MW);

(6) Mukesen Falls Hydropower Station (installed capacity of 600 MW);

(7) Isinba Hydropower Station (installed capacity of 183MW). The Ugandan Ministry of Energy after investigation and research also plans to develop more than 50 small hydropower stations with a total installed capacity of 210 MW.

Underground engineering represents the majority of the works for Karumu project (Uganda Karumu Hydropower Station)

It is expected that by 2040, the installed capacity of hydropower in the region will reach 20GW.

(Provided by Mr. Zhao Jianda) ■

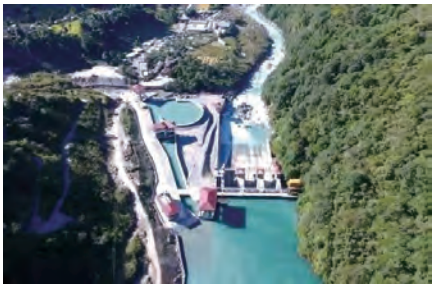
Exploitation and Utilization of Small Hydropower Resources in Southeast Asia and West Asia

In recent years, the rapid development of hydropower in the Asia-Pacific region has become the main driving force of global hydropower development. It is the fastest growing area of hydropower consumption in the world, with an increase of 4.3%. The fastest countries of the hydropower consumption growth in the region are Japan, Malaysia and Vietnam, with growth rates of 9.1%, 8.9% and 6.4% respectively, and the growth rate is at the world's leading level. In 2015, the proportion of electricity consumption from hydropower plants in the Asia-Pacific region is higher, accounting for 40.5% of the world's hydropower consumption, and hydropower consumption is still rising. Vietnam, Malaysia, Pakistan, India and other countries are accelerating the development of hydropower. In the future, the proportion of electricity consumption from hydropower plants in the Asia-Pacific region will be further enhanced.

The total population of the 10 ASEAN countries exceeds 600 million, of which 56% in the rural areas, 20% of the population so far with no access to electricity. There are many rivers in Southeast Asia, including the Red River, Mekong River, Chao Phraya River, Salween River, Irrawaddy River. The mountains and rivers are crossed, forming high drops, with huge hydropower potential, but the overall development rate of small hydropower is only 19%. The development rate of small hydropower for Laos, Myanmar, Thailand, and Vietnam is from 20% to 30%. Myanmar, Cambodia, Indonesia and Laos are in urgent need of electricity to meet the basic domestic demand.

Most of the South Asian countries are located in the southern slope of Himalaya, with Ganges, Indus and other rivers flowing through. The hydropower resources, especially the small hydropower potential is extremely rich, but the average development rate is only 20% so far. Among them, the SHP development rate of Pakistan and Nepal is only 12% and 5% respectively, the development rate very low and the potential great. In South Asian countries, the power coverage rate is generally not high, the living demand of residents for electricity is far from being met, the blackout often occurs.

Syria, Egypt (in the Asian part) and other West Asian countries have built large hydropower projects. In December 2014, during his visit Egyptian President Seth proposed to China that China's technology be adopted to improve the utilization of hydropower resources



Marshyangdi Hydropower Plant (A)

in Aswan Dam, fully reflecting the government's emphasis on hydropower development.

In addition, Southeast Asian and West Asian countries have also paid much attention to the development of solar energy and wind energy, and laid a good foundation for research, project demonstration and promotion of hybrid system on hydropower, solar and wind energy.

In recent years, the overall development of the world's hydropower is weak. On the whole, due to the global economic impact, the world's hydropower consumption is declining. The hydropower development in Europe and the United States has been relatively saturated. The rapid development of hydropower in the Asia-Pacific region has become the main driving force of global hydropower development.

(*Source:* HRC. Provided by Mr. Zhao Jianda) ■

The Average Development Rate of Renewable Energy in Central Asia is no more than 10%

Central Asia is the energy-rich region along the Belt and Road, is also China's the important strategic partners of the Belt and Road Initiative. The bigger rivers in Central Asia are the Amu River, the Sier River, the Yili River and the Tarim River. Most of them originate from the high mountains in Central Asia, with the melting snow and rainfall as the main sources of water. They are mostly inland rivers and hydropower resources relatively rich. Central Asian countries are abundant in oil and natural gas reserves, with rapid socio-economic development, infrastructure construction better. The national household electricity rates reached or close to 100%. But the Central Asian countries did not paid much attention to the development of small hydropower and other renewable energy, the average development rate less than 10%. Therefore, as a significant advantage of renewable energy, development prospect bright.

Many countries in Central and Eastern Europe attach great importance to the development of hydropower. Turkey, Poland, Romania, Serbia, Macedonia, Bosnia and Herzegovina, Bulgaria and other countries have dispatched participants to China to participate in various levels and channels of clean renewable energy international economic and technical cooperation training courses, with a good basis for cooperation. In recent years, Turkey, Macedonia, Serbia, Bosnia and Herzegovina paid attention to the development and utilization of hydropower resources. Chinese companies participated in the design and construction of many local hydropower stations, trusted and praised by the owners. The new economic belt along the country across Asia and Europe are full of light, solar energy resources are also very rich.

(*Source:* HRC. Provided by Mr. Zhao Jianda) ■

Two units synchronized at 18.4 MW Maranon small hydro project in Peru

Two of the three turbine-generator units at the 18.4 MW Maranon small hydro project in Peru have been synchronized, according to grid administrator COES.

The facility, on the Maranon River in the Nueva Flores district of Huanuco department, cost US$85.6 million to build and was developed by Hidroelectrica Maranon. The plant is connected to the national grid via a 39 km long 60 kV transmission line, according to BNamericas. Average annual production of the facility is expected to be 419.1 GWh.

Work on the project began in August 2013. The estimated completion date for the facility is July 2018.

(From HRW)

Congo Republic's 19.9 MW Liouesso hydroelectric project inaugurated

The Congo Republic's 19.9 MW Liouesso hydroelectric plant has been officially commissioned, following a ceremony that took place in the African country on 29th May 2017.Located on the Sangha River near the northern town Liouesso, the facility Liouesso was constructed by the China Gezhouba Group at a cost of about US$110 million.

The project is intended to both increase and diversify Congo's power supply, which has risen steadily from a cumulative 90 MW in 2000 to 214 MW with Liousseo's completion, according to government data.

(From HRW)

Upgrades to New York's 12 MW Crescent, 12 MW Vischer Ferry small hydro facilities completed

Work to improve the 12 MW Crescent and 12 MW Vischer Ferry small hydro facilities on the Mohawk River in New York has been completed, at a total cost of $26 million.

The work also included equipment upgrades to the 5 MW Ashokan plant.

These facilities are owned by the New York Power Authority.

New York Governor Andrew M. Cuomo announced the completion of the work on April 13.

The state says in a press release: "These improvements help New York move further toward Governor Cuomo's Clean Energy Standard that requires that 50 percent of the state's electricity needs to be generated from renewable energy sources by 2030."

Four of the eight turbine-generators at the Crescent and Vischer Ferry facilities were updated through NYPA's $20 million Life Extension and Modernization Program. Under a related $6 million initiative, NYPA also completed upgrades to control equipment at all three facilities. These initiatives are part of NYPA's Five-year Strategic Plan to upgrade and maintain its assets so they deliver optimal outcomes for energy customers.

NYPA purchased the Crescent and Vischer Ferry plants from the New York State Department of Transportation in 1984 and added two turbine-generator units to each project in 1990. In 1993, NYPA overhauled the two original turbine-generators units at each facility, which dated back to 1925.

The recently completed upgrades involve the turbine-generator units added in 1990 and include refurbishing the major components and replacing three flow-regulating gates and two overhead cranes, which were nearly a century old.

NYPA is currently undertaking an engineering assessment for the overhaul of the four original turbine-generator units.

NYPA operates 16 generating facilities, and more than 70% of the electricity it produces is clean, renewable hydropower.

(From HRW)

Small hydro booming in Brazil as country nears energy surplus

A report from Brazil's Ministry of Mines and Energy shows the South American country is tracking toward an energy surplus for the first time in nearly eight decades as the nation's small hydro sector also continues to boom.

The current rise in Brazil's small hydro market can be traced in large part to 2015 legislation that streamlined much of the authorization process.

Since then, the government has approved close to 7.7 GW worth of small hydro proposals, according to data from Brazilian power regulator Agencia Nacional de Energia Eletrica (ANEEL), with investments totaling US$19 billion.

The Brazilian government said more than 200 MW of small hydro were added to the country's grids in 2016—adding to nearly 5 GW of cumulative small hydro capacity being generated by 440 plants.

Small hydro represents about 3% of Brazil's total generation mix, which, for the first time since 1941, is projected to post an energy surplus.

Hydropower will make up 12.4% of this mix, according to the Brazilian Ministry of Mines and Energy, though the bulk of the country's power still comes from renewables. Of the 82% of energy generated by renewable sources, nearly 70% is hydroelectric.

The government said the energy surplus is being created by an uptick in oil and gas production, coupled with a decrease in consumer demand for electricity.

(From Hydroworld)

Scientists release roadmap to guide 139 countries to 100% renewables, including hydro

A total of 139 countries worldwide could convert to 100% renewable energy—from wind, water and solar by 2050, according to scientists in the Atmosphere/Energy Program at Stanford University.

To achieve this, these scientists present roadmaps that would:

- Avoid 1.5 degrees Celsius global warming and millions of annual air pollution deaths
- Reduce social cost of energy and create 24.3 million net long term jobs
- Reduce power disruption and increase worldwide access to energy

In an article published online in Joule magazine, they say, "… Every country must have an energy roadmap based on widely available, reliable, zero emission energy technologies."

These roadmaps "are far more aggressive than what the Paris agreement calls for, but are still technically and economically feasible," they say. They are based on a solution of electrifying all energy sectors and providing all electricity with 100% wind, water and solar power.

The authors briefly address tidal and wave power, saying that "… we assume that two technologies not yet widely used, tidal and wave power, are installed in small amounts in a few countries."

Regarding the amount of generation needed, the authors do not propose building additional hydropower, instead saying the average capacity factors of hydropower plants are assumed to increase from their current world average values of about 42% to up 50%. "This assumption is justified by the fact that in many places, hydropower use is currently suppressed by the availability and use of gas and coal, which will be eliminated here. If current capacity factors are limited by low rainfall, it may also be possible to make up for the deficit with additional run-of-the-river hydro, pumped hydro, or non-hydro [wind, water and solar] energy sources."

The final mix in these countries would be 4% hydropower, 0.58% wave, 0.06% tidal, and the remainder from solar (57.55%), wind (37.14%) and geothermal (0.67%).

The authors also address "the additional energy-storage capacity needed for balancing time-dependent supply and demand during a year," but it is not clear how pumped hydro fits in the future mix.

(From Hydroworld)

Azerbaijan: A significant focus on small hydropower

In what is just the latest of a recent series of developments, Azerbaijan recently commissioned the 3MW Cicekli or Chichakli (which translates as Flower in English) small hydropower facility.

Owner Azerenerji JSC says Ilham Aliyev, President of Azerbaijan, attended the opening of the station, which is located in Asagi Zurnabad settlement of the Goygol district and was commissioned after a major overhaul.

This hydroelectric power station was built in 1927 but was completely destroyed by flooding in 1997. Current work involved major renovations and the installation of new equipment. Three turbines and generators were installed at the station, each with a capacity of 1 MW. In addition, substations were constructed at the station and transmission lines were built.

The station has a water basin capacity of 153,000 cubic meters. The derivation canal is 5 square meters in width and 3,800 meters long, leading to a pipe with a diameter of 1.6 meters and a length of 500 meters.

The plant "is of economic and social importance." It is capable of generating 20 million kWh of electricity annually.

"In accordance with the instruction of the President of the Republic of Azerbaijan to attract private investment in the economy, the station is currently privatized through an investment competition," Azerenerji said in a press release.

Azerenerji says that under the president's leadership, "Significant achievements in the field of electric power have been achieved in Azerbaijan." The company says that, to date, 14 hydropower stations have been commissioned and four plants with a total capacity of about 15 MW are being constructed.

In fact, in early August, President Aliyev participated in the opening ceremony of the 1.5MW Balakan hydropower plant. Azerenerji says the president laid the foundations of this station in 2010. On the Balakan River, this facility contains three turbine-generator units, each with a capacity of 500 kW.

And in mid-June, a ceremony was held to celebrate the full filling of the Takhtakorpu Reservoir with water. This reservoir feeds the 25MW Takhtakorpu hydropower plant, which meets all the electricity demand of the Shabran district.

Azerenerji is the state power engineering enterprise carrying out energy production and distribution. All of the shares in the company are owned by the state.

(From Hydroworld)

List of SHP Resources Development of Countries along the Belt and Road (Partly)

No.	Regions	Countries	Theoretical Potential of SHP (MW)	Installed Capacity of SHP (MW)	SHP Development Rate (%)
1	East Asia	Mongolia	53	28	53
2	Central Asia	Kazakhstan	2,707	78	3
3		Tajikistan	115	12.18	11
4		Turkmenistan	23	5	22
5		Uzbekistan	1,760	56.32	3
6		Kyrgyzstan	275	32	12
7	South Asia	Pakistan	2,265	281	12
8		Bangladesh	0.15	0.01	7
9		Afghanistan	1,200	75.14	6
10		Sri Lanka	400	194	49
11		India	15,000	3 198	21
12		Nepal	1,430	70.25	5
13		Bhutan	8.8	8.8	100
14	South-east Asia	Cambodia	300	1.9	1
15		Laos	50.2	10.5	21
16		Thailand	700	146	21
17		The Philippines	1,876	248	13
18		Vietnam	2 205	621.7	28
19		Malaysia	116.6	87.7	75
20		Indonesia	1,267	99.4	8
21		Myanmar	167.35	35.97	21
22	West Asia, North / East Africa	Turkey	6,500	175	3
23		Egypt	32	7	22
24		Ethiopia	1,500	6.16	0
25		Kenya	3,300	33	1
26	Central and Eastern Europe	Bulgaria	280	263	69
27		Romania	730	387	53
28		Serbia	409.3	49.6	12
29		Montenegro	240	9	4

(Data sources: UNIDO & ICSHP, World Bank and Country Reports provided by HRC's participants. Provided by Mr. Pan Daqing)

Implementation Plan on Cooperation of "Clean Energy and Rural Electrification" for Countries along the Belt and Road of HRC

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC)

(Simplified Version)

Background

Originating from China and belonging to the world, the Belt and Road Initiative (the abbreviation B & R) is the national top strategy, the short term of "Silk Road Economic Belt" and "21st Century Maritime Silk Road", and is China' general guidelines of opening to the outside world and foreign economic cooperation in the future. Fully relying on the existing bilateral and multilateral mechanism of China with the relevant countries, based on the existing and effective regional cooperation platform, the Belt and Road Initiative will take the historical symbol of ancient Silk Road, hold high the banner of peaceful development, actively develop economic cooperation and partnership with the countries along the Belt and Road, jointly create community of shared interests, community of destiny and community of the responsibility for political mutual trust, economic integration and cultural inclusiveness.

1 Foundation of HRC's existing cooperation with the countries along the Belt and Road

1.1 Actively carry out foreign aid training for related countries to strengthen capacity-building services

Since the establishment, HRC has been actively conducting international training and conducting extensive technical seminars. So far, 95 training workshops/seminars have been successfully held, with a total of 2000 participants from 113 countries, benefiting a large number of countries along the Belt and Road, including such countries in Central Asia, South Asia and Eastern Europe as Uzbekistan, Kyrgyzstan, Tajikistan, Pakistan, Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia, Indonesia, the Philippines, India, Bangladesh, Turkey, Poland, Romania, Bulgaria, Serbia, Montenegro, Macedonia, and African countries like Egypt, Ethiopia, Kenya. In recent years, HRC has been expanding the scale of training, continue to expand the breadth and depth of the training, training language from single language development to multi-languages, the venue has been extended from China to foreign countries or a combination, the cooperation mode from multilateral to multi-bilateral. The training covers topics such as water resources planning management, hydropower development, solar energy development, wind energy development, hybrid energies and rural electrification. Several training workshops/seminars have been held for a number of ASEAN countries on small hydropower and other clean renewable energies and rural electrification and achieved good results.

1.2 Extensively conduct intergovernmental scientific and technological cooperation to promote multi-bilateral technical exchanges

Over the years, with the technical advantages and industry influence and in the framework of government cooperation, HRC has actively carried out multi-bilateral technical cooperation on small hydropower and other renewable energies. Through joint research, project demonstration and technology transfer and promotion, remarkable achievements have been scored in the small hydropower and other renewable energy development and rural electrification construction. HRC has also become the base of international scientific and technological cooperation for renewable energy and rural electrification of Zhejiang province.

In cooperation with the Renewable Energy Technology Agency of Pakistan HRC has completed the *"China-Pakistan Joint Research Center for Small Hydropower"* as entrusted by Chinese Ministry of Science & Technology for assistance to developing countries. The project received strong support from the government departments of the two countries. On April 20, 2015, General Secretary Xi Jinping unveiled with Pakistani Prime Minister Nawaz Sharif the plate for the *"China-Pakistan Joint Research Center for Small Hydropower Technology"* and other seven Sino-Pakistani cooperation projects during a state visit to Pakistan. *"China-Pakistan Joint Research Center for Small Hydropower"* has become a research and development and capacity-building base for renewable energy technology research between China and Pakistan.

HRC has long been friendly and trustworthy with the Vietnam Academy of Water Sciences, the two sides have applied successfully and implemented to the two government departments for medium and long-term international scientific and technological cooperation and exchange projects. In 2011, the two sides jointly applied for long-term intergovernmental scientific and technological cooperation project from Ministry of Science and Technology between China and Vietnam - *"Emergency-supporting Technology for Rural Hydropower against Disasters Caused by Climate Change"*. At present, HRC has completed the installation of a container-type micro hydropower unit which is taken as the power supply of black-start. The on-site commissioning is being undertaken, and the technical researches have been launched jointly on SHP black-start and emergency-supporting technology for rural hydropower against disasters.

HRC has applied for the implementation of *"clean energy based rural electrification technology and model sharing"* project funded by China-APEC Cooperative Fund. In the field of the rural electrification based on clean energy, HRC is conducting exchange and cooperation with Vietnam and Indonesia by providing human resources training, sharing advanced technology and successful experience on rural electrification and promoting trilateral cooperation.

Some of the African countries along the Belt and Road are rich in water resources, small hydropower theoretical reserves huge, but the development rate very low and coverage rate generally not high, and enjoying good development prospects. For example, the theoretical reserves of small hydropower resources in Ethiopia and Kenya are 1500 MW and 3300 MW, respectively, and the installed capacity only 6.16 MW and 33 MW respectively, and the electrification rate less than 30%. Over the years, through the exchange and communication with African participants, HRC is fully aware of the urgent needs of the electric power for the vast number of African countries, the desire on developing small hydropower and other renewable energy, realizing significance and the construction of rural electrification could play in poverty alleviation and settling the issue of *"Agriculture, farmers and rural areas"*. In March 2014, HRC sent experts to Ethiopia and Kenya to carry out technical cooperation on renewable energy development. In Ethiopia, the group visited the Coordinator at Vice Prime Ministerial Coordinator, Minister of Communications and Information Technology, the Minister of Water Irrigation and Energy, the Minister of Science and Technology and the President of the State Power Corp. The two sides discussed on the cooperation of planning compilation for renewable energy, technology transfer and personnel training. At the same time, the delegation also signed a MOU on Planning

of Comprehensive Developing Water Resources in a Typical River Basin and a Regional Grid with the Ethiopian Energy Development Authority and explored with the Energy Commissioner of African Union on the establishment of African training center on renewable energy. In Kenya, the delegation met with the Deputy Minister of Energy and Petroleum and understood the development of renewable energy in Kenya, such as hydropower, photovoltaic and wind energy, and reached a cooperation agreement on capacity building and joint research, demonstration and technology transfer for hybrid system integrating SHP, wind power and solar power. The above follow-up cooperation is continuing to promote.

1.3 Actively explore the international market, promote project contracting

In recent years, HRC has actively pursued the "going global" strategy and continued to expand small hydropower technology and equipment export business in Pakistan, Nepal, Vietnam, Indonesia, Malaysia, the Philippines, Turkey, Macedonia, Serbia, Albania, Kenya and other countries. At present, HRC has successfully exported containerized hydropower technology and equipment to Vietnam, Macedonia; provided planning of hydropower resources for Serbia and other countries to; smoothly implemented small hydropower technical services, exporting and installation of complete electro-mechanic equipment sets for over 50 countries like Mongolia, Pakistan, Nepal, Sri Lanka, Laos, Myanmar. So far, HRC succeeded in the implementation of over 100 small hydropower projects for electromechanical equipment exports and consulting, design services to promote project contracting and create a good economic and social benefit, stimulating the export of small hydropower technology and equipment in China, especially in Zhejiang province. At the same time, the energy development and rural electrification construction has been effectively promoted in the related countries, really benefitting the local governments and people.

2 The main contents and ideas of the cooperation on energy and rural electrification for countries along the Belt and Road

2.1Conduct technical education (training) and research to promote capacity building

2.1.1 Expand the channels to increase the scale of education (training)

(1) As one of the first foreign aid training institutions in China, HRC will continue to strengthen contact with the Ministry of Water Resources, the Ministry of Commerce and the relevant departments of the Ministry of Science and Technology, and carefully organize the Training tasks of Ministry of Commerce, Ministry of Science and Technology. At the same time, HRC will do a good job in platform construction work, establish domestic and international high-skilled personnel training demonstration base; actively apply to the Ministry of Commerce as *"China's base of foreign aid training in small hydropower and rural electrification."*

(2) Make full use of the Chinese government and international funds, organize regional training and research projects for countries along the Belt and Road. For instance, conduct small hydropower and rural electrification technical training for southeast Asian countries funded by the *"China-ASEAN Cooperation Fund"*; conduct training on clean energy technology for Asian countries under the *"Asian regional cooperation special fund"*; conduct training of small hydropower, hydro energy resources development planning for Southeast Asian and South Asian countries under Perez-Guerrero Trust Fund (PGTF) in the United Nations Development Program and so on.

(3) Strengthen cooperation with Power Construction Corporation of China Group, China Energy Construction Group, the Three Gorges Group and other large state-owned enterprises, conduct special training for its overseas hydropower station operation and maintenance and management. Such as the training hydropower operation and management for participants from Sri Lanka, and the training on operation and maintenance for two hydropower projects of Uganda in collaboration with SINO HYDRO and China International Water & Electric Corporation.

2.1.2 Broaden the technical scope according to the demand of countries along the Belt and Road

(1) Conduct training on hybrid renewable energy generation technology for Southeast Asian countries, and regularly hold training courses on renewable energies like small hydropower, solar energy, wind energy and etc. Southeast Asian countries full of islands, very rich in hydropower, solar, wind and other renewable energy resources, there is a wide range of market demand and development potential in the ASEAN countries to have comprehensive development of energy resources in these areas

(2) For South Asian countries, to carry out training workshops on "water resources management", "water resources development planning", "agricultural irrigation", "small hydropower standard system" and other technical seminars. South Asian countries are crossed with several large rivers, rich in water resources, but small hydropower development technology is weak. Pakistan, Nepal, Sri Lanka and other South Asian countries focus on integrated water resources management, water resources development planning, hydropower standard system and other aspects of capacity building.

(3) For Western Asian and Eastern European countries, carry out technology promotion on "hydropower station operation and maintenance", "hydropower station technology and equipment", "automation control" and etc. The economy in that region develops rapidly, infrastructure conditions ripe, and many hydropower stations built. There is big training demand of proven technology and equipment in the power plant operation and maintenance, the refurbishment of the old power plants, automation monitoring, the containerized equipment and etc.

(4) For the East African countries, conduct training workshops on "small hydropower", "rural electrification" and other topics. East African countries are rich in water resources, most of which have not yet been effectively developed, with low coverage rates and there is a serious shortage of electricity in rural areas. The transfer of knowledge and skills of "small hydropower and rural electrification" is very much in line with the needs of East African countries, which will benefit the farmers, agriculture and the rural areas, protect the ecological environment, further improve the level of its electrification and promote the sustainable development of economy and society.

(5) In Egypt and other North African countries, conduct training workshops on "photovoltaic irrigation", "small hydropower and photovoltaic power generation technology" and other topics. Based on the good solar energy resources in North Africa, we will take Egypt as a breakthrough and cooperate with the Ministry of Water Resources and Irrigation to carry out the project of water lifting for irrigation using PV, provide technical training and demonstration equipment for photovoltaic technology, and further develop small hydropower / solar power generation technology research and project demonstration.

(6) Under the support of the Ministry of Water Resources, strengthen the cooperation with the Exchange Center of Ministry of Water Resources, the Yangtze River Water Resources Commission, the Ministry of Water Resources Irrigation and Drainage Center, Dam Center of the Ministry of Water Resources and other research institutes to undertake training of the industry on "flood control and disaster mitigation", "dam construction", "water-saving and irrigation", "Climate change "and other related topics.

2.1.3 Conduct "going global" training to set up overseas education (training) center

Establish university (or organization) network for education (training) or the countries along the *"Belt and Road"*, innovate education (training) mode, and promote educational activities for countries along the *"Belt and Road"*. Based on virtual technology, cloud technology and the Internet + and other advanced means, collaborate with domestic and foreign universities and educational institutions to build jointly overseas education (training) center; cultivate talents by carrying out technical training, academic education and skills training for developing countries. Meanwhile, lay the foundation for the network establishment of project contracting.

(1) In cooperation with domestic university, implement degree education, technical education and technical training for countries along the *"Belt and Road"* and build jointly overseas education (training)

center. Combined with the advantages of HRC's think tank, professionals and international platform, promote education and training system for rural hydropower development, based on virtual reality and the Internet +. Focusing cooperation with ASEAN and the AU on the establishment of overseas education (training) centers in Indonesia and Ethiopia in cooperation.

(2) With the implementation of Mongolian hydropower project of HRC, we will carry out "training workshop on hydropower operation and maintenance technology". Mongolian is rich in hydropower resources, the development rate not high, there is urgent training need in hydropower operation and maintenance technology for the country's water and energy sector. Many times they hoped to send HRC's experts to provide technical training and we have also applied to the Dept of Aid to Foreign Countries, Ministry of Commerce for conducting "going global" training in Mongolia.

(3) For government officials of South Asia, conduct "Seminar on developing planning of hydro energy Resources for South Asia". The project has been funded under Perez-Guerrero Trust Fund (PGTF) in the United Nations Development Program (UNDP) and has received a positive response from the Nepal Electricity Agency.

（4）In cooperation with Rwanda Energy Group and Rwanda Ngali Energy Development Consulting Company, organize the "Training Course on SHP Technology in Rwanda" and invite Rwanda Ngali Energy Development Consulting Company, conduct foreign aid training of design, operation, maintenance, management and refurbishing the small hydropower stations as the focus, and gradually form a long-term fixed bilateral training mechanism to enlarge the training effect.

2.2 Strengthen multi-bilateral exchanges and cooperation, based on the existing platform

2.2.1 Meet HRC's old participants and deepen the basis of cooperation

Make full use of the large number of foreign aid training participants widely distributed and many with high-level titles, reinforce the tracking mechanism of the old participants, carry out regular directional return visit. To South Asian Pakistan, Southeast Asian Indonesia, Central Asian Kyrgyzstan, West Asian Georgia, North African Egypt and other key areas of key countries, HRC will organize visits annually to the old participants, visit the national water conservancy, energy sector and tap the potential for cooperation.

2.2.2 Promote multi / bilateral cooperation, the construction of regional cooperation center

Through the multi-bilateral technology research and exchange, and constantly publicize and promote China's mature technology of SHP-based rural hydropower and the appropriate equipment to explore the cooperation modes to meet the local actual needs of the countries. Such as joint research and project demonstration with key countries, technology transfer, joint experiment and fabrication to promote all-round cooperation of technology and project contracting. Including: to further expand the region's influence *"China-Pakistan Joint Research Center for Small Hydropower"* in the South Asian, consolidate the results of cooperation; in cooperation with the ASEAN organization, set up *"China-ASEAN Technology Transfer Center for Renewable Energy"* in Indonesia to promote the implementation of *"Assessment of island energy resources and research on development modes for ASEAN Countries"*, to carry out the development cooperation on ASEAN island energy resources; make use of demonstration effect of containerized hydropower plants in Macedonia to set up *"China-West Asia/Eastern Europe Experiment & Manufacturing Base for SHP Equipment"*; in Uganda set up *"Renewable Energy Technology Research and Training Center in East Africa"*; and in Kyrgyzstan, jointly launch the "technology research and development and demonstration on SHP-Solar Hybrid Power Generation"; in cooperation with the Egyptian Ministry of Water Resources and Irrigation to carry out "Technology and Equipment R+D and Demonstration for Water-lifting Irrigation with Solar Photovoltaic."

2.2.3 Attach importance to platform construction, create a national-level international scientific and technological cooperation base

Relying on "International scientific and technological cooperation base on renewable energy and rural

electrification of Zhejiang province" platform, extensively conduct scientific and technological research and development, focus on results transfer. Adopt the "importing and going global" approach, vigorously carry out the introduction and promotion of advanced technology and equipment; strengthen contact and technical exchanges with government departments, in water conservancy, hydropower, marine energy, environmental and other sectors of countries along the "Belt and Road", advocate the "Green" and "ecological" development concept; strengthen ties with the World Bank, ADB and other international financial organizations, carry out high-level academic exchanges and promote international cooperation in project contracting.

2.3 Follow the "Belt and Road" initiative to promote "going global" for energy and rural electrification

2.3.1 Actively promote planning and standards "going global"

(1) According to the demand of water resources development and priority development areas in Pakistan, Laos, Nepal, Tanzania and other countries, HRC will apply for a small amount of funds from the Chinese government to assist these countries in compiling regional power planning and water resources development planning of key rivers for to laying the foundation of the Engineering design of hydropower stations and exports of complete equipment sets. At the same time, pay attention to ecological and environmental protection and promote the sustainable, green and healthy development of hydropower development.

(2) Promote the existing small hydropower standards in English, such as *"Technical specifications in construction of small hydropower station"*, *"Guidelines of SHP electrical and mechanical equipment"*, *"Acceptance norms of construction for small hydropower stations"*. Organize to translate more standards related to hydropower design, consultation and construction (Including contracts and tender documents of water conservancy and hydropower construction), as well as small hydropower equipment manufacturing standards, do a good job of international standards so as to promote the work. In cooperation with energy ministries in Nepal and Kenya to jointly establish the framework system for small hydropower standards, to promote its promulgation, such as *"Technical specifications in construction of small hydropower station"*, *"Guidelines of SHP electrical and mechanical equipment" "Acceptance norms of construction for small hydropower stations"* and other applicable standards.

2.3.2 Actively promote engineering consulting, design and equipment "going global"

HRC has cooperated extensively with the countries along the *"Belt and Road"* in engineering consulting, design and supply of complete equipment sets and has a good mutual

trust and market base. HRC will provide further service for engineering planning, design and consultation of hydropower development and etc in areas rich in hydropower potential in the Southeast Asia, South Asia and Africa. At the same time, with the help of financing platform, vigorously explore the hydropower market in Laos, Myanmar, Indonesia and other ASEAN countries, Serbia, Romania, Bosnia and Herzegovina and other Eastern European countries, as well as those African countries where there is a serious shortage of electricity. In collaboration with domestic international engineering contracting companies, hydropower equipment manufacturers and construction enterprises, implement general contracting projects and provide project financing service with banks (including the Asian Infrastructure Investment Bank, China Export-Import Bank, Bank of China) and other financial institutions and credit protection companies.

(*Source:* HRC) ■

Endeavoring with Faith on a Long Journey Ahead, A Promising Future Will Come on the Belt and Road

—An Overview on HRC's Engagement in South-South Cooperation to the Belt and Road Initiative

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC)

ZHAO Jianda, LIN Ning, WANG Xujun, ZHANG Tian, SHI Jin

Abstract: *From South–South Cooperation to the Belt and Road Initiative, HRC has made great achievements in international cooperation in small hydropower with developing countries. HRC has hosted with success 95 training workshops, seminars, ministerial-level seminars on small hydropower, rural electrification, water resources, renewable energy, climate changes etc. for over 2000 technicians and officials from 113 countries, including countries along the Belt and Road. HRC's foreign-aid trainings have successfully been upgraded in training venues from home to overseas, in training forms from multi-lateral to bilateral, in training languages from English to English, French, Russian, etc. in level of training from workshop to seminar to ministerial level, in contents of training from small hydropower technology to water conservancy, renewable energy, etc. In response to the Belt and Road Initiative, cooperation from joint research, technology transfer to pilot projects has been carried out for shared development. HRC has successfully offered services including supply of electromechanical equipment, installation services, consultation and design for over 100 projects in 50 countries, which fuels and effectively facilitates the development of clean energy, rural electrification and production capacity cooperation in*

small hydropower, benefiting both the local government and its people. Following the guidelines of Belt and Road Technical Innovation Action Program, HRC is progressively planning and implementing a new strategic layout and action strategy for the international small hydropower exchange. HRC is going to undertake to substantialize the function of the four overseas centers and scale up them step by step under support of the Chinese government and international organizations.

Preface: *Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (National Research Institute for Rural Electrification, briefed as HRC), as the only specialized research institute of promoting and providing technical services for the development of rural hydropower and electrification in China, was founded in 1981 with the co-sponsorship of Chinese government and UN organizations including UNDP and UNIDO. It serves as an important window for international cooperation with other countries in small hydropower field.*

Foreign Aid Training with a Long History and Remarkable Success

As time passes by, it has been nearly 40 years since HRC got involved in South–South Cooperation in the field of small hydropower. The accumulation of international resources and talents has laid a great foundation for international exchange and cooperation. Backed with and China's governmental foreign-aid policy and capital, HRC has long been in international scientific and technologic cooperation with the other developing countries in renewable energy and rural electrification, offering technical and consultancy services in small hydropower to developing countries based on its professional advantages. The foreign aid training programs have helped capability building for countries along the Belt and Road. From *South-South Cooperation* to *the Belt and Road Initiative*, HRC has made great achievements in international cooperation in small hydropower with developing countries.

In the past nearly 40 years, entrusted by Chinese Ministry of Commerce, Ministry of Foreign Affairs, Ministry of Water Resources, Ministry of Science and Technology, NDRC, UNDP, UNIDO, FAO, ILO, the ASEAN Secretariat, etc., HRC has hosted with success 95 training workshops, seminars, ministerial-level seminars on small hydropower, rural electrification, water resources, renewable energy, climate changes etc. for over 2000 technicians and officials from 113 countries, including countries along the Belt and Road in Central Asia, South Asia, Eastern Europe including Uzbekistan, Kyrgyzstan, Tajikistan, Pakistan, Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia, Indonesia, the Philippines, India, Bangladesh, Turkey, Poland, Romania, Bulgaria, Serbia, Montenegro, Macedonia as well as countries in Africa including Egypt, Ethiopia, Kenya, etc. The contents of training workshops mainly cover small hydropower planning, design, feasibility study, hydrology, geology, water conservancy, electromechanical equipment, automation, economic appraisal, environment evaluation, operation and maintenance of power plants, investment and financing of small hydropower, micro hydro and containerized hydropower plant, etc. as well as hybrid energy system, green ecological hydropower, water resources management, flood control and disaster mitigation, dam construction and management, water-saving irrigation, greenhouse gas,

Figure 1. Distribution of training participants

energy transformation and climate change, etc. Distribution of training participants refers to *Fig. 1*.

In recent years, HRC has not only conducted many training programs entrusted by Chinese Ministry of Commerce, Ministry of Science and Technology, Ministry of Foreign Affairs and NDRC, but it has also applied for China-ASEAN Cooperation Fund, APEC Fund and UNDP Perez-Guerrero Trust Fund for many multi/bilateral training workshops or seminars. Meanwhile, HRC offers trainings of operation, maintenance and management as well as technical support for Chinese enterprises running business in overseas market. HRC's foreign-aid trainings have successfully been upgraded in training venues from home to overseas, in training forms from multi-lateral to bilateral, in training languages from English to English, French, Russian, etc. in level of training from workshop to seminar to ministerial level, in contents of training from small hydropower technology to water conservancy, renewable energy, etc. Besides, HRC has innovated the mode of education/training by means of virtual technology, cloud technology and internet plus to enhance the width and depth of capacity building for developing countries. Moreover, the scale of education/training has been expanded gradually. In collaboration with ASEAN and African Union, HRC plans to set up training centers in Indonesia and Ethiopia, and a research and training center on renewable energy technology in Uganda.

|| Fruitful Achievements in Production Capacity Cooperation in Small Hydropower

In response to the Belt and Road Initiative, and based on the international resources accumulated from the international training and cooperation in the past years, HRC has offered services including supply of electromechanical equipment, installation services, consultation and design for over 100 projects in 50 countries. In addition, it has designed power plants for clients from Vietnam, Indonesia, and Mongolia, provided electromechanical equipment and installation services for partners in Pakistan, Turkey, Peru and other countries, and conducted preliminary planning of hydropower resources for companies from Serbia, Laos, etc. Those projects have promoted industrial cooperation, created great social and economic benefits, and pushed the export of small hydropower technology and equipment especially in Zhejiang province. Meanwhile, it effectively facilitates the development of clean energy, rural electrification and production capacity cooperation in small hydropower, benefiting both the local government and its people. Refer to *Table1*.

||| Building a Bright Future on The Belt and Road

1 Joint Research for Mutual Benefit and Win-Win Cooperation

Under the framework of governmental cooperation, HRC has taken advantage of its technical strength and industrial influence to implement multi/bilateral technical cooperation in the field of small hydropower and other renewable energy. HRC has successively carried out technical exchange and international cooperation with America, Canada, Australia, Italy, Pakistan, Nepal, Vietnam, Indonesia, Malaysia, Laos, Serbia, Macedonia, Turkey, Ethiopia, Rwanda, Uganda, Kenya, South Africa, etc. in the field of small hydropower technology, hybrid power generation system and off-grid solar power generation technology. Besides, many provincial and state level projects have also been accomplished including China-Pakistan Joint Research Center for Small Hydropower, Water Flow Type Generator Technology, Distributed Power Supply and Equipment of Hydro-based Hybrid System and Research & Sharing on Rural Electrification Mode Based on Clean Energy.

Over the past years, HRC has made remarkable achievements in the development of renewable energy including small hydropower and the construction of rural electrification through joint research, pilot projects construction, technology transfer and popularization, Cooperation goes well with water conservancy and hydropower research institutes and universities in Laos, Mongolia, Egypt, Macedonia and other countries for joint research and pilot projects in fields of off-grid renewable energy, low-head hydropower generation technology, oasis region water resources development and management, containerized small hydropower station technology, and

Table 1. HRC Overseas Small Hydropower Projects (incomplete statistics)

S.N	Project	Installed Capacity	Service Scope	Completion
1	Kota Hydropower Station in Malaysia	2×2000kW	Hydro Equipment Supply&Design	1997
2	Moco-Moco Hydropower Station in Guyana	2×250kW	Hydro Equipment Supply&Design	1999
3	Corojo Hydropower Station in Cuba	2×1000kW	Hydro Equipment Supply&Design	1997
4	Moa Hydropower Station in Cuba	2×1000kW	Hydro Equipment Supply&Design	1997
5	Micro Hydropower Station in Vietnam	3000 + sets	Hydro Equipment Supply&Design	1999
6	Micro Hydropower Station in India	1×60kW	Hydro Equipment Supply&Design	2000
7	Tea-plantation Power Plant in Sri Lanka	1×200kW	Hydro Equipment Supply	2005
8	Dao and Pei MHPs in Philippines	1×40kW+1×30kW	Micro Hydro Equipment Supply	2006
9	Basaran Hydropower Station in Turkey	2×300kW	Automatic control system	2006
10	Gera-II Hydropower Station in Peru	1×1950kW	Hydro Equipment Supply	2005
11	Tashir Hydropower Station in Mongolia	3×3450+1×650kW	Hydro Equipment Supply&Design	2006
12	Wanique Hydropower Station in Fiji	2×400kW	Hydro Equipment Supply	2007
13	Sandia Hydropower Station in Peru	1×1200kW	Hydro Equipment Supply	2007
14	Yalnizca Hydropower Station in Turkey	3×5000kW	Hydro Equipment Supply	2007
15	Pinar Hydropower Station in Turkey	3×10000kW	Hydro Equipment Supply	2007
16	Keklicek hydropower station in Turkey	2×4500kW	Equipment Supply	2007
17	Akcay Hydropower Station in Turkey	2×11500kW+1×5500kW	Hydro Equipment Supply	2007
18	Khe Dien Hydropower Station in Vietnam	2×4500kW	Automatic control system	2008
19	Garzan-I Hydropower Station in Turkey	2×21000kW	Hydro Equipment Supply	2008
20	Kizkale hydropower station in Turkey	1×250kW	Equipment Supply	2008
21	OTLUCA-1 hydropower station in Turkey	3×12.296MW	Equipment Supply	2008

(continued)

S.N	Project	Installed Capacity	Service Scope	Completion
22	OTLUCA-2 hydropower station in Turkey	3×1936kW	Equipment Supply	2008
23	BOĞUNTU hydropower station in Turkey	3×1107kW	Equipment Supply	2008
24	SARACBENDI hydropower station in Turkey	4×5918kW	Equipment Supply	2008
25	YUVARLAKÇAY hydropower station in Turkey	2×1655kW	Equipment Supply	2008
26	AMLICA-III hydropower station in Turkey	3×9052kW	Equipment Supply	2008
27	Kartalkaya Hydropower Station in Turkey	3×2700kW	Hydro Equipment Supply	2009
28	MuratI Hydropower Station in Turkey	3×8410kW	Hydro Equipment Supply	2009
29	Murat II Hydropower Station in Turkey	3×3416kW	Hydro Equipment Supply	2009
30	Kale Hydropower Station in Turkey	3×11700kW	Hydro Equipment Supply	2009
31	Osmancik Hydropower Station in Turkey	2×4850kW	Hydro Equipment Supply	2010
32	Chichekli Hydropower Station in Azerbaijan	3×1000kW	SDJK-2000	2010
33	Hillan Hydropower Staion in Pakistan	2×320kW	DZWX-2000	2010
34	Rangar-I Hydropower Staion in Pakistan	2×320kW	DZWX-2000	2010
35	Halmat Hydropower Staion in Pakistan	2×160kW	DZWX-2000	2010
36	Getik Hydropower Station in Armenia	2×2000kW+1×1600kW	SDJK-2000	2010
37	Vietnam Thai An Hydropower Station	2×50MW	Hydroelectric Design	2010
38	Sena Hydropower Station in Turkey	2×10800kW	Hydro Equipment Supply	2011
39	Turija Mini-Hydro Station in Macedonia	1×160kW	Containerized Micro Hydro Units	2011
40	Gikira Hydropower Station in Kenya	2×200kW	Hydro Equipment Supply	2011
41	Ozluce Hydropower Station in Turkey	2×18900kW	Hydro Equipment Supply	2011
42	Vietnam Thai An 220kV substation	Rated capacity of transformer: 160/160/50 MVA, transformation ratio: 225±8×1.25%/115/10.5kV	Hydroelectric Design	2011

(continued)

S.N	Project	Installed Capacity	Service Scope	Completion
43	Muong Hum Hydropower Station	2×16MW	Hydroelectric Design	2011
44	Kemercayir Hydropower Station in Turkey	2×6435kW+1×3015kW	SDJK-2000	2012
45	Uchanlar Hydropower Station in Turkey	2×4950kW+1×2250kW	SDJK-2000	2012
46	Ucharmanlar Hydropower Station in Turkey	2×7380kW+1×2430kW	SDJK-2000	2012
47	Binek Hydropower Station in Turkey	2×2800kW	SDJK-2000	2012
48	Gangelas Hydropower Station in Angola	1×1004kW+1×250kW	Hydro Equipment Supply	2013
49	Toplec Hydropower Station in Macedonia	1×200kW	Containerized Micro Hydro Units	2013
50	Suoi Tan Hydropower Station in Vietnam	1×100kW	Containerized Micro Hydro Units	2013
51	PA Hydropower Station in Cuba	1×20kW	SDJK-2000	2013
52	GUIN Hydropower Station in Pakistan	2×125kW	Hydro Equipment Supply	2013
53	RANGAR-II Hydropower Station in Pakistan	2×225kW	Hydro Equipment Supply	2013
54	IKILER Hydropower Station in Turkey	2×3050kW	Hydro Equipment Supply	2013
55	GARZAN-I EK Hydropower Station in Turkey	1×3240kW	Hydro Equipment Supply	2013
56	SIRVAN Hydropower Station in Turkey	2×15MW	Hydro Equipment Supply	2013
57	MAYARI-R Hydropower Station in Cuba	2×1250kW+1×400kW +1×50kW	Hydro Equipment Supply & SDJK-2000、DZWX-2000	2014
58	MAYARI-L Hydropower Station in Cuba	1×1150kW	Hydro Equipment Supply & SDJK-2000	2014
59	Tara khola Hydropower Station in Nepal	2×190 kW	Hydro Equipment Supply	2015-
60	Ragati Hydropower Station in Kenya	3×3200 kW	R&D Design	2015
61	PAKKAT Hydropower Station in Indonesia	2×6.3MW	Hydroelectric Design	2015
62	Nam Ming Hydropower Station in Laos	2×6300 kW	Feasibility study design & EPC Intent Agreement	2016-
63	Butao HEPP in Philippines	2×800 kW	Hydro Equipment Supply	2017-

was awarded International Sci-tech Base of Renewable Energy and Rural Electrification of Zhejiang Province. Furthermore, HRC has established a center abroad of hybrid energy power generation, and the equipment and technology of hydro, wind and solar complimentary system has already been widely applied abroad.

HRC has applied and conducted *"Research & Sharing on Rural Electrification Mode Based on Clean Energy"* funded by China-APEC Cooperation Fund, and carried out exchange and cooperation with Vietnam and Indonesia in clean energy-based rural electrification and offered personnel training for the two countries, sharing advanced technology and successful experience in China's rural electrification. The three parties have also formulated a cooperative plan.

HRC has maintained a friendly and trustful relationship with Institute for Hydro Power and Renewable Energy (HIR), Vietnam. Both sides have for many times applied successfully to their own governments for international sci-tech cooperation projects. In 2011, both sides successfully applied to Ministry of Science and Technology of both countries for the long-term intergovernmental exchange project, Emergency-supporting Technology for Rural Hydropower against Disasters Caused by Climate Change. Both sides have worked together to do research on "black start" of small hydropower and emergency safeguard technology of rural hydropower against disasters.

2 Four Centers, An Overseas Layout

With support and guidance of Ministry of Water Resources, Ministry of Commerce, Ministry of Foreign Affairs, Ministry of Science and Technology and embassies and consulates, HRC has cooperated with partners from Pakistan, Indonesia Ethiopia and Serbia in joint research and technology transfer in an aim to construct four overseas centers, i.e. *China-Pakistan Joint Research Center for Small Hydropower and Rural Electrification, China-Indonesia Joint Research Center for Hydro-based Rural Electrification Technology, China-Africa Technology Transfer, Research & Training Center on Clean Energies & Rural Electrification and China-Serbia Joint Research And Training Center On Renewable Energy Technology.* HRC are working to turn *China-Pakistan Joint Research Center for Small Hydropower to SHP R+D & Pilot Base for South Asia*. Following *China-Africa Technology Transfer, Research & Training Center on Clean Energies & Rural Electrification, China-ASEAN technology Transfer Center on Renewable Energy* centered in Indonesia will be initiated. Additionally, *China-West-Asia, East-Europe-Caucasia SHP Technology & Equipment Development Base,* a Serbia centered institute, will be established.

(1) In cooperation with Pakistan Council of Renewable Energy Technologies (PCRET), HRC has completed the foreign-aid project of Chinese Ministry of Science and Technology, *China-Pakistan Joint Research Center for Small Hydropower,* which received vigorous support from both governments. On April 20, 2015, Chinese President Mr. Xi Jinping together with Pakistani Prime Minister Mr. Nawaz Sharif unveiled the nameplate for the center and other 7 projects cooperated by both countries during his state visit to Pakistan *(Fig. 2)*.

Fig. 2 Chinese President Xi Jinping unveiled together with Pakistani Prime Minister *China-Pakistan Joint Research Center for Small Hydropower* and the other 7 cooperative projects

Fig. 3 Plaque with the China-Pakistan Joint Research Center for Small Hydropower

On July 8, 2017, the 18th Session of the Pak-China Joint Committee on Science and Technology Cooperation was held in Islamabad. China's Minister of Science and Technology Wan Gang investigated operation of China-Pakistan Joint Research Center for Small Hydropower during his visit to Pakistan Council of Renewable Energy Technologies, and discussed follow-up in-depth cooperation in photovoltaic, hydropower, wind power and so on. Today, with the strong support of the Ministry of Science and Technology, HRC is actively committed to the Special Project of Strategic International Cooperation in Scientific and

Technological Innovation under National Key R&D Program - China-Pakistan Joint Research Center for Small Hydropower and Rural Electrification. It aims to level up and extend research scale and scope from the existing China-Pakistan National Joint Research Center for Small Hydropower Technology and build a pilot base; Innovative capability will be enhanced for Pakistan in renewable energy and rural electrification through cooperation and exchanges. Simultaneously, small hydropower and rural electrification technology and experience in china can be applied and disseminated in South Asian countries to create technology innovation exchange mechanism for small hydropower and rural electrification in South Asia with shared development and mutual benefit to promote international production capacity cooperation in clean energy and rural electrification. The project has been officially launched.

(2) On May 12, 2017, the second technology transfer and training center-Africa Technology Transfer, Research and Training Center for Clean Energy and Rural Electrification was inaugurated in Addis Ababa University of Science and Technology, Ethiopia. The Center is open to African countries, undertakes capacity building, joint research, technology transfer, pilot projects in clean energy and rural electrification and implements China-Africa cooperative programs including agricultural modernization, infrastructure, green development and poverty reduction, promoting China-Africa common development and achieving win-win cooperation.

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

Presently, the work to each stage is unfolding in an orderly manner.

(3) In 2017, HRC undertakes Zhejiang Belt and Road scientific and technological innovation cooperation program—China-Indonesia Joint Research Center for Hydro-Based Rural Electrification Technology Hydropower. Together with Indonesian PLN and Ministry of Energy, HRC established the joint research center to carry out hybrid energy based rural electrification technology development and initial equipment production, conduct human resources training and establish pilot power plant, promoting China's hybrid (small hydropower, wind, solar) power technology and fully activating radiation effect of the research center to develop cooperation with other ASEAN countries, Laos, the Philippines, Malaysia, etc. On December 2017, a delegation of HRC went to Indonesia to promote HRC's cooperation with ASEAN and paid a visit to Dr. Sanjayan Velautham, Director of the ASEAN Energy Center, conducting an in-depth exchange of views, and an agreement on establishing a *"China-ASEAN Clean Energy and Rural Electrification Technology Transfer & Training Center"* and project cooperation reached. The delegation paid a visit to the Indonesian Electric Power Company to discuss the joint research and personnel training cooperation plan for the island's clean hybrid energy technology and signed a memorandum of understanding. In the meantime, the delegation also discussed with the Brawijaya University, Indonesia about the technology cooperation on hybrid energy for seawater desalination and discussed with PLN Corporate University, Indonesia on personnel training and education cooperation.

(4) On May 2017, HRC signed a memorandum of understanding with the University of Belgrade, Serbia to discuss the exchange of small hydropower and other renewable energy technology development and pilot projects, deciding to establish *China-Serbia Joint Research and*

Training Center for Small Hydropower Technology as common goal.

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

3 Disseminating Chinese Standards Globally

Moreover, HRC plays an active role in formulating (revising) national standards and industrial standards in small hydropower, disseminates existing Chinese small hydropower english standards in production capacity cooperation., and vigorously organizes more translation for standards in fields of hydropower planning, design, consulting, construction, and operation and maintenance standards (including water conservancy and hydropower project construction contract and tender documents), as well as small hydropower equipment manufacturing standards, etc.. It is participating in and promoting process of internationalization of Chinese water conservancy and hydropower standards.

Ⅳ Perspective

The boat will eventually dock albeit enduring tempestuous waves and furious wind sometimes. On the new starting point to a new journey in the new era, following the guidelines of *Belt and Road Technical Innovation Action Program* and with work philosophy and approach of capacity building-joint research-production capacity cooperation, HRC will be dedicated to human resources training and technical development services for countries along *the Belt and Road* in water resources, small hydropower, clean energy and climate change, working together with our partners for joint technology research and pilot projects to promote technology transfer and equipment manufacturing localization, promoting internationalization of Chinese standards and international cooperation in production capacity.

HRC undertakes to substantialize the function of the four overseas centers and scale up them step by step under support of the Chinese government and international organizations. Their services will radiate in scientific research and industrial cooperation, and appropriate technology, mature products and solutions for water conservancy, hydropower and rural electrification will be provided for countries on *the Belt and Road*. energy hybrid technologies based on photovoltaic, hydropower and wind power will be developed to promote technological progress, achieve production cooperation and benefit local people's livelihood.

Endeavoring with faith on a long journey ahead will lead to a promising future on the belt and road. With nearly 40 years of accumulation and experiences in training and international exchanges and cooperation, the team of HRC will be well prepared with energetic, glorious and, indomitable spirit to participate in *the Belt and Road Initiative* on a larger scale, in a higher standard and to a deeper level, and are convinced that the walk on the belt and road in a new journey of small hydropower international exchange and cooperation will be steady and enduring. HRC will contribute to realize rural electrification in countries on the Belt and Road and cope with global challenges in energy, environment and climate change.

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HRC's Annual Report on Foreign Affairs in 2016 and its Work Plan for 2017

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC)
National Research Institute for Rural Electrification (NRIRE)

In 2016, led by the Ministry of Water Resources of China (MWR) and its affiliated Nanjing Hydraulic Research Institute (NHRI), and supported by the Ministry of Commerce (MOFCOM) and the Ministry of Science and Technology of China (MOST), HRC comprehensively implemented the guiding spirits of the 18th National Congress of the CPC and fully grasped and put into practice the guiding principles of General Secretary Xi Jinping's addresses. All HRC staffs worked with full enthusiasm, rigorous attitudes and pragmatic style, so as to actively host international training, widely undertake external exchange and implement multi/bilateral S+T cooperation. It also strived to expand its overseas market, thus attaining fairly good achievement in the work of foreign affairs and getting off to a good start of "The Thirteenth Five-Year Plan".

I International Training

In order to enhance the foreign-aid capacity-building, deepen the South-South Cooperation, popularize Chinese SHP technology and related E/M equipment, uplift China's international influence in the field of water resources and rural energies, while promoting exchange and cooperation among the developing countries, especially with the countries along the Belt and Road. HRC has successfully organized 7 international training workshops (seminars) in 2016, five of which are foreign-aid training programs of MOFCOM, and the other two belong to foreign-aid training program of MOST and Sinohydro Bureau 14 Co. Ltd respectively, with the participation of 157 officials and engineers in the field of water resources, SHP and rural electrification from 33 countries in total.

The five training courses (seminars) entrusted by MOFCOM include *2016 Seminar on Small Hydropower & Rural Electrification for Asian Countries*, a 21-day one with the participation of 24 officials from 7 Asian countries; *2016 Seminar on Small Hydropower & Rural Electrification for English-speaking African Countries*, a 21-day training with the participation of 22

officials from 10 African countries; *2016 Training Course on Small Hydropower Technology for Rwanda*, a 30-day training in Kigali with the participation of 30 officials from Ministry of Infrastructure, Rwanda Energy Group, Integrated Polytechnic Regional Center, MINEGA Energy, Ltd, etc.; *2016 Training Course on Integrated Management of River Basins for Southeast Asian Countries*, a 21-day one with the participation of 18 officials from Cambodia, Myanmar and Vietnam; *2016 Seminar on Small Hydropower and Sustainable Development of Rural Communities for Officials of Asian and Africa Countries*, a 21-day seminar with the participation of 28 officials from 10 Asian and African countries.

The foreign-aid training program entrusted by MOST is *2016 International Training Workshop on Rural Electrification*, a 15-day seminar co-organized by HRC and ICSHP with the participation of 30 officials and engineers from 13 countries.

In addition to the programs entrusted by MOFCOM and MOST, in 2016 HRC firstly finished a special training program entrusted by Sinohydro Bureau 14 Co., Ltd. for its oversea EPC project, i.e. *2016 Training Course on Hydropower Operation & Maintenance for Sri Lanka*, which is a 2-month one focusing on hydropower operation and maintenance, with the participation of 5 managers of hydropower stations in Sri Lanka.

In 2016, HRC not only successfully hosted international trainings, but also expanded training channels and enriched the training contents. The training programs have been not only focused on SHP and rural electrification, but also involved with the expertise of hydropower operation & maintenance and integrated management of river basins as well. Moreover, HRC hosted another training course on small hydropower technology for Rwanda successfully, and HRC's training there was welcome and highly evaluated by trainees and the Economic and Commercial Counselor's Office of Chinese Embassy to Rwanda.

These foreign-aid training programs, on one hand, aim to disseminate Chinese advanced experience and applicable technology to rest world and help cultivate the professionals for other developing countries, thus improving their competence in water resources management, small hydropower development and realization of rural electrification. On the other hand, all the training programs shall promote the economic and technical cooperation with developing countries especially those along *the Belt and Road* and further expand the export of China's hydropower technology, equipment and related standard, thus making the training programs mostly stimulate the manufacturing and supply of Chinese products so as to better realize the "Go Global" strategy.

II Foreign Exchanges

1 Conferences and Meetings

(1) From March 16th to 18th, HRC staffs attended the Wrapping-up Meeting on 2015 Training Courses for Developing Countries and Work Plan for 2016, held by the Department of International Cooperation, MOST in Wuhan.

(2) On April 9th, HRC staffs attended the "Working Meeting for Foreign-aid Training Organizers in Zhejiang Province" organized by the Academy for International Business Officials (AIBO), MOFCOM.

(3) On June 12th, HRC staffs attended "The 2nd Forum on China-South Asia Technology Transfer & Collaborative Innovation" held in Kunming. H.E. Mr. Yin Hejun, Vice Minister of the MOST, addressed a key-note speech and expressed his appreciation to HRC for setting up the "*China-Pakistan Joint Research Center for Small Hydropower*" and organizing the *Seminar on River Development Planning for South Asia Countries*.

(4) On Nov. 10th, entrusted by the Department of International Cooperation, Science and Technology, MWR of China, HRC organized the "*China-Austria Seminar on Sustainable Hydropower Operation & Development*". H.E. Mr. Chen Lei, Chinese Minister of Water Resources, H.E. Mr. Andrea Ruprecht, Austrian Minister of Agriculture, Forestry, Environment and Water Resources, and H.E. Ms. Ileana, Austrian Ambassador to China, attended the seminar and delivered speeches. Experts from HRC made presentations on "Green Hydropower Construction in China" and "Planning and Development of Green Hydropower for Small and Medium Rivers".

(5) From Nov. 23rd to 24th, HRC staffs attended "*The 21st Annual Meeting of China South-South Cooperation Network*" organized by China Center for International Economic Exchanges (CCIEE) in Kunming.

(6) On Dec. 13th, HRC staffs attended *"2016 Training Course for Foreign Affairs Liaison Officers"* organized by the Department of International Cooperation, Science and Technology, MWR in Guangzhou.

(7) On Dec. 16th, HRC staffs attended "2016 Working Meeting on National Base for International S&T Cooperation", which was held in Hangzhou and organized by the Science and Technology Department of Zhejiang Province.

2 Foreign Guests Visiting HRC

In 2016, HRC received 9 delegations of 28 visitors in total, respectively from Pakistan, Turkey, Cote d'Ivoire, Cuba, Laos, Nepal, Vietnam, etc. for technical exchange and project cooperation.

(1) From Jan. 19th to 26th, a delegation of 2 persons headed by Mr. Khalid Islam, former Director General of Pakistan Council for Renewable Energy Technology visited HRC. Both sides discussed cooperation on solar power and hydropower projects.

(2) From Jan. 28th to Feb. 1st, a delegation of 2 persons including Mr. Halit, an engineer from Fernas Construction Co. Ltd. in Turkey visited HRC for checking the E/M equipment to be supplied by HRC for Sirvan hydropower project in Turkey, and discussed the delivery and other issues. In addition, visits were also arranged to some equipment manufacturers, which laid a solid foundation for future cooperation.

(3) On May 3rd, a 2-member delegation headed by Dr. Bernard Salomé, the adviser to the President of the Republic of Côte d'Ivoire, visited HRC. Two sides reached a consensus on capacity-building, technical R&D, project demonstration and popularization in Côte d'Ivoire and other Western African countries.

(4) From July 17th to 31st, a delegation of 5 persons including Mr. Aneramos Frank, an operator of Mayari Hydropower Project in Cuba, attended the training course on power plant operation and management in HRC.

(5) On Sept. 24th, a delegation of 2 persons headed by Mr. Wasey, Chief of Marketing of Descon, Pakistan, visited HRC for discussing mutual potential cooperation.

(6) From Oct. 31st to Nov. 2nd, a 6-person delegation headed by Nguyen Hong Phong, Chairman of CONG LUC Investment & Construction Company in Vietnam, visited HRC, Zhejiang Jinlun Electromechanic Co., Ltd. and Hangzhou Sanhe Electric Control Equipment Co., Ltd., etc., and signed a Preliminary Agreement on Cooperation.

(7) On Oct. 10th, a delegation of 6 persons headed by H.E. Mr. Sinava Souphanouvong, Vice Minister of Energy and Mines of the People's Democratic Republic of Laos, paid a visit to HRC. Dr. Sinava was one of the participants of "*1994 TCDC Training Workshop on Small Hydropower Technology*" organized by HRC. This visit aimed at promoting bilateral cooperation between HRC and the Institute of Renewable Energy Promotion (IREP), the Ministry of Energy and Mines of Laos. With the witness of Vice Minister, the Memorandum of Understanding (MOU) was successfully reached and signed, which initiated the bilateral cooperation on small hydropower and other renewable energies between HRC and IREP.

(8) On Oct. 28th, Mr. Sujit Acharya, Chairman of Energy Development Council in Nepal, paid a visit to HRC. A MOU was signed for promoting the bilateral cooperation on international training, information exchange and power plant construction in the field of renewable energy.

(9) From Nov. 1st to 4th, a 2-member delegation headed by Mr. Vilaysone Bouphalad, Deputy Director General of Department of Science, Technology and Innovation, the Ministry of Science and Technology of Laos, visited HRC for discussing mutual cooperation on four hydropower projects in Laos. A visit to E/M equipment manufacturers was also arranged.

3 HRC Visits to Other Countries

In 2016, HRC dispatched 4 delegations of 16 staffs respectively to visit Laos, Rwanda, Ethiopia, Uganda, Uruguay and Bolivia etc. for technical consultation, project cooperation and China's foreign-aid training.

4 Information Dissemination

In 2016, HRC edited and published 6 issues of *Small Hydropower* in Chinese and *SHP News* of 2016 in English. Besides, the training alumni database has been updated, and the website released nearly 100 pieces of news in Chinese and English. Tens of contributions have been submitted to China Center for International Economic Exchanges and China South-South Cooperation Network.

In addition, the national standard called "*Electromechanical Equipment Guide for Small Hydroelectric Installations*" has been translated from Chinese into English, and the final draft was submitted with the comments of the experts for final approval of the Ministry of Water Resources of China.

III International Scientific & Technology (S&T) Cooperation

In 2016, HRC actively worked for *Implementation Plan on Energy and Rural Electrification Cooperation with Countries along the Belt and Road*, and carried out inter-governmental S&T cooperation by taking advantage

of training participants, with the main achievements shown as follows:

1. HRC completed site investigation for NamHam-I, NamHam-II hydropower projects and NamBo reservoir power plant in Laos, and signed Minutes of Meeting (MOM) with the Department of Science and Innovation, Ministry of Science and Technology of Laos, on the basis of which, HRC applied to the Ministry of Commerce of China for *Foreign-aid Reserved Project* and *Major Foreign Strategic Reserves Project* respectively called "*Refurbishment of NamHam-I Hydropower Station & Construction of Off-grid Solar Power Generation System in NamBo Area*" and "*River Development Planning in NamHam and Refurbishment of NamHam-I Hydropower Station*.

2. HRC applied for a cooperative project of S&T Innovation of Zhejiang Province for the *Belt and Road* called "*Joint Research Center of Rural Electrification Based on Hydropower*", and planed to cooperate on research, transfer and demonstration of rural electrification technology with PLN PUSHARLIS, Indonesia and the Technical R&D Center for Electricity and Renewable Energy, Ministry of Energy of Indonesia. The project has successfully passed the thesis evaluation.

3. HRC applied for *2017 Training Course on Small Hydropower and Rural Electrification for Ethiopia* and made efforts on the establishment of *Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa*, the proposal for cooperation was drawn up and the project gained great support from the Mission of the People's Republic of China to the African Union. Also, HRC signed a Memorandum of Technical Cooperation (MOC) with Addis Ababa Science and Technology University (AASTU) and ZTE (H.K) Limited Ethiopia Branch (ZTE), with the purpose of promoting the establishment of *Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa*.

4. HRC submitted the Department of Science & Technology of Zhejiang Province the self-evaluation report as the provincial international cooperation base, which summarized HRC'S achievements in international cooperation of science and technology during the period of 2014-2015.

5. HRC signed MOU with the Institute of Renewable Energy Promotion, Ministry of Energy and Mines of Laos to carry out mutual cooperation on human resource training, joint research on renewable energy technology and project demonstration, etc

6. HRC has been actively preparing for *Seminar on Hydropower Development Planning for South Asian Countries* financed by Perez-Guerrero Trust Fund (PGTF) of UNDP, which is to be held in Katmandu, Nepal.

Moreover, HRC's application for 2017 PGTF-financed project called *Seminar on Renewable Energy and Off-grid Hybrid Power Generation System for East African Countries* has been approved.

IV International Marketing & Trading

In 2016, HRC accomplished a large amount of work in SHP planning, design, consultation, E/M equipment supply and on-site installation as well as overhaul or maintenance for old hydropower stations, etc. These services not only meet the demands of other developing countries, but also really benefit the local governments and people and even show Chinese technical capability in the field of water resources and hydropower to the international community, which has achieved favorable economic and social benefits as a final result.

1 E/M Equipment Supply, Installation and Commissioning

HRC supplied the E/M equipment for Sirvan hydropower project in Turkey, and finished the on-site installation instructions for Ikiler hydropower project in Turkey and the right bank station of Mayari hydropower project in Cuba. HRC also provided after-sale services and spare parts for Ozluce, Kale, Garzan, Yalnizca, Binek hydropower projects in Turkey, and in Pakistan, HRC implemented on-site installation instruactions for three hydropower stations. In Benin, HRC supplied a solar off-grid power system and instructed the owner to install and commission.

2 Hydropower Project Planning, Design and Consultation

HRC designed for Thuan Hoa hydropower station in Vietnam, and Chianali and Deg Outfall hydropower stations in Pakistan. The design was started for Upper Baluchang hydropower project in Myanmar, the feasibility study contract was signed for Nam Ming hydropower station in Laos, and the feasibility and site investigation are to be commenced for Ragati hydropower project in Kenya soon.

3 Development of New Projects

HRC actively explored the opportunities for the EPC contracting of hydropower projects in Laos and Kenya, and signed a preliminary agreement on Nam Ming hydropower station in Laos. HRC cooperated with CNOOD Shanghai to jointly explore the market in Serbia and undertook the site investigation on BH cascade hydropower project. Also, HRC continuously made commercial offers and technical proposals for potential hydropower projects in Turkey, and developed the hydropower markets in Vietnam and Indonesia, as well as prepared to provide off-grid solar power systems to Africa.

V Work Plan for 2017

In 2017, HRC will earnestly observe the relevant principles and policies of foreign affairs formulated by the Central Government. Under the leaderships of Department of International Cooperation, Science and Technology of the Ministry of Water Resources and Nanjing Hydraulic Research Institute, and with the strong supports from Ministry of Commerce and Ministry of Science and Technology of China, HRC will continuously host the foreign-aid trainings, especially the training in other countries and the training on operation, maintenance and management for Chinese EPC contractors aiming to improve its overseas marketing capability. Meanwhile, by taking advantage of being "Zhejiang International S&T Cooperation Base of Renewable Energy and Rural Electrification", and following the strategy of *the Belt and Road* construction, HRC shall strive to establish technical transfer center, R&D center, or demonstration and training base respectively in Southeast Asia, Africa, Eastern Europe and other regions, in order to further promote the economic and technical cooperation.

1 International Training

HRC will continue to carry out the foreign-aid training programs.

While doing the "*coming-in*" training, priority shall be given to the "*going-out*" training programs including the training courses on small hydropower and rural electrification for Rwanda, Ethiopia and Pakistan. In addition, HRC will hold *Seminar on Hydropower Development Planning for South Asian Countries* in Nepal, *Seminar on Renewable Energy and Off-grid Hybrid Power Generation System for East African Countries* in Uganda, and carry on the 2nd training for *M* Dam hydropower project in Sri Lanka. Furthermore, HRC shall organize the training course on hydropower development for Eastern Africa jointly with Kenya Power, and plan to start the training on operation, maintenance and management of two hydropower stations in Uganda.

2 International S&T Cooperation

HRC will actively apply for the key project of strategic international innovative cooperation on science and technology, and popularize the achievements of *China-Pakistan Joint Research Centre for Small Hydropower Technology* to Nepal, Bangladesh, Sri Lanka and other South Asian countries, thus striving to develop it into a *R&D and Demonstration Base on Small Hydropower Technology for South Asia*. HRC shall continue to carry out bilateral and multilateral cooperation with Indonesia, Malaysia, Vietnam, Laos and other ASEAN countries, communicate with Addis Ababa Science and Technology University (AASTU) and ZTE (H.K) Limited Ethiopia Branch (ZTE), and carry out technical exchanges and cooperation with all African countries to promote the establishment of *Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa*. Also, HRC shall take the advantage of existing friendly cooperative relationships to conduct R&D on small hydropower technology, and develop and apply the proven technology and equipment for West Asia, Eastern Europe, Caucasus countries including Turkey, Macedonia and Georgia, so as to establish the "*Development Base of Small Hydropower Technology and Equipment for West Asia, Eastern Europe and Caucasian Regions*".

3 Overseas Engineering Design & Consultation

HRC will continue with the final part of the design and on-site technical service for Thuan Hoa hydropower station in Vietnam, the construction drawing design and on-site monitoring for Upper Baluchang hydropower project in Myanmar, and also complete the feasibility design of Nam Ming hydropower station in Laos and the feasibility study report of Ragati hydropower station in Kenya. Meanwhile, HRC shall broaden the cooperation channel and try the best to undertake more projects about design and consultation.

4 Development of Oversea Market

Based on the Belt and Road construction, HRC will continuously develop markets in Southeast Asia, including Myanmar, Laos, Indonesia and Vietnam. HRC shall follow and provide technical services and E/M equipment for these low-head hydropower stations in Eastern European countries such as Serbia, Macedonia and Romania. Meanwhile, HRC will explore the African market, and relying on the existing projects in Turkey, Peru, Kenya and other countries, the cooperation between HRC and any other country is going to be enhanced.

5 Fully taking the advantage of being the "Family of Small Hydropower in the World", HRC will strengthen the extensive exchange with other governmental departments or counterparts, and further enhance the cooperation with World Bank, Asian Development Bank and other international financing organizations, thus expanding the business scope and deepening the influence of HRC itself.

6 HRC will improve its management on foreign affairs, and take measures to compile the two magazines named *SMALL HYDRO POWER* in Chinese and *SHP News* in English, as well as renew the HRC website, and also contribute papers to the magazines such as the South-South Cooperation Network, thus strengthening the advertising.

(*Source:* HRC) ■

Chinese Minister Made a Study Trip to China-Pakistan Joint Research Center for SHP

On July 8, 2017, the 18th meeting of the Joint Commission on Science and Technology Cooperation between China and Pakistan was held in Islamabad. China Science and Technology Minister Mr Wan Gang co-chaired the meeting with Pakistani Minister of Science and Technology Rana Tampere Hussein. The two sides exchanged views with focus on issues such as technology transfer, biotechnology, disaster prevention and mitigation, marine science and joint funding projects, and reached a consensus on the future planning of cooperation between China and Pakistan.

Science & technology cooperation is an important part of China-Pakistan all-weather strategic partnership. At present, China and Pakistan are to jointly build *"The Belt and Road Initiative"* as an opportunity to continue to promote all areas and all-round cooperation. During his visit to Pakistan, Minister Wan Gang visited Pakistan Renewable Energy Technology Council to investigate the progress of the *"China-Pakistan Joint Research Center for Small Hydropower"*, which was jointly established by HRC and Pakistan, and explored deeply on the further cooperation of developing photovoltaic power generation, hydropower, wind energy and so on. *"China-Pakistan Joint Research Center for Small Hydropower"* is one of the eight China-Pakistan cooperation projects jointly launched by the Chinese President Xi Jinping during the state visit to Pakistan in April 2015, together with Pakistani Prime Minister Nawaz Sharif.

Taking the advantage of minister's visit to the *"China-Pakistan Joint Research Center for Small Hydropower"*, HRC will continue to deepen and strengthen scientific and technological innovation cooperation and cultural exchanges between the two countries in the field of clean renewable energy and rural electrification technology, on the basis of the existing good cooperation. HRC will spare no efforts in devoting itself to deepening and expanding bilateral cooperation and enhancing the relationship between China and Pakistan.

Guided by the action plan of scientific and technological innovation in the framework of *"The Belt and Road Initiative"*, HRC is transforming *"China-Pakistan Joint Research Center for Small Hydropower"* into *"SHP R+D & Pilot Base for South Asia"*; set Indonesia as the center, establishing *"China-ASEAN Technology Transfer Center for Renewable Energy"*; cooperate with the African Union in Ethiopia to establish *"China-Africa Technology Transfer, Research and Training Center for Clean Energy and Rural Electrification"*; set Serbia as the center, establishing *"SHP Technology and Equipment Development Base for West Asia, East Europe and Caucasian Region"*. The next step of HRC is to seize the opportunity, with the strong support of the Chinese government and international organizations, we will gradually make the four overseas centers *"real"*. Among HRC's around 1900 international participants from 112 countries, let some of the excellent ones be HRC's *"staff"* for the four overseas centers. HRC will double its efforts to conduct scientific research and industrial cooperation. Supported by the hybrid technology of *"photovoltaic power generation, hydropower, wind energy"*, the technological progress will be promoted as to achieve production capacity and benefit the livelihood of the local people's. In order to realize the rural electrification for the countries along *"The Belt and Road Initiative"* and cope with global challenges in energy, environment, climate change and etc, HRC is to make due contribution for the people's well-being.

(*Source:* HRC) ■

HRC Attended the 6th World Hydropower Congress Held in Africa

A Visit to Dr. Ing Seleshi Bekeie, Ethiopian Minister of Water, Irrigation and Electricity

Attendance of the 6th World Hydropower Congress

From May 9th to 11th, 2017, Dr. Xu Jincai, Director General of HRC, and Mr. Lin Ning, Division Chief of Foreign Affairs and Training of HRC, attended the 6th World Hydropower Congress related to the topics about hydropower development, long-distance transmission, grid interconnection and storage of renewable energies etc. in Africa.

Africa is rich in clean energy, and the potential of hydropower, solar and wind energy respectively accounts for 12%, 40% and 30% of the global. However, the development rate in Africa is low, and over 600 million people still have no access to electricity. With joint efforts of International Hydropower Association, Global Energy Interconnection Development and Cooperation Organization, African Union Commission, U.N. Economic Commission for Africa, World Bank etc., the 6th World Hydropower Congress was held in Africa for the first time. Present at the congress were participants from governments, research institutes, universities, commercial & financial sectors and non-governmental organizations. The congress was aimed to promote hydropower development, combat climate change, and make a blueprint for the development and operation of hydropower in the ten years to come. Ethiopian Prime Minister Hailemariam Desalegn, Mabdalla Hamdok, Executive Secretary of U.N. Economic Commission for Africa, Rachel Kyte, CEO of UN "Sustainable Energy For All" organization, Ken Adams, president of International Hydropower Association were all present at the opening.

The delegation headed by Dr. Xu Jincai, Director General of HRC, paid a visit to Dr. Ing Seleshi Bekeie, Ethiopian Minister of Water, Irrigation and Electricity, Mr. Chen Ning, Counselor of the Mission of the People's Republic of China to the African Union, and Ms. Liu Yu, the Economic and Commercial Counselor of Chinese Embassy to Ethiopia.

A Visit to Mr. Chen Ning, Counselor of the Mission of the People's Republic to the African Union

A Visit to Ms. Liu Yu, the Economic and Commercial Counselor of Chinese Embassy to Ethiopia

(*Source:* HRC) ■

HRC Set up the "Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa" in Ethiopia

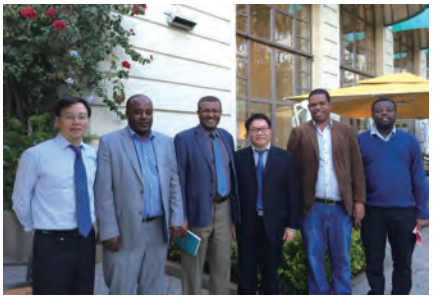
On May 12, 2017, the inauguration ceremony of *"Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa"* was held in Addis Ababa Science and Technology University (briefed as AASTU). Mr. Chen Ning, Counselor of the Mission of the People's Republic of China to the African Union, Dr. Nurelegne Tefera, President of AASTU, and Dr. Xu Jincai, Director General of Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (briefed as HRC and also called National Research Institute for Rural Electrification) were present and addressed on the ceremony. Present at the ceremony were also representatives from ZTE Ethiopian Branch, Kenya Power & Lighting Co. Ltd., Rwanda Energy Group, Tanzania Renewable Energy Association and Uganda Electricity Generation Company Limited.

The *"Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa"* is the second technical transfer & training center that HRC set up abroad. On April 20, 2015, HRC set up the first technical transfer & training center in Pakistan, which is called *"China-Pakistan Joint Research Center for Small Hydropower"*. Chinese President Xi Jinping, together with Pakistani Prime Minister Nawaz Sharif, unveiled for 8 China-Pakistan cooperative projects during his visit to Pakistan.

The *"Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa"* was set up in Addis Ababa, the capital of Ethiopia and the headquarters of the African Union. It is open to all African countries and help to promote agricultural modernization, infrastructure construction, green development and poverty alleviation of Africa with the cooperation between China and Africa in the field of rural energy and infrastructure development towards a goal of common development and double wins through capacity-building, joint R+D, technical transfer and project demonstration.

HRC delegation headed by Dr. Xu Jincai paid a visit to AASTU, and reached consensus about the following work plan after detailed discussion with President Dr. Nurelegne Tefera and other two Vice Presidents of AASTU.

Inauguration of *"Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa"*



A visit to Addis Ababa Science and Technology University

(*Source:* HRC) ■

HRC Delegation Visited Laos and Indonesia for Enhancing Cooperation with ASEAN

From Nov. 29 to Dec. 6, 2017, a delegation of 4 persons headed by Dr. Xu Jincai, Director General of HRC, visited Laos and Indonesia for enhancing cooperation with ASEAN.

A visit to Dr. Sommad PHOLSENA, Minister of Natural Resources and Environment of Laos

In Laos, HRC delegation paid a visit to Dr. Sommad PHOLSENA, Minister of Natural Resources and Environment, and Dr. Sinava SOUPHANOUVONG, Vice Minister of Energy and Mines. Also the delegation had an intensive exchange for future cooperation with Mr. Saysana SITTHIPHONE, Director of Chief Cabinet of Lao-China Cooperation Commission and Mr. Chantho MILATTANAPHENG, Acting Director General of Institute of Renewable Energy Promotion (IREP). During the stay in Laos, the delegation visited Mr. Wang Qihui, the Economic and Commercial Counsellor of Chinese Embassy to the People's Democratic Republic of Laos. The delegation introduced HRC's efforts and contributions to the *"Belt and Road Initiative"* and the related cooperation in Laos in the field of water resource management, environment assessment, hydropower development and dam safety management, etc.

In Indonesia, HRC delegation paid a visit to Dr. Sanjayan VELAUTHAM, Director of ASEAN Center for Energy (ACE), and had an in-depth discussion and reached consensus on building-up of *"China-ASEAN Technology Transfer and Training Center for Clean Energy and Rural Electrification"*.

Besides, HRC discussed with PLN Indonesia the joint research and personnel training plan for the hybrid power generation technology with use of clean energy on islands, and a MOU was signed. HRC delegation met

A visit to Dr. Sinava SOUPHANOUVONG, Vice Minister of Energy and Mines of Laos

A visit to PLN Corporate University, Indonesia

with Brawijaya University, Indonesia to discuss the cooperation on hybrid power generation technology for seawater desalination. In addition, personnel training and education programs were also touched upon between HRC and PLN Corporate University. The delegation then visited Mr. Tan Shufu, the Economic and Commercial Counselor of Chinese Mission to ASEAN, and introduced the cooperation with ASEAN countries and the future work plan. Mr. Tan expressed his strong support for HRC to conduct personnel training, joint research and technical demonstration in cooperation with ACE. In addition, the delegation paid a visit to Mr. Xie Chengsuo, Head of Science and Technology Section of Chinese Embassy in Indonesia, and reported the cooperation activities of HRC with Indonesian side.

HRC has long been a good partner to ASEAN countries, and has hosted with success more than 60 training courses, seminars and workshops in renewable energy development and rural electrification with more than 300 participants from ASEAN countries. HRC has also completed engineering design, consultation, E/M equipment supply for lots of projects in ASEAN countries including Laos, Indonesia, the Philippines, Vietnam, Malaysia, Burma, Thailand, etc.

ASEAN is now one of the most dynamic and fastest growing economic regions in the world. The region is projected to grow by at least 4% per year on average over the next five years, but could be 6%-provided ASEAN moves towards greater integration. To fuel this growth, the demand in primary energy is expected to grow by an average of 4.7% per year from 2013 to reach 1,685 Mtoe (million ton of oil equivalent) in 2035, according to the ACE's 4th ASEAN Energy Outlook (AEO4). Against this backdrop, the theme of the new ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 as ***"Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability, and Sustainability for All"*** *was endorsed. The key initiative under this APAEC include strategies to achieve higher aspirational targets to improve energy efficiency and increase the uptake of renewable energy (RE) sources. The component of renewable energy is expected to increase to 23% by 2025 in ASEAN Energy Mix. Plans to broaden and deepen collaboration with international organizations will be stepped up to benefit from their expertise and enhance capacity building in the region.*

So, it is believed that the cooperation between ASEAN countries and HRC will be intensified and boosted in the near future in the field of energy which serves the common interest and addresses the common challenges of both sides.

A visit to Dr. Sanjayan VELAUTHAM, Director of ACE

(*Source:* HRC) ■

Seminars Hosted by HRC in 2017 (Partly)

"Seminar on Hydropower Development Planning for South Asian Countries" Concluded in Kathmandu

As part of the important follow-up of the *"China-Pakistan Small Hydropower Technology Joint Research Center"* and one of the important items for establishment of "Small hydropower technology R+D and demonstration base in South Asia", the "2017 Seminar on Hydropower Development Planning for South Asian Countries" concluded on March 30 at the capital Kathmandu of Nepal and has achieved fruitful results.

Minister of Science and Technology of Nepal, Vice President of Nepal Science and Technology Research Institute, Huang Jianping, Deputy Director of NRIRE attended the grand closing ceremony and delivered speeches. Representatives of various nationalities spoke and evaluated highly for the seminar.

The seminar lasted for three days, covering technical seminars, power station visits and cooperation talks. During the seminar, our experts and representatives of countries fully communicated, had in-depth discussion to reach a consensus, and signed cooperation agreements.

The participating institutions and representatives will use the platform of the seminar to strengthen mutually beneficial cooperation in the field of small hydropower, improve the level of rural electrification in South Asia, promote sustainable socio-economic development and benefit the people's livelihood. The seminar will further promote bilateral and multilateral cooperation between China and South Asian countries in the field of clean energy, realize advanced technology research and development and transfer, and build a solid foundation for the construction of *"Small hydropower technology R+D and demonstration base in South Asia"*.

The seminar was highly regarded and reported by many local media in Nepal.

2017 Training Course on SHP and Rural Electrification for Rwanda Held Successfully in Kigali

During Sept. 13 to Oct.7, *"2017 Training Course on SHP and Rural Electrification for Rwanda"* was successfully held in Kigali, Rwanda by HRC with the coordination of Energy Development Co. Ltd. (EDCL) of Rwanda Energy Group. A total of 31 participants from Mininfra, EDCL, Integrated Polytechnic Regional Center, Ngali Energy Ltd., Novel Energy, Prime Energy Ltd., Pepro Ltd. and So Energy International etc. attended this training.

This training course is the 92nd one that HRC implemented and the 3rd one accomplished in Rwanda. Much attention was paid to this training and HRC dispatched staffs earlier to arrange local training activities in Rwanda including training subject, study tour and work scope. The training was made through classroom presentation, site investigation and preliminary design, as to better the knowledge and the hand-on practice of Rwandan engineers for feasibility study and preliminary design of SHP

and rural electrification.

This training covered the subjects of hydrology, geology, civil works, mechanical engineering, electrical engineering, construction management etc., and presented some key issues of feasibility study and preliminary design. Study tour was arranged to investigate Nyabeshaza hydropower site, and based on site conditions, HRC professors taught participants to compile the feasibility study report. This training achieved the target of improving the expertise and experience of local professionals through technical sharing and transfer, and meanwhile, it also enhanced the cooperation between HRC and the concerned governmental departments and local private investors of Rwanda.

Strong supports were given to this training course from the Economic and Commercial Counsellor's Office of Chinese Embassy to Rwanda, and the Counsellor Mr. Zhang Liyong and the Secretary Ms. Peng Jie presented the opening and closing ceremonies and issued the certificates from the Ministry of Commerce of China.

"Seminar on Renewable Energy and Off-grid Hybrid Power Generation System for East African Countries" Held in Africa

Just before the "*Belt and Road Forum for International Cooperation*" held in Beijing, from May 12 to May 14, the "*Seminar on Renewable Energy and Off-grid Hybrid Power Generation System for East African Countries*" sponsored by Perez-Guerrero Trust Fund (PGTF) was held in the venue of *"Africa Technology Transfer, Research & Training Center on Clean Energy & Rural Electrification"* by the National Research Institute for Rural Electrification, MWR of China (also known as Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power) (HRC). There were in total 24 participants from East Africa countries including Ethiopia, Kenya, Rwanda, Tanzania, and Uganda present at the 3-day-long seminar. Mr. Chen Ning, the Counselor of the Mission of the People's Republic of China to the African Union, Dr.Nurelegne Tefera, President of Addis Ababa Science and Technology University (AASTU) and Dr.Xu Jincai, Director General of HRC attended and addressed the opening ceremony.

The seminar covered lectures, study tour and technical discussions. Representatives from HRC, AASTU and ZTE Ethiopian Branch made presentations on renewable energy technologies and development. Participating representatives from Kenya, Rwanda, Tanzania and Uganda made country reports at the seminar, sharing the expertise of renewable energy and the status of development in East Africa. Besides, the participants visited a wind farm, for which Chinese company provided EPC services with joint investment. Resolution for future cooperation was also reached and signed.

This seminar is an important event of scientific and technical cooperation of *"Africa Technology Transfer, Research & Training Center on Clean Energy & Rural Electrification"* which was jointly set up by HRC, AASTU and TE Ethiopian Branch. This center is the second for technical transfer and training set up by HRC abroad, and is located in Addis Ababa, the capital of Ethiopia and headquarters of African Union. More trainings and seminars will be sequentially organized by this center in Ethiopia, East Africa countries and African Union countries in order to promote capacity building for the development of clean energy and rural electrification in the African countries.

2017 Seminar on Small Hydropower and Sustainable Development of Rural Communities for ASEAN Countries Concluded in Hangzhou

Entrusted by the Ministry of Commerce of China and organized by HRC, 2017 Seminar on Small Hydropower and Sustainable Development of Rural Communities for ASEAN Countries was held successfully in Hangzhou from 14 to 27 September. 19 officials from Indonesia, Laos, Vietnam, etc. came to attend the seminar.

During the seminar, officials enjoyed the specific lectures covering the advanced technology and proven experience in the field of small hydropower (SHP) and rural community sustainable development. Site visits were arranged to Three Gorges Project, Gezhouba Water Conservancy Project, and other typical hydropower stations and relevant manufacturers, which enables officials to have a comprehensive understanding about China's achievement in promoting the sustainable development of rural communities through SHP development and rural electrification program, and also laid a solid foundation for future cooperation among all the participating countries. Furthermore, the representative from each country delivered country report respectively. Based on full communication and sharing of technical experience and project information, an in-depth discussion on how to carry out effective cooperation in related fields was conducted between officials and HRC specialists.

Under the common efforts of professors, officials and HRC's management team, the 14-day seminar was highly evaluated by the participating countries, and its successful fulfillment will definitely enhance further cooperation in the field of SHP and rural electrification between HRC and relevant departments in ASEAN countries and promote sustainable development of rural communities for ASEAN region.

2017 Seminar on Water Resources Management & Small Hydropower Development for Countries along the Belt and Road Held in Hangzhou

Entrusted by the Ministry of Commerce of China and organized by HRC, 2017 Seminar on Water Resources Management & Small Hydropower Development for Countries along the Belt and Road was held successfully in Hangzhou from 16 June to 13 July. 44 officials from 12 countries along the Belt and Road, including Afghanistan, Armenia, Azerbaijan, Bangladesh, Dominica, D.P.R. Korea, Egypt, Iran, Laos, Mongolia, Myanmar and Nepal came to attend the seminar. Based on the concerted efforts of all lecturers, participants and HRC training team, this seminar has achieved fruitful results. This is the 90th foreign-aid training program that HRC implemented since its establishment.

During the seminar, officials enjoyed the specific lectures covering the advanced technology and proven experience in the field of water resources and small hydropower. Site visits were arranged to Three Gorges Project, Tiexinqiao Water Experiment Center, Nanjing Hydraulic Research Institute, typical hydropower stations and equipment manufacturers, which enabled officials to have a comprehensive understanding about the updated technology and equipment manufacturing capability of water resources management and small hydropower development in China, and also laid a solid foundation for future cooperation. Furthermore, the representative from each country delivered country report respectively on the subject of water resources management and small hydropower development. Based on full communication and exchange of technical experience in the field of water resources and small hydropower, an in-depth discussion on how to carry out effective cooperation in the field of water resources and small hydropower was conducted between officials and HRC specialists.

Mr. Cai Runyaun, Division Chief of the Training Center of Ministry of Commerce, Mr. Fan Aihua, Division Chief of Department of Commerce of Zhejiang Province, Ms. Shi Xiaomei, Project Officer of the Training Center of Ministry of Commerce, Mr. Xu Jincai, Director General of HRC, Mr. Lin Ning, Division Chief of Foreign Affairs and Training of HRC, Ms. Shi Jin, Vice Division Chief of Foreign Affairs and Training of HRC presented at the grand closing ceremony. Mr. Cai and Mr. Xu delivered the speech respectively and awarded certificates from the Ministry of Commerce, together with Mr. Fan to all the participants.

Mr. Cai mentioned that there are numerous rivers and lakes in China with abundant water resources and small hydropower potential, ranking the 1st in the world. In recent years, Chinese government has not only accumulated plenty of experience, but also made a big progress after dedicated to water conservancy construction. The seminar provides a platform where China and other developing countries can enhance communication and promote water resources management and small hydropower development. He addressed: "…I sincerely hope this seminar could be a start of our mutual cooperation, through study and exchanges, to establish the bridge of friendship among us, thus laying a solid foundation for our mutual cooperation."

Mr. Xu made conclusion remarks on the activities and achievements of the seminar, and on behalf of HRC, he expressed heartfelt thanks to the Ministry of Commerce for his great supports, and to the participants for their earnest attitudes and friendly cooperation during the seminar. He mentioned: "… I am very pleased to learn that you are satisfied with this productive seminar and you feel that the time, about 28 days you spent here, is pleasant…It is expected that you will play a more active role in the development of water resources and small hydropower in your own countries, and you are warmly welcome to re-visit HRC, *'the Family of SHP in the World'* frequently in the future. We hope that more and more win-win cooperation would be achieved for common development."

On behalf of all the participants, Ms. Orujova Gunay, Chief Engineer of the Ministry of Ecology and Natural Resources, Azerbaijan delivered a speech at the closing ceremony, expressing her sincere gratitude to the Chinese government and showing her appreciation respectively to the Ministry of Commerce of China for sponsoring such a productive seminar and to HRC training team for the hard work and effective management. The other participants also expressed their willingness to take this seminar as a good opportunity to enhance the cooperation on water resources and small hydropower between China and their respective countries, thus ultimately bringing safe water and clean energy to the world.

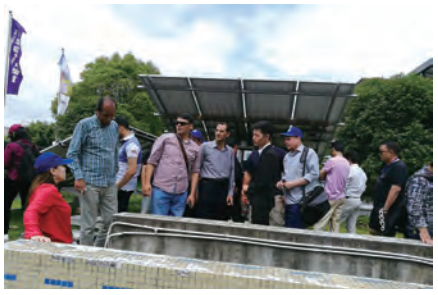
The seminar was warmly welcome and highly evaluated by the participating countries, and its successful fulfillment laid a solid foundation for HRC to actively implement the guiding spirit of the Belt and Road Initiative, and to carry out in-depth and friendly cooperation with the countries along the Belt and Road in the field of water resources and small hydropower.

2017 Seminar on Electrification Mode based on Clean Energy for the Countries along the Belt and Road Held Successfully in Hangzhou

Entrusted by the Ministry of Commerce and organized by HRC, 2017 Seminar on Electrification Mode based on Clean Energy for the Countries along the Belt and Road was held successfully in Hangzhou from 5 May to 1 June. 33 officials from 6 countries along the belt and road, including Afghanistan, Egypt, Indonesia, Mongolia, Nepal, and Samoa came to attend the seminar. Based on the concerted efforts of all lecturers, participants and HRC training team, this seminar has achieved fruitful results.

On behalf of all the participants, Mr. Hamzah, Assistant to the Minister of Energy and Water of Afghanistan delivered a speech at the closing ceremony, expressing the sincere gratitude to the Chinese Government and showing the appreciation to HRC training team for the hard work and effective management. He mentioned: "..... Beside sharing expertise in classroom, visiting equipment factories and project sites, including magnificent dam of Three Gorges, the wind farm, the garbage power plant and the solar energy manufacturer, etc., and the technological advancement, the peace and harmony, the kindness and hospitality of the Chinese people, were so impressive……Actually what made this seminar quite a special one, was finding friends from 6 countries in China, common in humanity and enthusiasm for development..... Let's make joint efforts to surmount obstacles we encounter and make contribute to the development of clean energy and the protection of environment.....". The other participants also addressed cordially, conveying their faithful thanks and strong desire for kind cooperation with HRC in future.

Mr. Fan Aihua, Division Chief from Zhejiang Provincial Department of Commerce, Mr. Xu Jincai, Director General of HRC and Mr. Huang Jianping, Deputy Director General of HRC, were present at the grand closing ceremony, and awarded the certificates from the Ministry of Commerce to all the participants.



The seminar was warmly welcome and highly evaluated by the participating countries, and its successful fulfillment laid a solid foundation for HRC to actively implement the guiding spirit of the Belt and Road Initiative, and to carry out the in-depth and friendly cooperation with the countries along the belt and road in the field of clean energy and electrification.

(*Source:* HRC) ■

The President of Addis Ababa Science and Technology University of Ethiopia Visited HRC

On October 31, 2017, a delegation including Prof. Nurelegne Tefera Shibeshi, the President of Addis Ababa Science and Technology University (AASTU) of Ethiopia visit HRC. AASTU is one of the two universities directly under the Ministry of Science and Technology of Ethiopia, and it focuses on cultivating professionals for the progressing of science and technology and promoting the socio-economic development of Ethiopia during the period of industrialization transformation. Its scientific research and talents have been highly attached importance by its government. Just in this May, cooperating with ZTE Ethiopian Branch and AASTU, HRC set up the *"Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification"* successfully in Ethiopia.

At the meeting, Director General of HRC Dr. Xu Jincai introduced the international cooperation and foreign-aid trainings accomplished by HRC under China's *"Belt and Road" Initiative*, emphasizing on the layout and planning of HRC's four overseas technical transfer and training centers. President Nurelegne expressed his appreciation for HRC's achievements, and together with HRC, he is willing to seek supports from both governments for further cooperation, and promote the establishment of the *"Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification"* in Ethiopia, so as to provide better technical support for the renewable energy development and utilization in Africa. Moreover, two parties discussed the follow-up work and other cooperative issues.

(*Source:* HRC) ■

Guests from Nepal Academy of Science and Technology Visited HRC

On November 1, 2017, a 2-person delegation headed by Dr. Suresh Kumar Dhungel, the Chief of Faculty of Technology of Nepal Academy of Science and Technology (briefed as NAST) visited HRC. NAST is an important research institute under the leadership of Nepalese Prime Minister to promote the technical advancement in the nation. A MoU is signed between NAST and HRC during the *"Seminar on Hydropower Development Planning for South Asian Countries"* in Kathmandu this March, which kicked off the bilateral cooperation on capacity-building, joint research and project demonstration etc.

At the meeting, Prof. Xu Jincai, the Director General of HRC briefed the international cooperation activities of HRC under the *"Belt and Road Initiative"*, and hoped to establish a regional center on small hydropower and rural electrification for South Asian countries on the basis of the built *"China-Pakistan Joint Research Center for Small Hydropower Technology"* in Pakistan to further promote research & development of key technology, and achieve the technology transfer as well.

Both sides discussed the follow-up work in capacity building, such as trainings, joint R&D and project demonstration etc. and planned to carry out more joint researches and trainings in the fields of hydropower, biomass energy, solar power, wind power and other renewable energies. Furthermore, both sides will seek more supports from governments to facilitate technical progress and accelerate the development of renewable energy for all South Asian countries.

A Kicking-off Meeting on the Key Project of Strategic International Sci-tech Innovation Cooperation under the National Major R&D Program Held in HRC

On November 13, 2017, a kicking-off meeting of the key special project of Strategic International Sci-tech Innovation Cooperation under the National Major R&D Program called *"China-Pakistan Joint R&D Center on Key Technology of Small Hydropower and Rural Electrification"* was held in HRC, with the attendance of experts and consultants from Department of Science and Technology of Zhejiang Province, Science and Technology Promotion Center of Ministry of Water Resources, Hydropower and Water Resources Planning and Design General Institute of Ministry of Water Resources, International Center for Small Hydro Power, Standard & Quality Control Research Institute of Ministry of Water Resources, Hydropower Management Center of Zhejiang Province, Tsinghua University, Zhejiang University, Zhejiang Water Conservancy and Hydropower College, etc.

This is the first time for HRC to take the lead in carrying out such a key project of Strategic International Sci-tech Innovation Cooperation under the National Major R&D Program. On the basis of the built *"China-Pakistan Joint Research Center for Small Hydropower Technology"* in Islamabad, the project shall be implemented to further expand the research scope, establish the showcase, and improve the innovation capability in the fields of SHP, other renewable energies development and rural electrification through cooperation and exchange. Meanwhile, with the support of China's *"Belt and Road Initiative"*, the application and popularization of Chinese technology and experience in SHP and rural electrification shall be promoted among South Asian countries, and a sci-tech innovation communication mechanism on SHP and rural electrification can be established to open up a *"Developing & Sharing, Mutual Benefit & Win-win"* prospect in South Asia, and finally the cooperation on clean energy and rural electrification would be accelerated in this region.

After listening to the report by project team, the consultants gave advice and specific guidance on project management, technical route, implementation plan, scheduling and budget, etc.

Mr. Dai Jiqun, Vice President of Nanjing Hydraulic Research Institute, Mr. Xu Jincai, Director General, Mr. Dong Dafu, Deputy Director of HRC, and representatives of foreign partner named Pakistan Council of Renewable Energy Technology including the Director General Dr. Raza Baqer etc. attended the kicking-off meeting.

(*Source:* HRC) ■

About the Newsletter

"SHP News" was firstly published on May,1984 by HRC under the sponsorship of UNDP/UN-ESCAP-REDP(Regional Energy Development Program) in association with UNIDO. It was officially permitted for publication with an ISSN No.0256-3118(International Standard Serial Number). The major objective of the journal is for constant exchange of information and experience in the small hydro power(SHP) section among Asian-Pacific countries and/or worldwide. The comprehensive coverage of "SHP News" includes:

1. General information of SHP development in relevant developing countries.

2. State-of-the art and/or new ideas and trends of SHP technology in various countries or worldwide.

3. Technical experience of SHP development, including articles written by experts and staff.

4. Policy, regulations, institutional issues and finance approaches in the SHP section.

5. Market conditions of SHP construction.

6. Opportunities for SHP business, including technical consultations and services, equipment supply, etc..

7. Major events and international activities in the SHP section mainly in developing countries.

8. SHP news

Since 1984, 95 issues of "SHP News" have been edited, published and disseminated to more than 30,000 readers in about 100 countries in the world. Our readers include individual persons and institutional organizations, such as relevant government officials, experts(technicians), professors(teachers), SHP institution or NGO staffs, etc. Organizations may include government sections, universities, research institutes, SHP developers, consultant firms, operations, manufacturers, financial and legal institutions, etc. Our training workshop trainees are special readers and contributors of the journal. There have been about 1100 technical persons participated in 70 more training workshops held by HRC during the past 3 decades. Most of them keep contact with us and offer articles and /or information to the journal, forming a vital source of the publication.

We hope to continue obtaining enthusiastic concern, encouragement and support from our readers. Contributions,advertisement and comments made on the journal are warmly welcome.

Please click http://www.hrcshp.org/shp for more and contact our editor……

E-Mail: **jdzhao@hrcshp.org**

Tongji Weir: The historical irrigation structure of diversion with a dam is situated on the ***SongYin*** stream with more than 1500 years in Lishui city, Zhejiang province, PRC. The structure was recognized as ***"World Heritage Irrigation Structure"*** by ICID (International Commission on Irrigation and Drainage) in 2014, listed as ***World Heritage Site*** as recognized by UNESCO.

***Photo by**: Ms.Yingqing*