SHP NEWS

Volume 33, 2018
ISSN 0256-3118

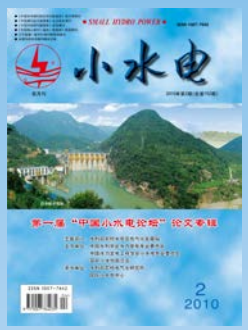
Newsletter of the Asia-Pacific Regional Network for Small Hydro Power (RN-SHP)

HANGZHOU REGIONAL CENTRE FOR SMALL HYDRO POWER
亚 洲 太 平 洋 地 区 小 水 电 研 究 培 训 中 心
中 国 杭 州

SMALL HYDRO POWER

Where can you find renewable energy leads in China…

–An authoritative & professional periodical in the field of small hydropower



The Chinese magazine -"Small Hydro Power" was launched in March 1984, and has received a huge welcome from its many readers worldwide.

Small Hydro Power appears bimonthly, providing world coverage of small hydropower(SHP) issues. All the technologies are covered at a level that will be understandable to a wide professional readership, and useful summaries are provided for specialists in particular areas.

Small Hydro Power is great reading for everyone working with, or interested in SHP, at any level: industry, policy-making, research, student or as a private energy user.

Regular contents:

- ●Strategy and policy
- ●International exchange
- ●Rural electrification
- ●Technology exchange
- ●Planning and design
- ●Project construction
- ●Renovation
- ●Electro-mechanical equipment
- ●Computer application
- ●Operation and Maintenance

ISSN 1007-7642 CN33-1204/TV
Subscription prices (1 year):$40.00 in Asia
Rest of the World $50.00
For details email
shpnews@hrcshp.org
and visit http://www.hrcshp.org/shp/cn

SMALL HYORO POWER NEWS

www.hrcshp.org

CONTENTS

Editor in Chief
Xu Jincai

Executive Chief Editor
Zhao Jianda
Tel: +86 571 88082848
jdzhao@hrcshp.org

Editorial Office
122 Xueyuan Road,
Hangzhou,P.R.China
Postcode:310012
Tel: +86 571 88082848
56729282
Fax: +86 571 88062934
E-mail:shpnews@hrcshp.org
http://www.hrcshp.org/shp

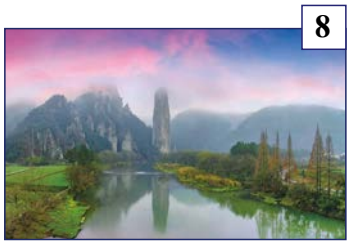
Published by
SHP News Editorial Office
Hangzhou Regional Centre
(Asia-Pacific) for Small Hydro
Power. Hangzhou 310012,
P.R.China

Supported by
UNDP/ESCAP Regional
Energy Development
Programme(REDP) in
association with UNIDO

SHP IN CHINA

SHP WORLDWIDE

HRC NEWS



Xi Calls for High-quality Growth Through Developing Yangtze River Economic Belt

WUHAN, April 26 (Xinhua) – Chinese President Xi Jinping on Thursday called for achieving high-quality economic growth through developing the Yangtze River economic belt.

Xi, also general secretary of the Communist Party of China (CPC) Central Committee and chairman of the Central Military Commission, made the remarks at a symposium on promoting the development of the Yangtze River economic belt in Wuhan, capital of central China's Hubei Province.

He stressed the importance of enhancing reform and innovation, strategic coordination as well as planning and guiding in developing the economic belt.

"It is a major decision made by the CPC Central Committee and a major strategy concerning overall national development to promote the development of the Yangtze River economic belt," Xi said.

He called for all-out efforts to protect the Yangtze River, saying there should be no large-scale development of the river.

"In developing the economic belt, the key lies in properly dealing with the relationship between pressing ahead on the whole and making breakthroughs in key areas, between ecological environment protection and economic development, between making an overall plan and making unremitting efforts, between getting rid of old growth engines and cultivating new engines, and between developing individually and developing in a coordinated way," he said.

Before the symposium, Xi on Tuesday inspected Hubei Xingfa Chemicals Group, China's largest

fine phosphoric chemicals maker and the largest relocated company in the Three Gorges Reservoir region.

"The Yangtze River is China's mother river, and we must protect it, while enterprises are the major force in protecting and building the ecological environment of the river," he said.

"We must move all polluting enterprises from along the Yangtze River with resolve... to root out hidden dangers of pollution," he stressed.

Xi called for putting restoration of the river's ecological environment high on the agenda in developing the Yangtze River economic belt.

"When we say there should be no large-scale development, it does not mean we cannot develop it at all, but we should stay away from destructive development of the river, and we should follow a green development path which puts ecology first," Xi said.

Also on Tuesday, Xi inspected the Three Gorges Project and the dam area's neighboring ecological environment.

Calling the Three Gorges Project a crucial piece of high-end equipment for the nation and a major symbol of China's development since the reform and opening-up, Xi stressed the importance of having the capability to make really important high-end equipment "using our own hands."

"To get core and key technology, begging alms won't work," Xi said. "We must rely on our own hard work."

On Wednesday morning, Xi inspected the ecological environment and development along the Yangtze River by ship.

Describing restoration of the river's ecological environment "an arduous task that the new era has entrusted to us" and "the high expectations of the people," Xi called for top priority to be given to stopping unplanned development and capping the total pollution discharge.

"We must not allow the ecological environment of the Yangtze River to continue deteriorating in the hands of our generation, and we must leave our descendants a clean and beautiful Yangtze River," he said.

On Thursday afternoon, Xi chaired a symposium on promoting the development of the Yangtze River economic belt.

"We must proceed from the long-term interests of the Chinese nation to put restoring the ecological environment of the Yangtze River at a dominant position, making all-out efforts to protect it, and forbidding large-scale development of the river," he said.

The aim is to build the economic belt into a golden economic belt featuring more beautiful ecology, more smooth transport, more coordinated economy, more integrated market and more scientific mechanisms, he said.

Saying that difficulties and challenges remain in developing the Yangtze River economic belt, Xi made five suggestions to promote the development of the Yangtze River economic belt.

First, efforts should be made to properly deal with the relationship between pressing ahead on the whole and making breakthroughs in key areas, so as to protect and restore the ecological environment of the Yangtze River in all aspects.

Second, efforts should be made to properly deal with the relationship between ecological environment protection and economic development, and explore a new path which puts ecology first while pursuing green development.

Third, efforts should be made to properly deal with the relationship between making an overall plan and making unremitting efforts, and stick to a single blueprint until the end.

Fourth, efforts should be made to properly deal with the relationship between getting rid of old growth engines and cultivating new engines, and facilitate the establishment of a modern economic system for the Yangtze River economic belt.

Finally, efforts should be made to properly deal with the relationship between developing individually and developing in a coordinated way so as to make the economic belt an efficient economic entity.

Vice Premier Han Zheng, a member of the Standing Committee of the Political Bureau of the CPC Central Committee and also head of the leading group for promoting the development of the Yangtze River economic belt, addressed the symposium.

(Source: Xinhua) ■

Xi Urges Stronger Independent Innovation Capacity

YICHANG, Hubei, April 25 (Xinhua) – President Xi Jinping has urged stronger independent innovation capacity for China during an inspection to the Three Gorges Dam, saying the country must master the core technology of high-end equipment.

China must rely on its own efforts, Xi said Tuesday at the dam, which lies on the Yangtze River near Yichang City, central China's Hubei Province.

As the world's largest hydropower project, the Three Gorges project is a multi-functional water control system consisting of a dam stretching 2,309 meters long and 185 meters high, 32 hydropower turbo-generators, a five-tier ship lock and a shiplift.

China would not have its leading ability if it had relied on others to build the dam, said Xi, also general secretary of the Communist Party of China Central Committee and chairman of the Central Military Commission.

The great rejuvenation of the Chinese nation can only be achieved through untiring struggle, he said.

Xi inspected the ship lock, the shiplift and the power plants on the northern bank of the Yangtze River, and listened to reports about work on topics including construction, power generation, navigation and environmental protection.

During an inspection to a new material industrial park on the Yangtze River, Xi stressed coordination in ecological protection and economic development.

Ecological restoration should be the top priority, Xi said, noting China's mother river must be protected, and any exploitation that is destructive to the environment must be forbidden.

China will push for industrial transformation and upgrades in the region, and foster suitable sectors under the precondition of ecological protection, to achieve high-quality development in a scientific, orderly manner, Xi said.

(Source: Xinhua) ■

Ambassador Liu Quan: The Road to Common Development

On April 23, 2018, Vanuatu Daily Post published a signed article titled 'The Road to Common Development' by Chinese Ambassador to Vanuatu Liu Quan. The full text is as follows:

Time flies. It has been two years since I came to Vanuatu as Chinese Ambassador. I'm not a stranger to this beautiful land since I worked here as a diplomat from 2001 to 2003. For the last 17 years, I have been following the economic and social development of this country of paradise. In the meantime, I am proud to be the participant and witness of the great achievement of Sino-Vanuatu relations.

I still vividly remember that the first important event I attended was the ground breaking ceremony of Korman Stadium in April, 2016. On that occasion, almost all the Ministers and leaders of Opposition were present. In my remarks I mentioned that China has nothing to hide. China and Vanuatu are true friends. We respect each other and support each other. On international arena, China and Vanuatu cooperate very well on regional and international issues of common concerns. I emphasized that my mission here is to strengthen China-Vanuatu Strategic Partnership featuring mutual respect and common development.

I am pleased to see that with our joint efforts, China-Vanuatu relations are in an excellent shape and it has set a good example for China's ties with other pacific island countries. China

attaches great importance to Sino-Vanuatu ties and "Vanuatu greatly values its relationship with China as an important development partner, friend and global leader."(quoted from recent statement of Prime Minister's Office)

I am pleased to see that Chinese medical doctors have served the people of Vanuatu for 30 years, alleviating the pains of thousands of patients. Furthermore, in recent years Guangdong Province of China has sent eye doctors to Vanuatu to perform cataract surgeries for the blind people, bringing light to them for a better life. It is worth mentioning that after TC Pam, Chinese Government responded quickly to donate about 5 million US dollars worth of humanitarian disaster relief materials to Vanuatu. A friend in need is a friend in deed. China's great efforts have earned wide appreciation from all walks of life.

I am pleased to see that over the years, China has funded more than 100 students of Vanuatu to study in China, pursuing degrees in science, technology, engineering and social science through Chinese Government Scholarship Program. Last year, I launched the Chinese Ambassador Scholarship in USP Emalus Campus, encouraging students to learn Mandarin and Chinese culture.

I am pleased to see that nearly one thousand people of Vanuatu have participated in the training seminars sponsored by China in recent years. These seminars have contributed a great deal to the capacity building of human resources of Vanuatu and at the same time, deepened people to people friendship between our two nations.

I am pleased to see that a lot of landmark buildings have been erected through China's aid. These buildings not only improve the level of public infrastructure, but also promote the positive image of Vanuatu at large. Just like Prime Minister said recently in an official statement that "They are buildings of National significance to this country."

I am pleased to see that Tanna-Malekula road and Santo wharf have significantly facilitated the export of local products and tourism industry, bringing tangible benefits to people of Vanuatu.

Especially, I am pleased to see that under the all around support from China, 2017 Pacific Mini Games has achieved great success. For this project, Chinese Government not only provided the Stadium, vehicles and all sports equipment, but also funded 190 athletes to receive training in China for five months. In addition, 15 Chinese coaches also came to Port Vila for intensive training and site coaching. I would like to once again congratulate Vanuatu to win 76 medals, which is an unprecedent achievement in its history. I shared the joys, pride and happiness with the people of Vanuatu.

Most of the projects mentioned above are funded by Chinese grants, including National Convention Center, Prime Minister's Office, Korman Stadium and Malapoa College, etc. Only a fraction of projects are funded by concessional loans from China. Facts speak louder than words. China's aid assistance have made great contributions to the development of Vanuatu and have earned wide recognition and appreciation from both the government and its people.

About the concessional loan, I need to point out that China always bears in mind the debt-paying ability and solvency of Vanuatu, avoiding heavy debt burden to the Government. All those relevant projects have been conducted with careful feasibility study and market research, so that they would deliver the desired economic and social benefits. China's experience tells us that "To be rich, one has to build road first." I believe that, at the request of Vanuatu Government, China's infrastructure loan projects will lay a solid foundation for the sustainable development of Vanuatu in the future.

Meanwhile, I'd like to take this opportunity to tell you a piece of good news. Several days ago, China International Development Cooperation Agency (CIDCA) was established. The launch of CIDCA is a landmark event in the history of China's foreign aid. It is a strong signal that China will further strengthen its cooperation with developing countries, and increase its aid to the least developed countries.

It is well known that when providing foreign assistance, China adheres to the principles of not imposing any political conditions, not interfering in the internal affairs of the recipient countries and fully respecting their right to independently choosing their own paths and models of development. The basic principles that China upholds in providing foreign assistance are mutual respect, equality, keeping promise, mutual benefits and win-win. China always listens to what Vanuatu wants and fully

respects the wishes and needs of the Government of Vanuatu. Just as Prime Minister said in an official statement, "Most of the projects that the Chinese people have provided to Vanuatu through their Government are aid assistance based on the requests by the Government of Vanuatu. These projects are important with no strings attached."

Some friends may notice that China's aid towards Vanuatu has been increasing year by year. This is because the fast economic growth of China has enabled itself to provide more foreign aid. Chinese people believe that China will do well only when the world does well. As the second largest economy and permanent member of UN security council, China is determined to fulfill its international responsibilities and obligations. Within its ability, China provides its assistance to other developing countries under the framework of South-South cooperation, to help other developing countries, especially the least developed countries, to achieve UN 2030 Sustainable Development Goals. China's aid to the developing countries is an important part of that great efforts. I believe the aspirations of the people for a better life should be the goal of all of us.

The year 2018 marks the 40th anniversary of China's reform and opening up. Over the past four decades, China has become the second largest economy, the largest industrial producer, the largest trader of goods, and the holder of the largest foreign exchange reserves in the world. 700 million people have been lifted out of poverty, which is unprecedent in the history of mankind. Not long ago, at the Boao Forum President Xi Jinping made it clear to the world that China's door of opening-up will not be closed and will only open even wider. In terms of foreign policy, China firmly upholds the international order and the system underpinned by the purposes and principles of UN Charter and dedicates itself to build a shared future for mankind. What's important is that China insists on abiding by the Five Principles of Peaceful Coexistence, namely, mutual respect for sovereignty and territorial integrity, mutual non-aggression, non-interference in each other's internal affairs, equality and mutual benefit, and peaceful coexistence. Based on those principles, China will never seek hegemony, expansion or sphere of influence. China has no geopolitical calculations and has no intention to build its own backyard garden, but to build a garden shared by all. We are now living in 21st century, the zero-sum game and Cold War mentality should be totally discarded.

30 years of diplomatic career give me the privilege to work in different countries. I notice that more and more people begin to learn and understand China. I recommend people to read the book "Xi Jinping: The Governance of China". I am quite sure that through this book one could find out the secret of China's success and better understand China's foreign policy. I also encourage the people of Vanuatu to visit China and see it through their own eyes. Seeing is believing. They would be amazed to discover a true picture of China.

There is a Chinese saying that "as distance tests a horse's strength, so time reveals one's heart." I believe in the judgement and wisdom of the people of Vanuatu and I am convinced that rumors and speculations will never prevent China-Vanuatu relations from moving forward. What I know for sure is that with our joint efforts, the road to common development will be even wider!

(Source: People's Daily Online) ■

Commentary: Urgent Need for China to Start New Round of Self-innovation

Along with the discussion on the urgency of making chips of our own, developing operating systems independently has also become a recent concern among the Chinese public.

Operating systems are related to the core competitiveness of information technologies. They are the groundwork for controlling a computer or network, and they can even control users' information and operations if it's necessary, said Ni Guangnan, an academician at the Chinese Academy of Engineering.

It's a long-cherished dream of Chinese scientists to independently develop an operating system like Windows. To this aim, China has developed the Kylin and other operating systems, but it is extremely difficult to make a system that's commonly used and widely applied.

People have compared development of the Windows operating system to the US's Apollo Moon-landing Project to describe how complex and difficult it is. Besides that, the Windows operating system has gone through many upgrades, each costing a huge amount.

The success of an operating system is dependent on the ability to build an industry chain, which holds the hardware developers, software developers and users together. But it also sets up a barrier for new players: even if they could develop a new operating system; they are still unable to jump out of the existing framework.

The current situation won't be changed unless some revolutionary opportunities emerge. Apple's iOS system and Google-developed Android system are two successful players emerging in the personal computer era and gaining ground by taking opportunities brought about by the progress of mobile Internet.

In the era of cloud computing and big data, core factors like operating systems will still exist for new opportunities.

Striving for self-innovation and making breakthroughs in core technologies will guard cyber security and propel China forward to become a cyber power. In 40 years of reform, China has built itself into a big player in regards to Internet, science and technology, and it is well-prepared to become a stronger one.

The country has to start a new round of self-innovation and defuse worries of conceding to others in developing chips and operating systems, as well as high-end manufacturing.

China will strive for breakthroughs in core information technologies, Chinese President Xi Jinping said in his speech delivered at a recent national conference on the work of cybersecurity and informatization.

(Source: People's Daily Online) ■

China's Endeavor to Build Clean, Beautiful Country Contributes to Global Ecological Development

China's endeavor to build itself into a beautiful country, which has been defined by President Xi Jinping as a goal to be met by 2035, contributes to promoting ecological development for the world and has won acclamations from the international community.

ADDING DIMENSION TO DOMESTIC POLICY

An environmental focus was incorporated into the country's development plan mapped out in the report delivered by Xi at the opening session of the 19th National Congress of the Communist Party of China (CPC) in October, an unprecedented move suggesting the country's determination to "provide more quality ecological goods to meet the people's ever-growing demands for a beautiful environment."

"The modernization that we pursue is one characterized by harmonious coexistence between man and nature," Xi said.

In his speech, Xi vowed to promote green development, solve prominent environmental problems, intensify the protection of ecosystems, and reform the environmental regulation system.

Ibrahim Thiaw, deputy executive director of the United Nations Environment Program (UNEP), told Xinhua in a recent interview that the congress "was a landmark because the leadership come out strongly to speak about not only social and economic issues, but also environmental issues."

"What we have seen recently in China is a very clear direction from the leadership that air and water pollution should not result in fatality and can be addressed with clear policy. We have seen the Chinese president and government adopt very clear positions and policy to help deal with pollution," Thiaw said.

Given China's status as the world's second largest economy and its political influence and leadership role

around the world, China's adoption of domestic polices in regard to the environment has global implications, he added.

OFFERING EXPERIENCE TO GLOBAL DEVELOPMENT

China has set prominent examples of successful practices concerning environmental governance, a recent case being Chinese individuals and company garnering half of the United Nations' highest awards on environmental protection this year.

In December, the UNEP honored six inspirational environmental leaders with the Champions of the Earth award in Nairobi, Kenya. The Saihanba Afforestation Community from China's northern province of Hebei was awarded for transforming degraded land into a forest covering 92,000 hectares, preserving and purifying huge volumes of water for major cities in northern China and spurring green sector growth.

"The Saihanba Afforestation Community have transformed degraded land into a lush paradise -- part of a new Great Wall of vegetation that will play a part in helping protect millions from air pollution and preserving precious water supplies," said Erik Solheim, executive director of the UNEP.

The community's work has proved that environmental degradation can be reversed, and that this is an investment worth making, Solheim added.

On the market side, China's bike-sharing company Mobike Technology Co. was awarded for exploring market-driven solutions to air pollution and climate change.

The World Wildlife Fund calculated that as of August 2017, Mobike users alone had collectively pedaled some 5.6 billion km, cutting more than 1.26 million tons of carbon dioxide emissions.

Solheim said the award to Mobike shows the private sector can make a healthy profit while at the same time making huge improvements to people's lives and the environment.

"It proves that environmental challenges are not problems, but opportunities. This work is an inspiration to China and the world," he said.

Mobike has already entered cities in Italy, Britain, Japan, the United States, Malaysia, Singapore, Thailand and South Korea, and is venturing out to the Latin American market.

At the technological front, China has been offering expertise and experience in smart, green innovation to the larger world for a harmonious coexistence of nature and mankind.

Claudia Assmann, deputy program officer of the UNEP, said that after years of efforts, China is on a good track of green development, especially in the areas of electric transport, solar energy and the "sharing economy."

SHOULDERING RESPONSIBILITY FOR INTERNATIONAL COOPERATION

As an important participant, contributor, and torchbearer, China is taking a driving seat in global cooperation to tackle ecological issues.

China is one of the first countries to have ratified the Paris Agreement, and has more than met its carbon emission reduction goals last year, exemplifying a responsible stakeholder's role in global efforts to fight against climate change.

Achim Steiner, administrator of the United Nations Development Program, said the agency and China share many common visions in global cooperation.

Miroslav Lajcak, president of the United Nations General Assembly for the 72nd session, praised China's job in establishing an assistance fund for South-South cooperation in support of developing countries' efforts to implement the agenda.

In 2015, China pledged a package of 3.1 billion U.S. dollars to the South-South Cooperation Fund on Climate Change for developing countries.

One country alone cannot address challenges for all. Besides China's endeavors, Xi also called for concerted efforts of the world to protect the planet.

"We call on the people of all countries to work together to build a community with a shared future for mankind, to build an open, inclusive, clean, and beautiful world that enjoys lasting peace, universal security, and common prosperity," Xi said in the report to the 19th CPC National Congress.

(Source: China Daily) ■

China's Green Development Creates Opportunities, Boosts Cooperation

From electric cars to garbage recycling, China's green path has provided inspiration and opportunities for global environmental protection enterprises.

The output of the energy saving, environmental protection and recycling industries in China totaled over 4.5 trillion yuan ($681 billion) in 2016, and eco-friendly investment from 2016 to 2020 is expected to top 17 trillion yuan nationwide, according to published statistics.

"Energy and environmental protection firms in the US have seen market opportunities in China, and are willing to invest in China," said Devinder Mahajan, professor at Stony Brook University, at the 3rd Sino-US Energy and Environment Forum held early this month.

For US auto giant Ford, business opportunities lie in China's huge market for new energy vehicles.

"China is taking the lead in the electric vehicle market as there is a real government push to clear the air," said Bill Ford, executive chairman of Ford Motor Company, at the 2017 Fortune Global Forum this month.

The US car maker announced a joint venture with China's Anhui Zotye Automobile to produce and sell electric cars in China, with plans to launch 15 electric car models in the country by 2025.

"China's program to electrify road transport has set an example for the world in green development approaches," said Erik Solheim, executive director of the UN Environment Programme (UNEP).

While foreign firms eye opportunities on China market, Chinese enterprises have cooperated with foreign counterparts in seeking green development.

As the contractor of Reppie, Africa's first waste-to-energy incineration plant in Ethiopia, the China National Electric Engineering Company introduced its technology and machinery to help the country's capital incinerate 1,400 tons of waste per day, roughly 80 percent of the city's rubbish. The plant is due to begin operating in January next year, according to the UNEP website.

A total of 44 China's environmental protection firms have signed 149 contracts with 54 countries so far, covering areas of solid waste management, water treatment and soil remediation, according to the E20 Institute of Environment Industry.

UNEP Deputy Executive Director Ibrahim Thiaw said that China had become a major contributor of clean technologies around the world, which would benefit developing countries.

Feng Liang, a senior official with the National Development and Reform Commission, said at a forum that China's green industry would enjoy growing popularity in the global market against a backdrop of international capacity cooperation and continued government support.

"China's green industry will gain a larger share overseas and embrace a golden era," Feng said.

The progress cannot be made without a series of campaigns that China has launched to fight pollution and environmental degradation, as decades of growth have left the country with smog, polluted water and contaminated soil.

Addressing environmental governance at an unprecedented level, the Communist Party of China (CPC) has incorporated "Beautiful China" into its two-stage development plan for building a great modern socialist country, according to the report delivered at the 19th CPC National Congress in October.

The toughest-ever environmental protection law was passed, and a "river chief" system was introduced to purify water. The government has drawn red lines in certain regions to strengthen environmental protection.

China has also been phasing out unclean and inefficient coal-fired boilers, setting up new monitoring stations for air, water and soil protection, and working to build a clean, low-carbon, safe and efficient modern energy system.

The effort has paid off. A total of 84 major cities met air quality targets in 2016, whereas the number was just three in 2013. The proportion of severely polluted surface water declined to 8.6 percent in 2016.

China's Saihanba Afforestation Community scooped the annual UN Champions of the Earth Award for its outstanding contribution to restoration of degraded landscapes.

"It proves that environmental challenges are not problems, but opportunities. This work is an inspiration to China and the world," said Erik Solheim, hailing the Saihanba Afforestation Community.

(Source: China Daily) ■

China, Belt and Road Countries Seek Deeper Cooperation on Energy

The Belt and Road Energy Ministerial Conference, held in east China's Suzhou city, Oct. 18, 2018.

China and over 10 Belt and Road countries Thursday pledged to build a cooperative partnership on energy to inject new impetus to energy development of various countries.

The pledge was made in a joint declaration announced at the Belt and Road Energy Ministerial Conference, which was held in east China's Suzhou city. Chinese President Xi Jinping sent a congratulatory letter to the conference.

The Belt and Road Initiative has been widely recognized and actively participated by the international community since it was proposed five years ago, with fruitful results achieved, Xi said in the letter.

"We are willing to work with all parties to continue joint efforts and stick to the principle of achieving shared growth through discussion and collaboration, to make in-depth and solid progress in Belt and Road cooperation and better benefit people of all countries," he said.

Xi stressed that energy cooperation has been a key field in jointly building the Belt and Road.

He said China is ready to work with other countries to strengthen energy cooperation within the framework of joint construction of Belt and Road, create favorable conditions for common development, jointly contribute to the sustainable development of global energy and safeguard world energy security.

Xi called for in-depth discussions and consensus during the conference on major issues such as deepening international energy cooperation and promoting global energy transition, to facilitate the establishment of the Belt and Road energy cooperative partnership that can contribute to the building of a community with a shared future for humanity.

Energy cooperation has been a key field in jointly building the Belt and Road. Since the initiative was proposed five years ago, a set of energy projects have been successfully launched, bringing great social and economic benefits.

To promote the utilization of clean, safe and efficient energy has become a common task worldwide.

Participants at the meeting also said that countries need to tap potentials for energy cooperation, solve problems in green energy development, speed up global energy transition, and jointly promote high-quality development of green energy.

(Source: yidaiyilu) ■

Small Hydropower Plants Defy What Is Meant by "Small"

Thiago Couto, Julian Olden, School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington USA

University of Washington researchers have publi-shed their first major assessment of small hydropower plants around the world and highlight the variability in how dams of varying sizes are categorised, regulated and studied. Julian Olden, Professor at the School of Aquatic and Fishery Sciences, and PhD student Thiago Couto give more details.

As aquatic ecologists, we have been very intrigued that amidst evolving conversations over the environmental sustainability of large hydropower, a remarkable surge in favor of Small Hydropower Plants (SHPs) has emerged. Broadly referring to facilities that differ from large hydropower plants by producing less electricity and operating in smaller rivers, we admit that the modifier "small" has long puzzled us.

Let's be honest, the words "small" and "large" are quite ambiguous. Based on our years of field adventures ranging from North to South America, and well beyond, we have seen SHPs that include an incredible diversity of dam sizes, operation modes, and flow control structures. So, just how small are SHPs with respect to their global number, physical attributes, and potential environmental impacts? In a recent paper published in the journal Frontiers in Ecology and the Environment, we sought to answer these questions.

Astonished

After scouring data from numerous articles, reports and policy documents, we were astonished to reveal an estimated 82,891 SHPs currently in operation or under construction in 150 countries across the world. China appears to be the global leader with more 47,000 SHPs in operation, largely sparked by private investments, technology leadership and rural electrification programmes. Europe is currently home to around 27,000 SHPs, where many nations have a long history of hydropower development and have witnessed a recent resurgence to meet international agreements promoting clean energy. Similarly, many other countries have initiated aggressive energy policies in recent decades that continue to fuel rapid SHP growth. Overall, we found that there are 11 SHPs for every large hydropower plant in the world.

Our assessment also revealed disparities in how countries classify hydropower plants as "small". Remarkably, almost one-fifth of all countries that currently operate SHPs do not have a formal (or widely accessible) national definition. For the remaining countries there are striking differences in maximum generation capacity, ranging from facilities generating less than 1MW for Germany and Burundi to a value of 50MW for Canada, China, and Pakistan. About three-quarters of countries with formal definitions classify SHPs as installations with less than 10MW; an international standard being increasingly recognised. The large diversity of definitions across countries - based exclusively on capacity - includes schemes that have substantially different dam sizes, reservoir areas and storage, outlet structures, and operating procedures. In one example, two SHPs in Brazil (São Sebastião, Braço Norte II) have the same capacity (10MW) but differ 30-fold with respect to their reservoir areas (0.2 and 6.0 km^2, respectively).

According to a global policy compilation, we found that at least 44 countries require a formal environmental licensing process to construct and operate SHPs;

leaving potentially upwards of over two-thirds of the world's countries without recognised environmental requirements. This concerns us because emerging research suggests that SHPs do cause environmental impacts, including those associated with the dam construction and land inundation, as well post-construction alteration to flow regimes, water quality, and the loss of habitat connectivity. Perhaps most under-appreciated is that the environmental impacts of SHPs may be manifested across multiple installations, and therefore should be considered collectively and not just in isolation. For example, the presence of multiple obstacles can exacerbate the difficulties of freshwater fish and other organisms to disperse.

Management challenges

Moving forward, our research points to three primary management challenges associated with SHPs. First, we advocate that environmental impact assessments should be compulsory during the licensing process for all SHP projects due to their enormous diversity of sizes, operations, and geographic locations. A hydropower project being labeled as "small" should not automatically lead to a faster and less comprehensive licensing process.

Second, environmental assessments must additionally go beyond individual SHP projects by considering the broader watershed context before new construction is approved. The continued proliferation of SHPs necessitates a systematic evaluation of cumulative effects of current and planned installations, an issue that is overlooked by most present-day environmental regulations.

Third, as aquatic ecologists we believe more science is needed to support management strategies and policy reforms that attempt to minimize the environmental impacts of SHPs while continuing to recognize their role in contribution to a more sustainable energy future.

REFERENCE:

Couto, T.B.A., and J.D. Olden. 2018. Global proliferation of small hydropower plants – science and policy. Frontiers in Ecology and the Environment, doi:10.1002/fee.1746.

http://www.waterpowermagazine.com/features/featuresmall-hydropower-plants-defy-what-is-meant-by-small-6218676/

Global Development of Renewables Must Increase by Six-fold to Meet Paris Agreement Goals

A report released this week by the International Renewable Energy Agency indicates the world-wide adoption of green generating sources must increase by at least six-fold in order to meet Paris Climate Agreement emission reduction targets.

The IRENA document, titled, "Global Energy Transformation: A Roadmap to 2050", was unveiled at the Berlin Energy Transition Dialogue and represents the organization's latest long-term outlook.

According to the study, the increase in renewable energy is necessary to meet the Paris Climate Agreement's goal of limiting the rise in global temperatures to two degrees Celsius through 2050. In its analysis, IRENA outlines a global energy system in which renewables make up about 66% of the world's total energy consumption and 85% of its generation – increases from 18% and 25%, respectively.

"An opportunity exists to ramp up investment in low-carbon technologies, and shift the global development paradigm from one of scarcity, inequality and competition to one of shared prosperity – in our lifetimes," said IRENA Director General Adnan Amin. "That is an

opportunity we must rally behind by adopting strong policies, mobilizing capital and driving innovation across the energy system."

The plan would require an increase in cumulative renewable investments by 30% to 2050, but would create more than 11 million additional power sector jobs. This would result in a 1% increase in global economic growth.

"Transformation will not only support climate objectives, it will support positive social and economic outcomes all over the world, lifting millions out of energy poverty, increasing energy independence and stimulating sustainable job growth," Amin said.

Though the worldwide growth in renewables has remained steady, increasing by 167 GW to a cumulative 2,179 GW in 2017 – IRENA projects fossil fuels including oil, natural gas and coal would continue to "dominate" the global energy mix in 2050 without a new emphasis on renewable deployment.

Hydroelectric power has a place in IRENA's roadmap, though much of the plan's emphasis is on developing lesser-utilized renewables like wind and solar.

Still, as IRENA noted in its Renewable Capacity Statistics 2018 report – issued earlier this month – growth across all of hydro's sectors is increasing.

(Source: HRW) ■

Namibia: A Prime Destination for Investment in the Hydro Sector

Namibia is a prime destination for investment in the hydro sector. The country has hydro potential of at least 10 000 GWh/year, of which only 11 per cent has been developed.

General View of Namibia Ruacana Hydro Project

Namibia has experienced a period of exceptional growth and economic stability (IMF Annual Report 2017), making it a prime destination for investments in the hydro sector. The hydropower potential of Namibia was re-evaluated in 2000 and according to this evaluation, the country has a theoretical potential of at least 10 000 GWh/year (equivalent to 2250 MW of capacity). The study indicates that while all of this potential is technically feasible, only 11 per cent has been developed.

Supporting the case for development, the World Bank reported this year that "Namibia's government continues to exercise the requisite leadership in developing and financing the policies it needs to address its development challenges, policies such as the Harambee Prosperity Plan, and the fifth National Development Plan".

NamPower typically imports more than 60 per cent of its annual energy usage from the SADC region, while the remainder is generated mainly by the Ruacana hydro scheme, which last year contributed 1593 GWh. The Ruacana turbine refurbishment project, which included the replacement of the turbine runners as well as upgrades to the governors and penstock inlet valves of Unit No. 1, 2 and 3, was completed in October 2016, after the upgrades on Unit 1 had proved to be successful. The installed capacity of the power station is now 347 MW, including the recent 15 MW increase (5 MW per unit).

Last year, NamPower awarded an EPC contract to add 330 kW of PV generation at the Ruacana site to supplement the auxiliary supply requirements of the power station. The site is located adjacent to the existing powerplant head bay structure and will house approximately 1200 Tier 1 solar PV panels with generation fed into the existing 11 kV power station.

Following the success of the Ruacana scheme, the 600 MW Baynes hydro project is a joint initiative being pursued on the Kunene river basin by the Angola-Namibia Permanent Joint Technical Commission (PJTC).

The Techno-Economic Feasibility Study was contracted to a consortium of Brazilian companies (Cunene Consortium) and was completed in

2013. The Environmental Social and Health Impact Assessment (ESHIA) studies were contracted to Environmental Resources Management (ERM). The ESHIA studies are at an advanced stage, with negotiations between the project affected communities still pending.

Project offices have been established in both Namibia and Angola and are tasked with managing all outstanding work necessary to make the project bankable. This includes the drafting of a bi-lateral country-to-country agreement, which is currently being developed by a multi-national legal consultancy (Miranda). The bi-lateral agreement will subsequently become known as the 'Baynes Treaty' and is scheduled to be completed by the middle of this year (2018). The Baynes Treaty will detail the project implementation model and relevant regulations, taking into account the bi-national nature of the project.

At the end of 2017, the Minister of Mines and Energy, Obeth Kandjoze, reported that development of the Baynes hydropower project will commence as soon as funds are available. Kandjoze said "all arrangements between Angola and Namibia with regard to the project remain in place and the project is strategically important to both Angola and Namibia in tackling power supply deficits". Like the Ruacana scheme, Baynes will function as a peaking station so that national bulk electricity supplier NamPower can avoid buying imported power during peak hours.

The Baynes power station is expected to run at full capacity during the wet season. During the dry season, generators will operate at maximum during peak periods only, and 71 MW would be generated during the off-peak periods.

In a recent development earlier this year, while meeting Namibian President Hage Geingob, Chinese Parliamentary Leader, Li Keqiang, indicated his country's readiness to synergize cooperation to promote Namibia's development strategy and jointly facilitate economic globalization and trade liberalization. As we go to press (mid-May, 2018) Mr. Keqiang scheduled to visit Namibia to finalize several partnership agreements between the two countries.

Another large project under development is the Neckartal project will include a curved gravity dam constructed with RCC. The structure which will span the Fish river and have a crest length of 520 m and a height of 80 m. More than 1 x $10^6 m^3$ of RCC will be needed to complete the dam that will store a reservoir volume of 850 x $10^6 m^3$. The scheme will irrigate agricultural land located approximately 21 km away. From a downstream abstraction weir, pumped water will be piped to a reservoir above the irrigation area, then gravity-fed to farms.

Salini Impregilo SpA was awarded the N$ 2.8 billion (US$ 0.22 billion) contract to build the dam, and earlier this year reported to the permanent secretaries of the ministries of finance and agriculture as well as the acting permanent secretary of the National Planning Commission that there is "there is no risk to construction". Meanwhile, Knight Piésold Consulting Engineers said it was difficult to pinpoint the completion date of the dam but estimated that it would be later this year.

Meanwhile, a feasibility study has been submitted for the proposed Vioolsdrift dam, which would be built on the Lower Orange river. This would be a joint venture between the Governments of South Africa and Namibia. It is likely that hydropower would be one of the purposes of the dam, which is planned to have a height of 80 m. Another planned dam is Epupa, which could be 160 m high, and would be on the Kunene river. The total storage capacity of dams (including Neckartal) will be 1.57 km^3.

At present, there is only one small hydro plant (0.5 MW) in operation. There are plans to implement about 13 more small plants on the Orange river,which could have a total capacity of 108 MW, and production of 380 GWh/year.

According to the World Bank Group flagship report "Doing Business 2018", Namibia is the economy that improved most notably in the area of enforcing contracts in 2016/17. "Namibia made enforcing contracts easier by introducing an electronic filing system and an electronic case management system for the use by judges and lawyers".

For parties interested in pursuing investment opportunities, the Government of the Republic of Namibia, through the Ministry of Mines and Energy, is responsible for the power sector while the Namibian Power Corporation (NamPower) is responsible for the generation and transmission of electricity.

(Source: Hydropower & Dams) ■

U.S. President Signs America's Water Infrastructure Act of 2018

U.S. President Donald J. Trump signed S. 3021, America's Water Infrastructure Act of 2018, on Oct. 23.

During the signing ceremony, President Trump said, "This important bill authorizes water infrastructure projects that benefit almost every state in the country."

Referencing his campaign promise to rebuild "America's crumbling infrastructure," President Trump says this bill will enhance coastal ports; reduce flood risks; restore ecosystems; upkeep inland waterways; upgrade dams, hydropower and irrigation systems; and improve drinking water treatment, storage and delivery.

Representative Greg Walden (R-OR) specifically referenced hydropower during the signing ceremony, saying, "... there's hydropower streamlining for licensing so we can get clean, carbon-efficient, carbon-neutral hydropower in existing facilities in an expedited way."

The National Hydropower Association says AWIA will "facilitate a more efficient licensing process for proposed projects at existing non-powered dams and for closed-loop pumped storage; shorten the approval timeline for projects utilizing existing conduits; provide regulatory incentives for investments at existing hydropower facilities; and modernize preliminary permit terms and deadlines for starting construction of newly licensed projects."

Under Title III – Energy, nine sections cover energy projects, several of these related to hydroelectric power, including modernizing authorizations for necessary hydropower approvals, qualifying conduit hydropower facilities, promoting hydropower development at existing nonpowered dams, closed-loop pumped storage projects, considerations for relicensing terms, J. Bennett Johnston Waterway hydropower extension, and stay and reinstatement of FERC License No. 11393 for the Mahoney Lake Hydroelectric Project.

(Source: HRW) ■

UNIDO Strongly Supports the Development of Hydropower in Africa

LUSAKA, 6 November 2018 – The 8th "Hydropower for Today" Forum, which opened today in Zambia's capital, explored opportunities related to hydropower for productive and business activities targeting eastern and southern African countries.

The Secretary General of the Common Market of Eastern and Southern African Countries (COMESA), the Chinese ambassador to Zambia and the Permanent Secretary of the Zambian Ministry of Water Resources delivered keynote speeches. "UNIDO very strongly supports the development of hydropower in Africa", said GUO Li, Director of the UNIDO Centre for South-South Industrial Cooperation (UCSSIC/China). "Hydropower is clean, affordable and affordable, and hydropower can help lift people out of poverty!".

In parallel, the International Centre of Small Hydropower (ICSHP), COMESA and UCSSIC/China organized a workshop on Small Hydropower for technical and managerial staff. About 150 participants from 6 African countries and 3 international organizations attended the Forum.

SMALL HYDROPOWER SECTOR IN POLAND

——FACTS, OPPORTUNITIES AND CHALLENGES

Ewa Malicka
President of the Polish Association for Small Hydropower Development (TRMEW)

A summary of the present status ofthe small hydropower sector in Poland should not be missed. Representing the Polish Association for Small Hydropower Development, the organization with a history spanning over 30 years, whose main objectives include development and promotion of small hydropower in Poland, I feel I have a duty to present such overview of this sector and I would like to do so in this article.

DEFINITION

There is no official definition of small hydropower (SHP) plants in Poland. However, normally installations with a total capacity of no more than 5 MW are included in this category[1]. This categorisation is also partially reflected in the Act on Renewable Energy Sources (Act on RES), according to which hydropower plants with a capacity up to 5 MW are currently entitled to receive "green certificates". However, the Act on RES also includes other size-dependent regulations, such as the capacity limit of 20 MW for hydropower plants entitled to auctions for renewables, separate solutions (prices, baskets in auctions and feed-in premiums (FIP)) for installations with a capacity not exceeding 1 MW, as well as separate solutions (prices, feed-in tariffs (FIT) and some simplified rules) for hydro facilities defined as "small installation" with a capacity below 500 kW.However, considering that in many countries a small hydropower plant is defined as a plant with an installed capacity less than or equal to 10 MW, I will use this criterion in this article to make it more comprehensible for international readers.

SHPP IN NUMBERS AND HYDROPOWER POTENTIAL OF RIVERS

In 2017, Poland had 766 hydropower plants, of which 756 were up to 10 MW[2]. The total installed capacity of hydropower plants in Poland was 988.38 MW of which 294.75 MW was the installed capacity of small hydropower plants. In 2016, electricity generation from all hydropower plants (renewable) was 2139.4 GWh, of which 908 GWh was produced in SHP plants[3]. In addition to the developed capacity, in 2017, 162 SHPP projects (up to 10 MW), with a total capacity of 55.97 MW and expected annual generation of 252 GWh, were pending approvals

or under construction[4].

Furthermore, the technically feasible potential capacity, which could be developed over a longer perspective, is likely to be much higher. The total theoretical hydropower potential of Polish rivers has been estimated to be 23.6 TWh/year with a technical potential of 13.7 TWh/year[5]. Out of this, the technical hydropower potential for SHP plants is estimated to be approximately 5 TWh/year of which approximately 50 per cent (2.5 TWh MW) is economically feasible[6]. Taking into account the current annual generation at SHPP plants (908 GWh) that would indicate that less than 20 per cent of the country's technical SHPP potential has been developed so far. Hydropower potential in Poland is characterized by uneven distribution throughout the country with 68 per cent of resources concentrated in the Vistula River basin, out of which half are allocated in the lower Vistula region. The Oder River basin contains 17.6 per cent of the hydropower potential, while 2.1 per cent is concentrated in the rivers of Przymorze as well as Warmia and Mazury regions, which are not connected with Vistula River Basin. Another 12.5 per cent of hydropower potential is concentrated in the remaining rivers in Poland. The rivers with the largest hydropower potential are the Vistula, Dunajec, San, Bug, Oder, Bóbr and Warta. Regions most favourable for hydropower development are southern parts of Poland (mountain area) as well as western and northern parts (due to existing hydro infrastructures)[5].

REPOWERING OF HISTORIC SITES

It is estimated, that in the 1920s and 1930s, there were over 8,000 hydropower facilities in Poland (many types of mills and some hydroelectric power plants). In 1953, there were still 7,230 installations, but only 2,131 remained by 1980s and only 300 were in use at that time7. The possibility of repowering these historic sites is indicated as the potential for economically feasible and environmentally sustainable small and micro hydropower generation both by the Government and non-governmental organizations. In the Energy Policy of Poland Until 2030 as well as in the Addendum To The National Action Plan For Energy From Renewable Sources utilization of existing state-owned damming structures for electricity generation is listed as one of the aims. To meet this objective, the National Water Management Authority took an inventory of the damming structures. The results showed that there are more than 14,000 dams and weirs (with minimum head of 0.7 m) of which only 4.5 per cent is used for electricity generation[7]. At the same time, similar objectives to develop micro-hydropower potential, by identifying and restoring suitable historic sites, were at the core of the European project RESTOR Hydro, cofunded by the Intelligent Energy Europe Programme of the European Union, with Poland as one of the project implementation countries. Within the project, the RESTOR Hydro Map was created indicating 50,000 SHPP sites in Europe with 8,000 located in Poland.

ADMINISTRATIVE PROCEDURES

Obtaining administrative permits for the SHPP project in Poland consists of several steps. Firstly, the environmental impact of the development needs to be considered and the environmental decision needs to be obtained. Furthermore, the decision on building conditions is necessary and issued by the local administration unless, in rare cases, there is a spatial development plan covering the investment area. A 'water-legal' consent and 'water-legal' assessment needs to be gained from the water authority. The next important stage is to acquire the rights to manage the real estate which is the property of the State Treasury (i.e. lands covered with running water and most probably the weir) from the water authority which is responsible for maintenance and ownership supervision over the estate. The final stage of the procedure is to acquire a permit for construction through an application to the 'Poviat' or 'Voivodship' authority. Apart from the decisions above, to start operating a power plant a decision on terms and conditions of grid connection and subsequently a grid connection agreement is required from the system operator. Finally, the concession to produce electricity from the renewable energy source from the Energy Regulatory Offi ce will be needed for plants with an installed capacity exceeding 500 kW. Plants with a capacity between 50 and 500 kW must be entered in

the register of electricity producers in small installations, also run by the Energy Regulatory Office, while micro producers (installations of up to 50 kW) need to notify the local system operator about their plan to start generation.

POLICY

Although Poland refers to sustainable development in its constitution (Constitution of Poland, Article 5), the electricity sector is still largely based on carbonintensive fossil fuels, and renewable energy sources development do not play a signifi - cant role for decision-makers.

The main energy policy objective in the fi eld of renewable energy sources, and the country's binding target from the EU 2020 Climate and Energy Package, is to increase the share of renewable energy sources in total energy consumption to at least 15 per cent by 2020, and further increase it in the following years. By 2016, Poland had reached an 11.30 per cent share of energy from renewable sources (including electricity, transport, heating and cooling sectors) in gross fi nal energy consumption3. The path indicating how Poland is intending to meet its 2020 targets is concluded in the National Renewable Energy Action Plan.

On 16 November 2017, the European Commission presented the Clean Energy for All Europeans proposals which, according to the Ministry of Energy, will imply the work on Energy Policy of Poland 2050. This longawaited document should determine a longterm vision for energy sector in Poland. Until then the Energy Policy of Poland until 2030 adopted in 2009 is the main energy-specifi c long-term strategy in force.

Another strategic document which indicates the main directions of the country's development, including those of the energy sector, was adopted in 2016. In the Strategy for the Responsible Development increasing the use of hydropower potential and hydropower sector development was classifi ed as one of the projects to be implemented. This objective should be achieved by means of "liquidation of administrative barriers constricting hydropower investments, development of hydropower equipment manufacturers industry as well as utilisation and refurbishment of existing, State-owned damming facilities for the purpose of hydro-power generation".

SUPPORT SCHEMES

Since 2005, support schemes for renewable energy have been based on green certifi cates. Renewable energy producers who could join this system by 1 July 2016 are supported in two ways: fi rst, they are entitled to obtain tradable certifi cates of origin (green certifi cates); second, in the case of installations up to 500 kW there is an obligation for electricity to be purchased by the appointed energy entities, with a price announced quarterly by the Energy Regulatory Offi ce and based on the average electricity sales price on the competitive market. Since mid-2012, the system has been destabilized mainly due to the oversupply of certifi cates, causing the value of green certifi cates to decrease from PLN 251.21 (€58.42) per MWh in 2012 to PLN 36.47 (€8.48) in 2017 and electricity price within the obligation of purchase to decrease from PLN 198.90 (€46.25) per MWh in 2012 to PLN 169.70 (€39.46) in 2016. On 20 February 2015, the Act on RES was adopted in Poland, introducing a support scheme based on tendering (auctions). In the new scheme, reference (maximum) prices are defined for each technology and additionally within the technology separate reference prices are defined for installations with capacity not exceeding 1 MW and separate for those with capacity above 1 MW. Auctions are conducted separately for existing and new installations and there are separate auction baskets for installations with capacity up to 1 MW and separate for larger ones. The producers who win a tender have the right to receive the offered price for 15 years. The key solutions comprised in the act came into force on 1 July 2016.Several auctions were carried out according to the these rules in 2016 and 2017, including two auctions for installations with productivity above 3 504 MWh/MW/year and with CO_2 emission levels up to 100 kg/MWh, where 93 offers from SHPP producers won contracts and were able to migrate from the certificate system to the system of guaranteed prices within auction system.

The latest amendment to the RES Act dated 7 June 2018 is the most significant for the small hydropower sector. It brought changes in the auction system, including implementation of simple

technological auction baskets, introduction of a mechanism which excludes bids with highest offers and softening thus far very strict sanctions for failing to generate the contracted volumes. But first of all, the latest amendment introduced FIT and FIP for small hydro and biogas installations. According to the RES Act, the guaranteed price for electricity fed into the grid by both existing and planned hydro installations which will join the FIT or FIP scheme in 2018 is PLN 495 (€115.12) per MWh for SHPP with a capacity lower than 500 kW and PLN 450 (€104.65) per MWh for those with a capacity of 500 kW - 1 MW.

WATER LAW

Another important legal act which has an impact on the SHPP sector is the new Water Law, adopted on 20 July 2017. This act entirely reformed water administration and management by introducing catchment- based approach and the National Water Holding "State Waters". From an SHPP perspective, the most significant changes include introducing fees for water use in the hydropower sector (PLN 1.24 (€0.29) per each MWh of electricity generated in a hydropower plant) and rules of enabling investors' utilization of stateowned weirs through tenders, with certain exceptions. Other important regulations, such as requirements for residual flow, fish migration and restrictions in developing new hydropower projects which have to be consistent with the EU Water Framework Directive are contained in Water Basement Management Plans and Conditions of Water Use in Water Regions.

THREATS

So far continuously changing legal conditions have made a challenge both for SHPP investors and operators. The reduction in prices of green certificates has been very perceptible for renewable energy producers, nevertheless, very few hydro producers have decided to make offers in tenders and switch from certificates to auction system, regarded as very risky, complicated and not appropriate for small producers.

At the same time, the small hydro sector is bearing an increase in the operational cost of SHPP due to the obligation to adapt facilities to more and more rigorous environmental requirements (building fish passes and fish barriers, increasing residual flow, etc) as well as the implementation of water pricing for hydropower in 2018. In addition, due to the financing model of the newly established "State Waters" the sector predicts a further increase in operational costs caused by the increase in fees for leasing damming structures and lands covered with water.

Last but not least, operators of existing SHPP plants are facing a threat of reduced profitability after the operational support period. According to the Act on RES, in 2020 small hydropower plants commissioned before 2005 (approximately 350 out of 740 installations) will be deprived of the support which could be claimed so far. Having very little profitability already, such a reduction of income could bankrupt many producers. The regulations on refurbishment, which could constitute a solution in such cases, are not clear enough, making the future of existing SHPP plants uncertain. So is the future of the whole sector in the longer term perspective, because all the regulations seem to disregard any development after 2020.

CONCLUSIONS

More than 80 per cent of technical SHPP potential capacity in Poland remains unexploited as a result of historical circumstances and various administrative barriers, but also due to its specific nature. Both the governmental inventory and the RESTOR Hydro project outcomes prove the need for adaptation of existing weirs, and for making use of sites characterized by very low heads and small flows. According to the SHPP sector, this goal can only be achieved with stable financial conditions and effective regulations, giving investors access to SHPP sites (i.e. state owned weirs). There is a chance that the newly adopted FIT and FIP system will reverse the stagnation in launching new SHPP projects. Thus, the SHPP producers and investors await the Energy Regulatory Office's decisions enabling their installations to join the FIT and FIP system, and seek strategic documents and a legal framework, especially as regards SHPP refurbishment, which would include a time horizon beyond 2020. They also hope for effective management of State-owned weirs by newly established "State Waters" which will allow utilisation of existing

weirs for hydropower purposes.

References:

1 European Small Hydropower Association. Guide on How to Develop a Small Hydro-power Plant – Polish edition. 2010.

2 Energy Regulatory Office. Map of RES as of 30 Sebtember 2017. Energy Regulatory Office http://www.ure.gov.pl/uremapoze/ mapa.html

3 Central Statistical Office. Energy from renewable sources in 2016. Statistics Poland. http://stat.gov.pl/en/topics/environment-energy/energy/energy-from-renewable-sourcesin-2016,3,9.html

4 Lis, Michał and Drzewicz-Karyś, Justyna. Investments in national hydropower. Hydroelectric Power Magazine (Energetyka Wodna). no. 1 (January 2018). http://www.energetykawodna. info/

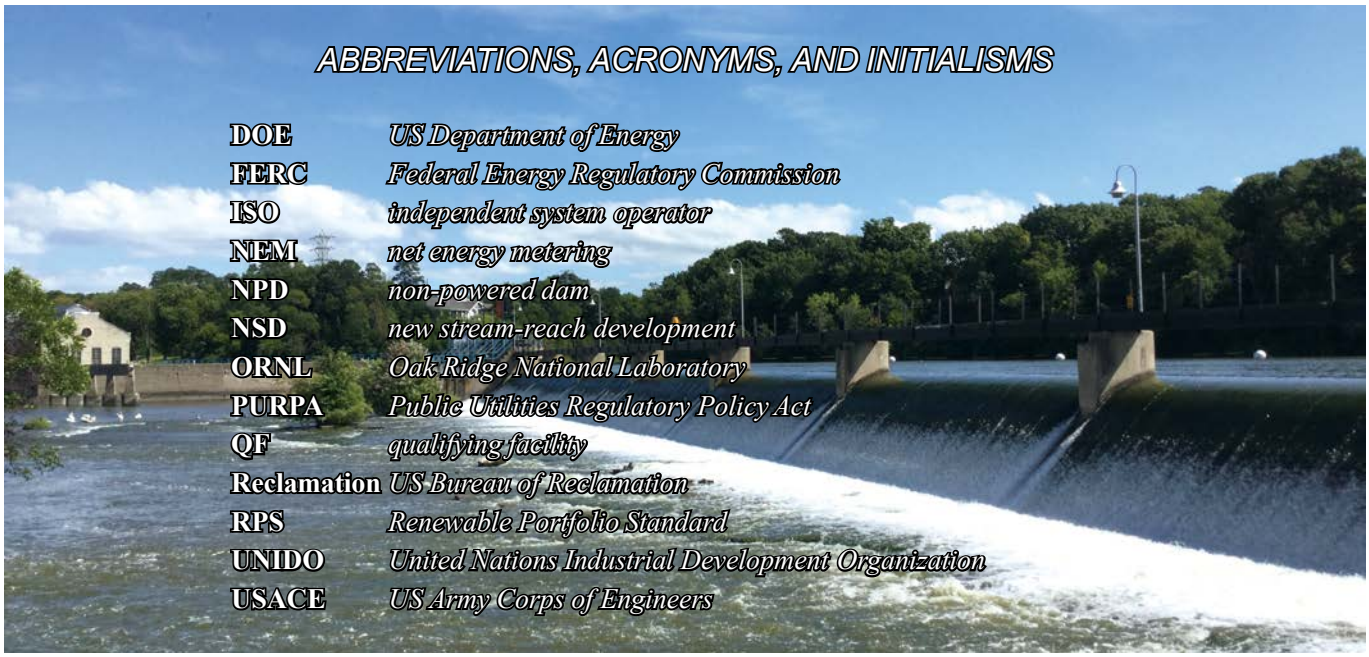
5 Hoffmann, A. and Hoffmann, M. Cadastre Of Technical Resources Of Water Energy In Poland. 1961, See also: Steller, J. Hydropower in Poland and in the European Union. Opportunities And Barriers Of Development. National Forum on Renewable Energy Sources. Warsaw.2005.

6 European Small Hydropower Association (2015). HYDI Database. http://streammap.esha.be/6.0.html

7 Geoportal KZGW, http://geoportal.kzgw.gov.pl/gptkzgw/catalog/main/home.page

Small Hydropower in the United States

Kurt Johnson, Boualem Hadjerioua, Rocio Uria Martinez



ABSTRACT

The limited development of new hydropower in the United States in the last decade has consisted mostly of small projects (those under 10 MW). Total US hydropower generation capacity has remained fairly constant in recent decades at 80 GW**,** which includes 3.6 GW of small hydro.

Currently planned new small hydro development totals 0.42 GW. The addition of hydropower generation equipment to existing infrastructure—primarily, existing non-powered dams and conduits—is the dominant trend in recent and planned new hydropower development. Federal efforts to support hydropower growth have been increasing in recent years.

KEY US FACTS

- **2018 population:** Approximately 329 million
- **Area:** 9,826,675 square km
- **Climate**: Varies widely according to location, including arctic regions in Alaska, tropical in Hawaii, Mediterranean in California, arid in the Southwest, and temperate across much of the country.
- **Topography:** Large central plains, hills, and low mountains in the East; mountains in the West. The highest point is Mount Denali (Alaska), which is 6,194 m above sea level. The lowest point is Death Valley (California), which is 86 m below sea level.
- **Rain pattern:** Varies according to location.
- **Overview of water resources:** Largest river systems based on flow volume are the Columbia River in the Northwest and the Mississippi River in the Southeast.

KEY US ELECTRICITY AND HYDROPOWER FACTS (2017)

- Total electricity generating capacity: **1,084,783 MW**
- Total annual electrical generation: **4,014,804 GWh**
- Total installed hydropower capacity: **80,089 MW across 2,248 plants**
- Total hydropower generation: **270,586 GWh**
- Total installed small hydro capacity: **3,612 MW across 1,646 plants**
- Total small hydro generation: **13,804 GWh**
- Untapped small hydro technical potential at non-powered dams (NPDs): **2,500 MW**
- Untapped small hydro technical potential for new stream-reach development (NSD): **4,321 MW**
- Untapped small hydro technical potential at existing conduits: **Unknown**
- Currently planned small hydro projects: **420 MW across 165 projects**

ELECTRICITY SECTOR

GENERAL INFORMATION

At the end of 2017, the United States had 1,084,783 MW of total utility-scale electricity generating capacity yielding approximately 4,000 TWh/year. Natural gas was the largest source (32%), followed by coal (30%), nuclear (20%), hydropower (7%), wind (6%), and solar (1%).

For many years, coal had been the largest single source of US electricity supply, but in recent years, natural gas generation has been growing rapidly, along with wind and solar (Figures 1 and 2).US electricity load growth has been minimal, with an electrification rate of essentially 100% (Figure 3).

DESCRIPTION OF ELECTRICITY SECTOR

Historically, the US electricity industry has consisted of a mix of private and public utilities that generate and deliver electricity to customers within exclusive franchise service territories. More than 3,000 electric utilities currently operate across the country.

More recently, some US states and regions have established competitive markets for both electricity generation and delivery. This has resulted in new entrants to all segments of the electricity industry, including generation, transmission, and delivery.

Because of the historically exclusive nature of utility service territories, the electric industry has been subject to a high degree of government regulation. Investor-owned utilities are regulated by the states in which they operate. Municipal utilities are operated by local governments and are overseen by local elected or appointed officials. Electric cooperatives are governed by a board of directors elected from the cooperative's membership.

The Federal Energy Regulatory

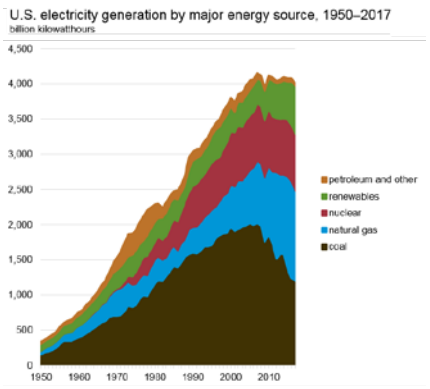


Figure 1: US electricity generation by major energy source, 1950–2017.

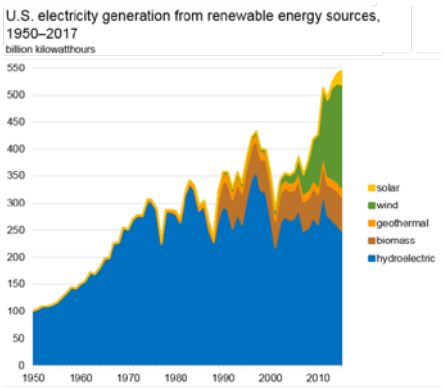


Figure 2: US electricity generation from renewable energy sources, 1950–2017.

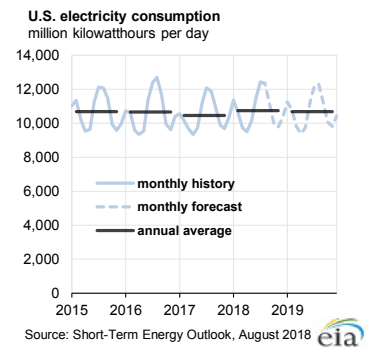


Figure 3: Trends in US electricity consumption.

Commission (FERC), an independent agency of the US government, regulates the interstate transmission of electricity. A key outcome of industry restructuring in recent years has been the formation of independent system operators (ISOs) that administer the transmission grid on a regional basis, including some portions of Canada. These entities were established to provide nondiscriminatory access to transmission for both electricity generators and distribution companies in competitive markets. The ISOs also perform centralized day-ahead dispatch of the generation resources in their service area to produce a least-cost production schedule for each hour of the next day, resolve gaps between generation and demand in real time, and operate ancillary service markets. The US-based ISOs are regulated by FERC.

The move toward greater competition in electricity supply and delivery has helped foster a shift in electricity generation sources, as noted in Figure 1.

ELECTRICITY TARIFFS

Electricity tariffs are a product of a utility's generation, transmission, distribution, and administrative costs, as well as return on investment in the case of investor-owned utilities. Recent electricity rates have been relatively stable with low annual growth, partly in response to low wholesale prices resulting from an abundance of natural gas (Figure 4). In 2017, average US electricity prices were as follows: residential: 12.9 cents/kWh; commercial: 10.68 cents/kWh; and industrial: 6.91 cents/kWh.

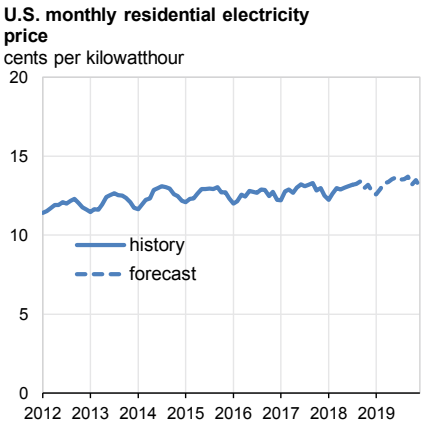


Figure 4: Trends in US residential electricity prices.

HYDROPOWER AND SMALL HYDROPOWER

US hydropower generating capacity (including projects of all sizes) increased by 2,042 MW from 2007 to 2017, bringing installed capacity to 80.09 GW across 2,248 separate plants (Figure 5). Of this net increase, almost 70% resulted from refurbishments and upgrades to the existing fleet. Most of the 117 new hydropower plants that have started operation since 2007 involved additions of hydropower generation equipment to NPDs (38) or conduits (74). The median size of new plants is less than 10 MW.

Roughly half of US hydropower capacity is located in three states: Washington, Oregon, and California. Three federal agencies—the US Army Corps of Engineers (USACE), the US Bureau of Reclamation (Reclamation), and the Tennessee Valley Authority—own nearly half of US hydropower capacity.

Most of the installed US hydropower capacity comes from large projects built between 1930 and 1970. Since the 1980s, most new hydropower capacity additions have been small.

SMALL HYDROPOWER DEFINITION

For this report, small hydropower is defined as hydropower projects under 10 MW, consistent with international definitions.

SMALL HYDROPOWER OVERVIEW

As of 2017, the existing fleet of US small hydropower plants consisted of 1,646 plants with a combined generating capacity of approximately 3,612 MW. The Northeast and the

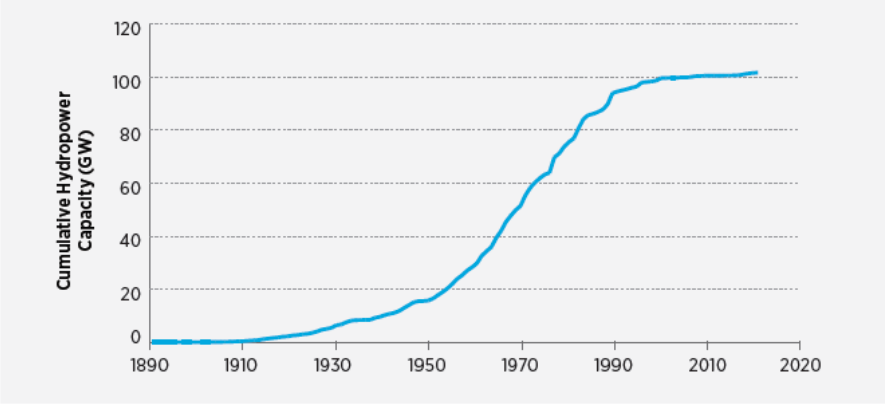


Figure 5: Cumulative US hydropower generating capacity, 1890–2015.

Southwest are the two regions with the highest number of small hydropower facilities (537 and 434, respectively). On average, the US small hydropower fleet generated 13,804 GWh per year for the period 2007–2017, approximately 5% of total US hydropower generation.

SMALL HYDROPOWER LICENSING PROCESS

Developers of small hydropower facilities need to follow different approval processes depending on ownership, project type, and other project attributes. Most projects require a FERC license or exemption from licensing. Although the exemption process is typically shorter than the licensing process, they both typically take multiple years.

Seeking authorization for development of hydropower at USACEowned dams involves obtaining a Section 408 approval from USACE in addition to a FERC license. Typically, the two processes have been implemented sequentially, with most of the work needed to obtain USACE approval taking place after a FERC license was issued. Securing federal authorization for development of hydropower at Reclamation-owned dams does not typically involve FERC, but rather a Lease of Power Privilege process.

The Hydropower Regulatory Efficiency Act of 2013 introduced a quicker, easier pathway to regulatory approval for the subset of projects involving the addition of hydropower to non- federal conduits (typically, existing pipelines and canals) with capacities of less than 5 MW. A developer for one of these projects needs to notify FERC of the intention to construct a hydropower facility. It will typically receive "qualifying conduit" status, completing the federal approval process, within 60 days unless FERC or the public contest the project's ability to meet the eligibility criteria.

UNTAPPED SMALL HYDROPOWER RESO-URCES

Potential new hydropower resources in the United States are classified into the three categories below.

Non-powered Dams

A national assessment of the capacity and energy potential realized from the addition of hydropower to NPDs identified 397 dams with technical potential capacities in the 1–10 MW range. The total estimated technical potential capacity for NPDs under 10 MW is about 2,500 MW. Their combined annual technical energy potential is 4,777 GWh.

New Stream-reach Development

A national assessment of NSD resources published in 2014 identified a potential technical capacity of 4,321 MW across 1,035 sites with estimated project sizes of less than 10 MW. The annual generation potential of these projects was estimated at 23,374 GWh.

Conduits

There has not yet been a comprehensive federal resource assessment of conduit hydropower, although some state and federal agencies have started to compile relevant data.

A 2012 study by Reclamation examined the energy development potential at Reclamation-owned facilities. That study and a related supplement found that 191 Reclamation canals had at least some level of hydropower potential and that 70 of those sites could be considered economically viable for development. This report concluded that there is 104 MW of potential capacity and 365 GWh of potential annual generation at the 373 Reclamation canals studied.

In 2018, Oak Ridge National Laboratory developed a methodology for analysis of the untapped hydropower generation potential of public water systems. A total of approximately 12 MW of potential conduit hydropower capacity was estimated in Oregon and 34 MW in Colorado. Their corresponding annual hydroelectricity energy supply is estimated to be 65 GWh/year in Oregon and 202 GWh/year in Colorado.

PLANNED SMALL HYDROPOWER PRO-JECTS

As of the end of 2017, the US hydropower "pipeline" of planned projects contained 214 projects with a combined capacity of 1,712 MW (Figure 6). Of these, 165 were small projects with a total combined capacity of 420 MW.

The majority of planned new small hydropower projects involve adding hydropower generation to existing dams or conduits. Only six projects would develop new stream-reaches.

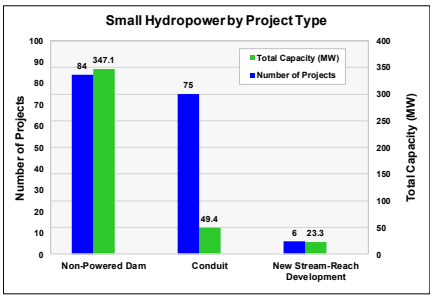


Figure 6: Planned small hydropower project development pipeline by project type, 2017.

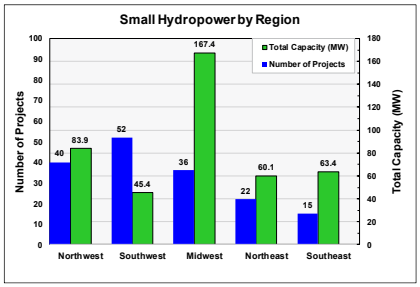


Figure 7: Planned small hydropower project development pipeline by region, 2017.

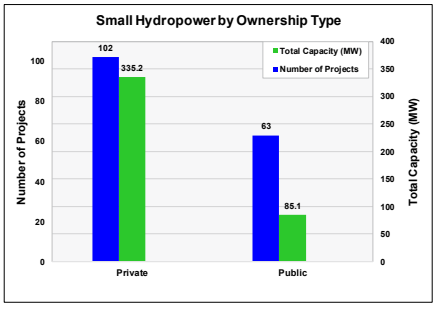


Figure 8: Planned small hydropower project development pipeline by ownership type, 2017.

The median capacities of small NPD and NSD projects are 4 and 5 MW, respectively. The median capacity of conduit projects is significantly smaller (0.42 MW).

The Southwest is the leading region by number of planned projects but ranks last in terms of proposed capacity (Figure 7). Most planned small hydropower capacity in the Southwest involves the addition of generation capacity to existing irrigation and water supply conduits; such projects are typically smaller than NPD or NSD sites.

Most proposed development is undertaken by private entities (Figure 8). Within the public category, most developers are municipalities (16 projects) or irrigation and water supply districts (42).

Projects in the Pending Permit and Issued Permit stages are undergoing feasibility evaluations (Figure 9). Attrition rates are high at these early stages of the development process. A project with a Pending Application has submitted an application for a federal permit. Projects with Issued Authorizations have already received their federal authorization and are more likely to proceed to construction. However, obtaining additional permits at the state or local level, finalizing engineering designs, negotiating power purchase agreements, and finalizing project financing are additional necessary steps before starting construction that usually take place at the Issued Authorization stage. These additional steps often pose challenges for small

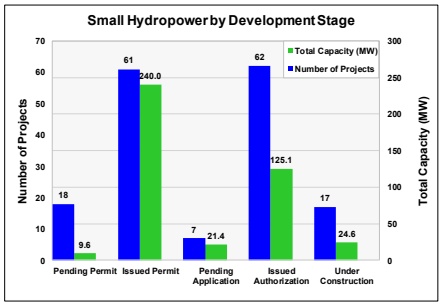


Figure 9: Planned small hydropower project development pipeline by development stage, 2017.

project developers, resulting in delays and cancellations of projects, so it is difficult to predict what percentage of the 62 small projects with Issued Authorizations totaling 125 MW will complete construction.

FINANCIAL MECHA-NISMS FOR SMALL HYDROPOWER

Federal Policy

A US Department of Energy (DOE)-administered federal incentive program supports the development of new small hydropower projects at existing dams or conduits. In 2014, Congress provided the initial funding allocation for the Section 242 Program, a hydropower incentive program that was created through the Energy Policy Act of 2005. The program has received congressional appropriations every year since 2014. Facilities can receive up to $750,000 per year for up to10 years, subject to availability through ongoing congressional appropriations. The program's incentive payments are paid on a per-kilowatt-hour-generated basis, with payment amounts depending upon overall program participation. The program's incentive payments have ranged from 0.9 cents/kWh to 1.5 cents/kWh. Although congressional authorization for the Section 242 Program expired in 2015, already-participating hydropower facility owners are allowed to receive up to 10 years of payments, provided that congressional appropriations continue to fund the program. Legislation also has been introduced in the United States Congress to reauthorize the Section

242 Program beyond its initial 10-year authorization, which would enable projects built after 2015 to also become eligible for 242 Program incentive payments.

State Policy

Some states, including those below, have created programs and policies specifically to financially support the development of small hydropower.

California. Some types of small hydropower projects are eligible for incentive funding through the state's Self-Generation Incentive Program.

Colorado. Colorado provides $15,000 feasibility grants for eligible entities, as well as low- interest (2%), long-term (30-year) loans that can fund project construction.

Oregon. Oregon provides financial assistance to small hydropower developers through the Energy Trust of Oregon.

RENEWABLE ENERGY POLICY

FEDERAL POLICY

The Public Utilities Regulatory Policy Act (PURPA), signed into law in 1978, opened the door to competition in the US electric power industry, particularly in the generation sector. PURPA conferred special rates and regulatory treatment on a new class of generators known as qualifying facilities (QFs). These consist of co-generation facilities and small power production facilities, with the latter defined as facilities generating 80 MW or less using a renewable energy source (i.e., hydro, wind, solar, biomass, waste, or geothermal). PURPA required electric utilities to interconnect with and purchase power from QFs at the utility's "avoided cost," defined as the cost that the utility would otherwise incur in either generating the power itself or procuring power from other sources.

With the Energy Policy Act of 2005, Congress made an important modification to PURPA, providing relief from PURPA's mandatory purchase obligation if FERC determines that QFs have nondiscriminatory access to the market. In this context, FERC determined that an ISO generally provides a sufficiently competitive market structure to support elimination of the PURPA purchase requirement for utilities operating within the ISO. At the same time, however, FERC established that "small QFs" do not have nondiscriminatory access to wholesale markets. Therefore, the PURPA purchase obligation for utilities remains in force for small QFs, making it possible for small hydropower generators to secure utility power purchase agreements. In May of 2018, FERC announced that it would launch a review of PURPA to examine issues involved in PURPA implementation and ways to address them.

The federal government also provides tax incentives to spur renewable energy development, including the production and investment tax credits; both of these expired at the end of 2016 for hydropower but are still available for other renewable energy technologies through 2021. Small hydro has also been eligible for federal accelerated depreciation tax treatment, and some states offer tax incentives and exemptions.

State Policy

Individual US states have adopted policies to encourage renewable energy development. The most prominent of these policies has been the adoption of a renewable portfolio standard (RPS). An RPS is a market-based policy that requires electric utilities and other retail electricity suppliers to supply a minimum percentage of their electricity sales from eligible renewable energy sources.

As of July 2017, 29 states and the District of Columbia had instituted RPS policies, covering 56% of total US retail electricity sales (Figure 10). Significant

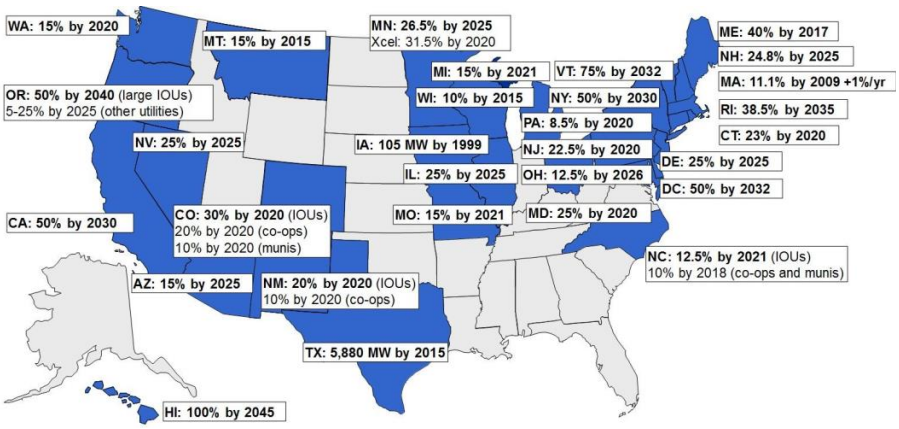


Figure 10: Status of renewables portfolio standard policies, July 2017.

RPS-related policy revisions in recent years include increased RPS targets for many states. In 2018, the California legislature approved legislation calling for California electric utilities to provide electricity using 100% clean energy by 2045.

Small hydro projects are typically RPS eligible, whereas large hydro projects are often excluded from RPS eligibility. Common hydropower restrictions for RPS eligibility include those based on capacity, type, and environmental sustainability criteria. One environmental standard is the Low Impact Hydropower Institute certification standard, used for RPS eligibility in a variety of states. Many RPS policies also have old requirements, such as for "new" development, which can disqualify hydro production from RPS eligibility.

A feed-in tariff is another policy that some states and utilities have adopted to incentivize electricity procurement from smaller renewable energy generators. A feed-in tariff provides a guaranteed payment stream at a fixed price for the renewable energy generator.

A small hydropower system installed adjacent to a local electricity load can typically take advantage of net energy metering (NEM). Under a NEM agreement, generated electricity is used directly by an adjacent facility; any excess generation can be exported to the utility grid for later use, and the generator receives a one-for-one credit at full retail value for any electricity generated onsite. Most US states have some form of NEM requirement, providing a potent economic incentive for distributed renewable energy generation, including small hydropower.

RECENT TRENDS IN SMALL HYDROPOWER

LEGISLATIVE REFORM

The Hydropower Regulatory Efficiency Act of 2013 directed FERC to explore a 2-year licensing process for hydropower development at existing NPDs. FERC published its report in May of 2017. In October of 2018, Con-gress passed the America's Water Infrastructure Act, legislation which included provisions to help streamline federal regulatory approval processes for hydropower. The bill shortens, from 60 to 45 days, the FERC process for qualifying conduit determination required by the 2013 Hydropower Regulatory Efficiency Act and replaces the 5 MW cap on qualifying conduit hydropower with a 40 MW cap. The bill also requires FERC to establish an expedited licensing process for NPD projects that will shorten the FERC decision timeframe for license applications to 2 years or less. The bill also requires FERC, USACE, and the US Department of the Interior to develop a list of existing federal NPDs that have the greatest potential for hydropower development.

US ARMY CORPS OF ENGINEERS HYDRO PROCESS REFORM

A 2012 DOE NPD report identified 12,000 MW of new hydropower capacity (projects of all sizes) across the United States. Most of that potential—7,200 MW—resides at USACE NPDs. In July 2016, FERC and USACE signed a memorandum of understanding that seeks to improve coordination between the two agencies related to the permitting process for NPD projects at USACE-owned dams. In 2018, USACE completed a policy report, that proposes to "update processes related to how USACE will review certain requests by others to alter a USACE civil works project," including the Section 408 process related to hydropower project development at USACE-operated dams. Any improvements in USACE administrative procedures would likely help streamline hydro development.

RECORD FEDERAL SUPP-ORT FOR HYDROPOWER

In recent years, Congress has provided record levels of funding for DOE's hydropower program. For fiscal year 2018, DOE received $105 million. Of this total, $70 million is directed to support marine and hydrokinetic energy programs, and $35 million will support the hydropower and pumped storage program, some of which supports small hydropower. In August of 2018, DOE's Water Power Technology Office announced up to $9 million in funding for innovative design concepts for standard modular hydropower and pumped storage hydropower. The first topic area in the funding opportunity seeks to stimulate innovative design concepts for small, low-head hydropower plants capable of lowering capital costs and reducing the environmental impacts

of development at NSD sites.

CONCLUSION

Small hydropower is the most cost-effective type of new hydropower development available in the United States because it typically uses existing infrastructure, including existing NPDs, canals, and pipelines. Record federal support for hydropower, along with recent legislative reforms, may help small hydropower achieve its substantial untapped potential. However, developers of new small hydropower may still face some challenges, including those described below.

Regulatory approval challenges. Developing new hydro projects has proved challenging in recent decades because of uncertain federal regulatory processes that have made it difficult for public- and private-sector investors to obtain long-term, low-cost financing to support project development.

Market challenges. In addition to the challenge posed by market competition from other electricity generating technologies (including natural gas, wind, and solar), hydropower's full value to the electric grid in terms of ancillary services and operational flexibility typically is not financially compensated in the current US electricity market.

Lack of comprehensive information regarding potential conduit sites. Although federal agencies have completed nationwide hydropower resource assessments for existing NPDs and NSD, a comprehensive national assessment regarding conduit opportunities has not been undertaken. These include water supply pipelines, which represent perhaps the most economically feasible type of new hydropower development because they can typically take advantage of higher energy value available through NEM.

Risk aversion regarding new technology. Existing dam and conduit owners are typically cautious and risk-averse with respect to the water systems for which they are responsible, making it difficult for them to recognize opportunities to develop hydro project sites. Furthermore, many water agencies have no understanding of available small hydropower technologies. Newer, more-cost-effective small hydropower technologies do not typically have long operational track records, making potential investors shy away from adopting them.

Lack of standardized technology. Almost every hydro project is custom engineered, presenting associated high engineering costs because each project is site specific.

Electrical interconnection. Uncertainty in the cost, timing, and technical requirements of grid interconnection can be challenging for small hydropower and other distributed energy resources because interconnection processes can be expensive and time consuming.

Electrical inspection. Because very few small hydropower projects are installed each year, most electrical inspectors are not familiar with them. Therefore, it can be difficult to secure electrical inspection approval for very small plants that are net metered. Small hydropower is not addressed in the National Electrical Code. Furthermore, the US small hydropower industry is not yet large enough to support mass manufacturing of standardized products that have completed independent certification. Costs associated with post-manufacture, in-the-field product testing and approval to ensure product safety can adversely affect a project's economic feasibility.

State and local policy issues. Challe-nges to small hydropower development can come from state and local regul-atory policies, including regulatory issues associated with water quality certifications and other state and local environmental requirements.

NOTE ABOUT CONTENT

This report was prepared in response to a request from the UNIDO and the International Center on Small Hydropower. It will be included in the World Small Hydro Development Report that is being released in 2019 to provide a global compilation of small hydropower data. This report was developed following content and length guidelines provided by UNIDO to ensure consistency among reports from each country, defining small hydropower as less than 10 MW. The report primarily utilizes text and data from the 2017 Hydropower Market Report as well as a previous similar report first published in 2015. Information and conclusions based on the under 10 MW definition do not reflect the overall status of hydropower development in the United States.

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

Xu Jincai

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

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

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

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

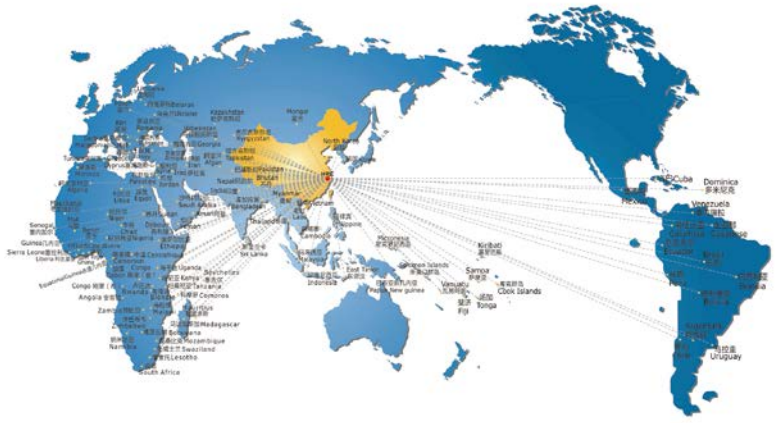


Figure 1. Distribution of training participants

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

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

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

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

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

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

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

II. Establishing Technology Transfer Centers and Conducting Joint Research

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

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

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

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

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

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

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

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

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

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

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

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

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

IV. Prospect

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

About the author

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

Extensive Cooperation on SHP & RE Between HRC and African Countries

In recent years, HRC has responded positively to the "One Belt and One Road" initiative and the spirit of the Johannesburg Summit of the Forum on China-Africa Cooperation and has maintained long-term friendly cooperation and exchanges with many African countries and carried out effective cooperation and communication in terms of capacity building, green development and agricultural modernization.

Since 1983, we have successfully conducted 104 training workshops of aid to foreign countries on water resources management, small hydropower development, rural electrification, climate change and other related topics, attended by more than 2,000 participants from 113 countries. Among them, 1086 government officials and technicians from the 46 African countries of water and energy sector participated in the training organized by HRC. Minister of Energy and Water Resources of Sierra Leone, Vice Minister of Water Resources and Irrigation of Egypt, Vice Minister of Water, Engineering and Housing of Ghana, Vice Minister of Natural Resources, Energy and Environment of Malawi, Vice Minister of Water Resources of Tanzania, Vice Minister of Water & Environment of Uganda and etc all came to China to participate in the ministerial symposium on water

resources organized by HRC. In addition, the textbooks of small hydropower training in English and French versions respectively have been edited and published, which are widely welcomed by hydropower technicians from African English and French countries.

In 2017, with the support of the Chinese Mission to the African Union, HRC established the "Technology Transfer & Research Training Center for African Clean Energy and Rural Electrification" in cooperation with the Addis Ababa University of Science and Technology in Ethiopia. Under the framework of the cooperation of the Center, HRC helped the Addis Ababa University of Science and Technology and Rwanda University to develop new energy disciplines, compile teaching materials and train teachers; Cooperate with Uganda and other countries to develop solar water pumping systems and hydropower containerized units appropriate to the renewable energy technology and applied research and small system demonstration of African countries; Collect and analyze information such as small hydropower, solar energy, rural distributed energy in typical African countries, providing technical advisory services of development planning, site certification and etc. HRC set up China-Africa Friendly

School of Rural Electrification, participating in the training of academic degree talents; vigorously promoting the Chinese SHP standards in English. Gradually build the "Technology Transfer & Research Training Center for African Clean Energy and Rural Electrification" into a cooperation platform for serving China-Africa clean energy and rural electrification industry, laying a good foundation for cooperation in developing green energy and promoting green sustainable development in Africa.

HRC actively implements the China-Africa cooperation plan, and actively promotes the infrastructure connectivity of mutually beneficial cooperation between China and Africa through the construction of demonstration projects such as design, consultation and complete equipment supply for small hydropower projects. In combination with the agricultural irrigation channel in Angola, Gangelas Small Hydropower Station was developed, making full use of the existing water conservancy infrastructure, realizing the comprehensive utilization of water resources with a smaller investment, and having positive demonstration benefits. Minister of Agriculture and Minister of Finance of Angola participated in the start-up meeting of the hydropower station and gave high praise; Provided equipment supply and installation guidance services for Kenya's first privately-invested small hydropower station, demonstrating the stability and cost-effectiveness of China's small hydropower equipment; Combined with the development plan of the Benin Rural Electrification Bureau, HRC has provided a set of off-grid solar power generation equipment, promoting the potential large-scale applications.

In addition, in the process of communication with African countries, HRC stressed on promoting Chinese culture, especially on water culture, respecting African civilization, focusing on strengthening humanities exchanges through technical cooperation, promoting the understanding and friendship between Chinese and African people, promoting the connectivity of "people's hearts and minds."

The red sun is rising and the prospect is brilliant. With the opportunity of the Beijing Summit of the Forum on China-Africa Cooperation and guided by "Beijing Declaration" and the "Beijing Action Plan", HRC will unswervingly further promote reciprocal cooperation with African countries in the areas of capacity building, green development, facility connectivity, humanities exchanges and etc., promote the mutual development of China and Africa and achieve win-win cooperation.

HRC's Annual Reporton Foreign Affairs in 2018 and Work Plan for 2019

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

In 2018, HRC earnestly studied and implemented the guiding spirits of the 19th CPC National Congress. Under the guidance of Xi Jinping Thought on Socialism with Chinese Characteristics for the New Era, and led by the Ministry of Water Resources (MWR) of China and its affiliated Nanjing Hydraulic Research Institute (NHRI), HRC followed the "Belt and Road" initiative. According to the Implementation Plan on Cooperation of Energy and Rural Electrification for Countries along the "Belt and Road", HRC organized international training, undertook extensive exchange and established four (4) overseas centers. Meanwhile, HRC promoted scientific and technological cooperation and innovation, strived to expand international market, and promoted capacity cooperation as well, so the work on foreign affairs scored fruitful results.

I. International Training

To enhance the foreign-aid human resource development, deepen the South-South Cooperation, and promote exchange & cooperation among the developing countries, especially for those along the "Belt and Road" in the fields of clean energy including water resources, small hydropower and rural electrification, and strengthen mutual understanding and enhance traditional friendship, HRC actively implemented ten (10) foreign-aid trainings and seminars for developing countries, entrusted by the Ministry of Commerce. There is a total attendance of 359 managerial and technical talents from 38 countries of Asia, Africa and Latin America. The training languages include English, French, Russian and Vietnamese. The training topics cover SHP development, clean energy, water management, resources investigation & planning, rural electrification, hydropower station and dam safety, water project management, poverty reduction and sustainable development, climate change and so on, among which 2 seminars were held for the countries along the "Belt and Road", Training Course on Small Hydropower Technology and Seminar on Construction and Management of Water and Hydropower Projects were held respectively in Ethiopia and Nigeria for the first time, Training Course on Small Hydropower Technology for Rwanda was held in the fourth consecutive year and the tailor-made bilateral training programs were implemented in China for D.R. Congo, Uzbekistan and Vietnam.

Furthermore, at the invitation of Department of Energy Management, the Ministry of Energy and Mines of Laos, HRC organized experts to lecture on hydropower station and dam safety management in Laos, and shared the latest technology of dam safety monitoring, dam risk assessment and management, and hydropower station safety with over 120 participants including officials from the Ministry of Energy and Mines and provincial departments of energy management and some hydropower developers. The plan of 2019 foreign-aid training programs was submitted to China International Development Cooperation Agency, and application for foreign-aid training program from the Ministry of Science and Technology of China was also submitted through the Department of Science and Technology of Zhejiang Province.

Table 1: List of Foreign-aid Training Courses in 2018

No.	Project title	Venue	No. of attendants	Participating countries
1	2018 Seminar on Water Resources Management & Small Hydropower Development for Countries along the Belt and Road	Hangzhou	43	Dominica, Ethiopia, Guyana, Kenya, Nepal, Palestine, Peru, Rwanda, South Sudan, Sri Lanka, Tajikistan, Ukraine, Uzbekistan, Zambia
2	2018 Seminar on Electrification Mode Based on Clean Energy for Countries along the Belt and Road	Hangzhou	23	Afghanistan, D.P.R. Korea, Ethiopia, Kenya, South Africa, Uzbekistan, Venezuela
3	2018 Training Course on Small Hydropower Technology for Rwanda	Rwanda	50	Rwanda
4	2018 Seminar on Construction and Management of Water & Hydropower Projects in Nigeria	Nigeria	61	Nigeria
5	2018 Training Course on Small Hydropower Technology for Ethiopia	Ethiopia	50	Ethiopia
6	2018 Training Course on Small Hydropower and Rural Electrification for The Democratic Republic of Congo	Hangzhou	20	The Democratic Republic of Congo (D.R. Congo)
7	2018 Seminar on Small Hydropower and Sustainable Development of Rural Communities for Developing Countries	Hangzhou	31	Egypt, Lesotho, Uganda, Kenya, Ethiopia, Mexico, Grenada, Guyana, Surinam
8	2018 Seminar on Small Hydropower and Rural Electrification for the Francophone African Countries	Hangzhou	41	Algeria, Madagascar, Senegal, Comoros, Burundi, Niger, Djibouti, Côte d'Ivoire, D.R. Congo, R. Congo, Mali, Equatorial Guinea
9	2018 Seminar on Water Resources Management and Small Hydropower Development for Uzbekistan	Hangzhou	20	Uzbekistan
10	2018 Training Course on Water Resources Investigation and Planning for Vietnam	Hangzhou	20	Vietnam

During the training courses, full exchanges were made among the team members of the project of National Key R&D Program of China called "China-Pakistan Joint R&D Center on Key Technologies of SHP and Rural Electrification" and participants from Pakistan, Nepal and Sri Lanka etc., for undertaking small hydropower demonstration, data collection and setting up a database, etc. in South Asian countries. The extensive exchanges enriched the training content, promoted the implementation of international cooperative project and enhanced the cooperation results of training programs.

Besides, HRC organized an editorial team to revise the content of textbook. Most of the work has been finished till now, which further improved the textbook quality. HRC signed a cooperative agreement with Hohai University for jointly establishing a practice base for international students. Both sides made full use of their own advantages and strengthened personnel training and exchanges in relevant fields. HRC recommended six (6) former participants to award the "Belt and Road" scholarship on water resources for their further education in Hohai University.

II. Important Meetings or Conferences

1. On April 10th, 2018, HRC staff attended the first meeting of China-Hungary Joint Steering Committee on Water Management Cooperation, which was organized by the Department of International Cooperation, Science and Technology, MWR, and HRC representative discussed cooperative issues with partners under the China-Europe Water Platform (CEWP);

2. From June 24th to 30th, 2018, HRC staff accompanied experts from Austria, Sweden and Italy to participate in the conferences and relevant activities of CEWP held in China. Cooperation in the fields of water and energy safety, green hydropower standards, etc. has been discussed;

3. From Sep. 3rd to 4th, 2018, Director General Dr. Xu Jincai attended 2018 Beijing Summit of the Forum on China-Africa Cooperation and discussed cooperative issues about capacity building and joint R+D in the fields of small hydropower and rural electrification with relevant African authorities;

4. From Oct. 23rd to 26th, 2018, HRC staffs attended International Symposium on Dam Safety and Risk Management organized by Dam Safety Management Center of MWR, NHRI, World Bank Group and Academic Division of Civil, Hydraulic and Architectural Engineering, Chinese Academy of Engineering, and gave presentations;

5. From Oct. 29th to 31st, 2018, HRC staff participated in the 23rd Annual Meeting of China South-South Cooperation Network organized by China International Center for Economic and Technical Exchanges;

6. From Nov. 1st to 2nd, 2018, Director General Dr. Xu Jincai attended the first Lancang-Mekong Water Cooperation Forum organized by MWR and the government of Yunnan Province. Dr. Xu exchanged ideas with relevant authorities of participating countries for cooperation on water management and development;

7. On Dec. 13th, 2018, Director General Dr. Xu Jincai attended the first meeting of Joint Working Team for China-Mongolia Water Resources Development Cooperation held by the Department of International Cooperation, Science and Technology, MWR. Dr. Xu introduced the cooperation between HRC and the partners in Mongolia and exchanged views about further cooperation;

8. On Dec. 14th, 2018, Director General Dr. Xu Jincai attended the 2018 Working Meeting on International Cooperation of Water Resources held by the Department of International Cooperation, Science and Technology, MWR, and introduced HRC's work and put forward suggestions on international cooperation for the new era;

9. From Dec. 19th to 20th, 2018, HRC staff attended 2018 Training Course on Water Resources for Director of Foreign Affairs held by the Department of International Cooperation, Science and Technology, MWR, and gave a presentation about how to apply and organize international trainings.

III. Exchange of Visits

1.Foreign Guests Visiting HRC

In 2018, HRC received 5 delegations of 28 foreign guests in a total, respectively from Rwanda, Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Singapore, Thailand, Vietnam, Ghana and Canada for technical exchange and project cooperation.

(1) On May 31st, 2018, a 2-person delegation headed by H.E. Mr. Charles Kayonga, the Ambassador of the Republic of Rwanda to China, visited HRC. H.E. Ambassador expressed his appreciation for the work and achievements that HRC did for Rwanda, especially the training courses successfully organized for Rwanda in past three years. The trainings won supports from local government and was welcome by trainees. Through further discussion, both sides listed mutual cooperation priorities and reached consensus.

(2) From June 28th to 30th, 2018, twenty (20) young talents working in water field from nine (9) ASEAN member countries including Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Singapore, Thailand and Vietnam were accompanied by the representatives of Lancang-Mekong Water Resources Cooperation Center and Hohai University to visit HRC. Young talents made exchange with HRC staffs and shared expertise, and also visited China Water Museum for understanding China's long history of water management and the related achievements.

(3) During Oct. 21st-22nd, 2018, Institute for Hydropower and Renewable Energy (IHR) of Vietnam sent a 3-people delegation to visit HRC. The two sides had discussion on cooperation of Lancang-Mekong water management, hydropower and dam safety, the development of renewable energy and other fields.

(4) On Nov. 9th 2018, Prof. Allen Curry from River Research Institute of Canada came to HRC and gave a presentation on Decision-Making and Scientific Support for Large-Scale Dam Demolition.

(5) On the afternoon of Nov. 28th 2018, a 2-person delegation from Genser Energy in Ghana visited HRC to discuss cooperation on technical services for two cascade hydropower

projects in Ghana. As required, HRC shall send consultants to Ghana for site investigation and data collection as soon as possible.

2. Outbound Visits of HRC

In 2018, HRC dispatched six (6) delegations of 26 staffs respectively to Laos, Ethiopia, Rwanda, Kenya, Uganda and Pakistan for international cooperation, foreign-aid trainings, etc.

(1) From March 21st to 26th 2018, two HRC staffs together with a delegation of Nanjing Hydraulic Research Institute (NHRI) visited Laos for organizing the Seminar on Hydropower and Dam Safety, which was co-sponsored by World Bank and South-South Development Center. Over 120 participants including officials from the Ministry of Energy and Mines, the provincial departments of energy management and some hydropower developers attended.

(2) From May 2nd to 14th 2018, a 3-person delegation visited Ethiopia, Uganda and Rwanda. The delegation paid courtesy call respectively to H.E. Dr. Ing Seleshi Bekele, Minister of Water, Irrigation and Electricity of Ethiopia, H.E. Dr. Ing Getahun Mekuria, Minister of Science and Technology of Ethiopia and other high-level officials of Ethiopia, and briefed China-Africa cooperation on clean energy and rural electrification based in Ethiopia. The delegation visited Rt. Hon. Dr. Ruhakana Rugunda, Prime Minister of the Republic of Uganda, Uganda Refugee Authority, Uganda Electricity Regulatory Authority and Uganda Rural Electricity Authority, and had exchange and discussion on the cooperation of solar pumping system, solar water purification and off-grid solar power generation system, as well as human resources training, standard formulation and technical transfer in the field of renewable energy including small hydropower and solar energy. In addition, the delegation paid visit to Uganda Electricity Generation Co., Ltd., discussing the renewal of MOU and the promotion and demonstration of solar pumping system and the development of rooftop solar power system. HRC delegation signed a MOU with University of Technology and Arts of Byumba in Rwanda for the cooperation on production, teaching and research in the field of renewable energy.

(3) From May 26th to June 4th 2018, a HRC delegation of 4 persons visited Ethiopia for negotiating the cooperation on engineering supervision for the transmission project of Gebe-II hydropower project, and visited Kenya to discuss Earth-head hydropower project and the water-supply planning in Nyeri County, etc.

(4) From July 16th to August 16th 2018, HRC delegation of 10 persons went to Rwanda and Ethiopia to implement foreign-aid training programs of the Ministry of Commerce of China respectively called "2018 Training Course on Small Hydropower Technology for Rwanda" and "2018 Training Course on Small Hydropower Technology for Ethiopia".

(5) From August 4th to 11th 2018, a 2-person delegation visited Ethiopia to investigate the progress of China-Africa Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification, wrap up available achievements and discuss the follow-up work. HRC delegation visited relevant enterprise, universities and authorities in Rwanda to discuss the setting-up of Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Eastern Africa.

(6) From August 6th to 12th 2018, HRC delegation of 5 persons visited Pakistan to implement a project of National Key R&D Program of China called "China-Pakistan Joint R&D Center on Key Technologies of SHP and Rural Electrification". The delegation had discussions with Pakistan Council of Renewable Energy Technology, Energy Department of Punjab and National University of Science and Technology of Pakistan about talent training, laboratory upgrading as well as the site selection of rural electrification demonstration and power generation for low-head irrigation canal and the off-grid hybrid power generation etc.

IV. Information Exchange

HRC edited and published *SHP News* of 2018 in English, which was shared with over 70 countries, including about 40 countries along the Belt and Road. Besides, the database of training alumni has been updated, and the website released nearly 100 pieces of news in Chinese and English. Tens of contributions have been submitted to Zhejiang Foreign Affairs Yearbook and China SSC Network (journal).

V. International Sci.-tech Cooperation and Technical Transfer

In 2018, HRC paid much attention to implement and apply for interna-

tional scientific and technological cooperative projects while actively exploring new orientations. HRC signed MOU respectively with University of Technology and Arts (UTAB) of Rwanda, University of Life Sciences of Mongolia and University of Natural Resources and Life Science of Vienna (BOKU), and renewed MOU with Institute for Hydropower and Renewable Energy (IHR) of Vietnam, Uganda Electricity Generation Co., Ltd. (UEGCL) and Energy Development Corporation Ltd. (EDCL) of Rwanda Energy Group. HRC continued to push forward the construction of four (4) overseas technical transfer centers, i.e. China-Pakistan Joint Research & Development Center on Key Technology of Small Hydropower and Rural Electrification, China-Indonesia Technical Transfer Center for Rural Electrification Technology Based on Hydropower, Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa and China-Serbia Joint Research and Training Center for Small Hydropower Technology by means of capacity building, join R+D, project demonstration and technical transfer etc., so as to make the full play of HRC itself and the role of its foreign bases as the cooperative platforms.

1. Trough personnel exchange, technical discussion and on-site investigation, the project of "China-Pakistan Joint Research & Development Center on Key Technology of Small Hydropower and Rural Electrification" was implemented as scheduled. The plan on upgrading of laboratory system was completed, basic data of hydropower on related rivers (or irrigation canals) in Punjab was collected, research of hydropower technology and fabrication of related E/M equipment for low-head hydropower in the irrigation area and the intelligent SHP control equipment were started, the assessment on the development of hydropower on typical rivers of Pakistan was made and the compilation of development plan was started accordingly. The comparison and analysis about the status quo and related standard of small hydropower development and rural electrification between China and Pakistan was made, the database framework for South Asian countries have been discussed and confirmed, the detailed plan on talents exchange and training was finalized and formalities for training the Pakistani talents in China has been finished.

2. HRC successfully implemented the project called "China-Indonesia Technical Transfer Center for Rural Electrification Technology Based on Hydropower", in cooperation with University of Brawijaya for site selection, project design and equipment fabrication. At the same time, the project financed by Lancang-Mekong Cooperation Special Fund called "Technology Sharing and Capacity Building on Hydropower Station and Dam Safety Management for Lancang-Mekong Countries and the project financed from China-ASEAN Maritime Cooperative Fund called "Assessment of Island Renewable Energy and Demonstration of Capacity Cooperation for ASEAN Countries" will be approved in late December. All the work laid a solid foundation for the establishment of China-ASEAN Technology Transfer Center on Renewable Energy and Rural Electrification.

3. HRC carried out capacity-building activities like trainings in cooperation with Addis Ababa Science and Technology University (AASTU) under China-Africa Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification and jointly trained a master student of AASTU, who had been studying in HRC for three (3) months. HRC staffs visited Africa including Ethiopia, Uganda and Rwanda for joint research and project demonstration on solar pumping technology, actively cooperated with universities like AASTU and University of Rwanda on discipline building, joint academic and vocational training. Great importance was attached to prepare setting-up of the sub-center in Eastern Africa.

4. Together with its foreign partner, HRC held the kick-off meeting (through wechat) for the project called "China-Serbia Joint Research on the Development Technology of Low-head Run-of-the-river Hydropower", discussed the follow-up plan, analyzed the recommended sites for demonstration, and launched the stetting-up of China-Serbia Joint Research and Training Center for Small Hydropower Technology.

In addition, HRC involved itself in the project called "Sustainable Hydropower Use and Integration in China and EU (SHUI-ChE)" under the framework of China-Europe Water Platform (CEWP), sent a staff to make research study in Europe, attended international conferences as well as arranged a study tour of its foreign partner in China. Meanwhile, HRC applied for other cooperative projects financed by Lancang-Mekong Cooperation Special Fund,

South-South Cooperation Fund, the Key Project of Intergovernmental Scientific and Technical Innovation and Asian Regional Cooperation Special Fund, all of which obtained remarkable achievements.

VI. Overseas Marketing

In 2018, HRC had been always committed to technical consultation, design and equipment supply of small hydropower and other renewable energies, carried out the supervision on E/M equipment installation as well as overhaul or maintenance for the built hydropower stations, etc., provided technical services and supplied equipment of SHP and other renewable energies for Nepal, Pakistan, Turkey, Papua New Guinea, Kenya, Democratic Republic of Congo, Ethiopia, Uganda, Laos, the Philippines, Cuba etc. These services satisfied the actual demand of other developing countries, really benefited the local government and people, and promoted the sustainable development of renewable energy and rural electrification construction.

VII. Work Plan for Year 2019

In 2019, HRC shall continue to implement the guiding spirits of the 19th CPC National Congress and Xi Jinping Thought on Socialism with Chinese Characteristics for the New Era, strictly carry out the guidelines and policies related to foreign affairs of the central government, closely follow the Belt and Road Initiative, and rely on its own advantages and meet the needs of foreign countries for capacity building, joint R&D, project demonstration and capacity cooperation. HRC shall continue providing technical training, pushing technical transfer and indigenization of equipment fabrication, promoting international standardization and enhancing the international capacity cooperation.

1. To Continue the Foreign-aid Trainings

HRC shall closely follow the work of Ministry of Water Resources, China International Development Cooperation Agency, Ministry of Science and Technology and other relevant authorities for continuously organizing the foreign-aid trainings, especially *Ministerial Workshop on Water Resources Management and Development Planning for Countries along the Belt and Road*, the multilateral training courses in China such as *Seminar on Water Resources Management and Ecological Small Hydropower Development for Countries along the Belt and Road* and *Seminar on Electrification Mode Based on Clean Energy for Countries along the Belt and Road*. To meet the demands of foreign countries, HRC shall design and implement the overseas training courses in Rwanda, Zambia and Nigeria, and the bilateral training programs in China for Uzbekistan, Samoa and others. Meanwhile, HRC shall continue to recommend qualified participants to apply for the "Belt and Road" High-level Talent Scholarship for their further study in China.

2. To Undertake Bilateral & Multilateral Joint Research

HRC shall concentrate more on inter-governmental cooperation and focus on the following bilateral and multilateral cooperative projects including joint research & demonstration.

(1) To undertake the project called "Technology Sharing and Capacity Building on Hydropower Station and Dam Safety Management for Lancang-Mekong Countries" which is financed by Lancang-Mekong Cooperation Special Fund. Governmental officials, researchers and experts working in the fields of hydropower and dam safety from Laos, Vietnam, Cambodia, Myanmar and Thailand will be invited to attend the *Training Course on Construction & Safety Management of Hydropower and Dam for Lancang-Mekong Countries.* HRC experts will visit Laos and Vietnam to make expertise exchange and investigation on the conditions, the management regulations and the technical standard system of hydropower and dam, and provide technical consultancy for the two countries. *Seminar on Safety Management of Hydropower and Dam for Lancang-Mekong Countries* will be held in Thailand to share advanced technology and proven experience. In addition, it is planned to promote the dam safety assessment and monitoring in Laos and Vietnam, set up the dam safety assessment system, and carry out technical promotion and equipment demonstration, so as to help Mekong countries strengthen their supervision and control on water projects, improve their emergency response capability, prevent disasters, and ensure the security of people's livelihood.

(2) To implement the project called "Assessment of Island Renew-

able Energy and Demonstration of Capacity Cooperation for ASEAN Countries" which is financed by China-ASEAN Maritime Cooperation Fund. Focusing on the Philippines and Indonesia, HRC will carry out the assessment and planning on clean energy resources for island countries and the renewable energy capacity cooperation between China and ASEAN countries, including survey and potential assessment on hydropower, solar energy, wind power, ocean energy and other renewable energies, compilation of development plan, and research & project demonstration on the development modes, technology and equipment for renewable energy development and rural electrification, so as to promote the establishment of China-ASEAN Technical Transfer and Training Center for Clean Energy and Rural Electrification.

(3) To enhance the cooperation with China-EU Water Platform (CEWP) and promote China-EU exchange and cooperation on green hydropower. HRC shall continuously make research on ecological hydropower with University of Natural Resources and Life Science of Vienna (BOKU), Austria and Research Institute of Environment of Stockholm, Sweden. On the occasion of a foreign-aid training course, Symposium on Greening and Upgrading Small Hydropower will be held in Lishui, Zhejiang in May 2019, which aims to exchange ideas and share the achievements of China-EU cooperation on green hydropower development, including concept, standard, technology, equipment and etc. with the countries along the Belt and Road, thus promoting the realization of 2030 Sustainable Development Goals (SDGs).

(4) To implement the eight major initiatives of China-Africa cooperation, i.e. industrial promotion, green development and capacity building. Through technical exchange, talent cultivation, vocational education, project demonstration etc., HRC shall cooperate with African countries for sharing the technology of clean energy and rural electrification, so as to shape a vocational education system, develop teaching software, and research and develop teaching equipment, applying internet technology, cloud platform and VR technology, and set up a demonstration of vocational education. Meanwhile, HRC shall make use of its technical and personnel advantages, to undertake research on policy and technology for clean energy development and rural electrification under the background of climate change, conduct technical training, share Chinese expertise, practice, standard etc. with African countries and make planning on water resources and hydropower, so as to help African countries to realize the 2030 Sustainable Development Goals (SDGs).

(5) To conduct a strategic analysis on water and clean energy with the countries along the Belt and Road, jointly carry out policy research and provide assistance for flood control and water utilization. Based on an overall & systematic analysis and policy research, HRC shall fully understand the development planning, administrative policy, legislation, standard and constraints on water resources in the countries along the Belt and Road, which shall provide data and strategic support to the extensive cooperation among China and other countries along the Belt and Road.

(6) To make efforts for approval of the applied projects, and focus shall be given to the project of China-ASEAN Maritime Cooperation Fund called "Assessment of Island Renewable Energy and Demonstration of Capacity Cooperation for ASEAN Countries", the project of China-Indonesia Maritime Cooperation Fund called "Seawater-desalination Demonstration with Hybrid Power Generation of Wind & Solar Energy for Islands", the project of South-South Cooperation Fund called "China-Africa Technical Transfer and Capacity Building on Rural Clean Energy", the project of China-APEC Cooperation Fund called "Research & Sharing on Innovative Technology for Hydropower and Dam Safety based on Digitalization", China-South Africa Intergovernmental Sci.-Tech. Innovation Cooperative Project called "Joint Research on Hybrid Power-generation System of Wind & Solar Energy", China-Mongolia Intergovernmental Sci.-Tech. Innovation Cooperative Project called "Application & Research on Decentralized Generation Technology of Clean Energy in Pastoral Areas", etc. HRC shall seek for various financing channels to apply for the "BRICS Countries" cooperative project, cooperative project with developed countries and intergovernmental sci.-tech. cooperation projects. Combining "bringing in" and "going out", HRC shall promote scientific and technological innovation, through expertise exchange with developed countries and at the same time, share these with the developing countries.

3. To Build Up Four (4) Overseas Technical Transfer Centers

In 2019, HRC will focus on the following work to continuously make steady progress on the construction of four overseas technical transfer centers.

(1) Center for South Asia: based on the implementation plan of the project called "China-Pakistan Joint Research & Development Center on Key Technology of Small Hydropower and Rural Electrification", research study of young Pakistani engineers shall be arranged so as to jointly undertake hydropower resources assessment, joint R+D on low-head hydropower technology of irrigation canal, select the site and make design for the demonstrative project. The further research on the adaptability of small hydropower and rural electrification mode in South Asia will also be made.

(2) Center for ASEAN Countries: China-Indonesia Joint Research Center of Rural Electrification Technology based on Hydropower shall be built up, which includes setting-up of a demonstrative project of hydropower-based hybrid power generation in Indonesia, personnel training, technical exchange and promotion. Together with the partners in Indonesia and the Philippines, HRC shall carry out the assessment and planning on clean energy resources and the capacity cooperation of renewable energy for ASEAN countries, organize and implement the projects respectively called "Technology Sharing and Capacity Building on Hydropower and Dam Safety Management for Lancang-Mekong Countries" and "Assessment of Island Renewable Energy and Demonstration of Capacity Cooperation for ASEAN Countries", and cooperate with ASEAN Energy Center (ACE) to establish China-ASEAN Technical Transfer and Training Center on Renewable Energy and Rural Electrification.

(3) Center for Africa: under the framework of Technical Transfer, Research and Training Center on Clean Energy and Rural Electrification for Africa, HRC will undertake capacity building, joint research, technology transfer and project demonstration in the field of clean energy and rural electrification, and establish the Sino-Africa Friendship Research Institute on Rural Electrification. Meanwhile, HRC will join hands with partners in Rwanda, Côte d'Ivoire, Zimbabwe, South Africa, Egypt, etc. to prepare for the setting-up of sub-centers of clean energy and rural electrification in Eastern Africa, Western Africa, Southern Africa and Northern Africa.

(4) Center for East Europe: HRC shall continuously implement the project called "Joint Research on the Development Technology of Low-head Run-of-the-river Hydropower", one of the Intergovernmental Scientific and Technical Innovation Cooperative Projects under the National Key R&D Program. According to the implementation plan, HRC shall cooperate with University of Belgrade, Serbia to do joint research on low-head run-of-the-river hydropower development technology, share the assessment & planning technology of hydropower resources on typical rivers, make simulation research and demonstration of low-head run-of-the-river hydropower development, and facilitate the building-up of China-Serbia Joint Research and Training Center for Small Hydropower Technology.

4. To Promote Capacity Cooperation on Technology and Equipment

In 2019, HRC shall enhance the export of its technology and equipment to foreign countries, including the following projects.

(1) To undertake technical consultancy and design for the capacity upgrading of a hydropower plant in Vietnam, inclusive of the on-site survey, engineering design, etc.

(2) To undertake technical consultancy and design for the rehabilitation of two (2) hydropower stations in the Democratic Republic of Congo, inclusive of the on-site survey, engineering design, etc.

(3) To undertake design, consultation and equipment supply for a hydropower station in Kenya, inclusive of on-site survey, engineering design, equipment supply and installation service, etc.

(4) To undertake technical consultancy, design, supervision on fabrication of the turbine-generator units and supply of automatic control system for a hydropower station in Papua New Guinea.

(5) To complete the installation and commissioning of electromechanical equipment of a micro hydropower station in Nepal.

(6) To complete engineering design, equipment supply, installation & commissioning of a hydropower station in Laos.

(7) To undertake on-site survey, engineering design, equipment supply, equipment installation and commissioning for two cascade hydropower stations in Ghana.

(8) To implement bidding projects of solar irrigation systems in the Philippines and carry out on-site survey, engineering design, equipment supply and installation, etc.

5.To Make Water and Hydropower Projects "Going Global"

HRC has carried out extensive and intensive exchange and cooperation with the countries along the Belt and Road in the field of rural hydropower, and made lots of achievements in promoting the sustainable development of social economy in rural areas of these countries. These countries also have urgent demands for technologies, talents and funds in the field of irrigation and water conservancy. As irrigation and water conservancy are closely related to agricultural development, therefore, based on different natural and geographical conditions of the countries along the Belt and Road, the cooperation on irrigation and water conservancy needs to be carried out, which is of great significance in increasing agricultural production, ensuring food security and improving the capability of fighting against natural disasters. Next, HRC will give emphasis on cooperation in water projects including irrigation and water conservancy, and carry out all-round and multilevel cooperation on sustainable development of rural areas with countries along the Belt and Road to help accelerate the realization of the goals of the 2030 Agenda for Sustainable Development.

6. Internationalization of Standards

HRC shall continue to promote and internationalize Chinese standards on engineering design, consultation and construction technology, and keep translating the related standards on SHP design, consultation and construction, inclusive of those on engineering contracts, tender & bidding documents and equipment fabrication, for their application and popularization abroad.

7. Foreign Affairs Administration

HRC shall continuously strengthen its administration on foreign affairs and improve HRC website and two magazines, namely SMALL HYDRO POWER in Chinese and SHP NEWS in English, provide articles for Zhejiang Foreign Affairs Yearbook and China SSC Network, and share achievements on water policy, technology, equipment, as well as good tale of water cooperation between China and foreign countries.

In the year of 2019, all HRC staffs will earnestly study the major national policies and guidelines, implement the thought of President Xi concerning water conservancy work, and focus on the key tasks of the Ministry of water Resources and orient on the Implementation Plan of HRC on the Cooperation for Countries along the Belt and Road. It is expected that, with the spirit of "stamping on stone and scratching iron with marks", the work and self-development of HRC will leap to a new higher level.

(*Source:* HRC) ■

5 Comprehensive Assessment of Consultation Programmes for Green SHP of Lishui City Passed the Peer Review

In September 13-14, 17, 2018, the comprehensive evaluation for consulting project of the green development for rural hydropower in the five counties such as Suichang County, Songyang County, Jinyun County, Yunhe County and Jingning County of Lishui City, Zhejiang Province, which was presided and completed by HRC, passed the expert review organized by the people's governments of each county in Hangzhou.

The participating experts highly praised the consultation results of the five counties in Lishui City. They expressed that the assessment report objectively reflected the important role played by rural hydropower in the county on local economic and social development, greenhouse gas emission reduction and environmental protection, and carefully analyzed the current problems in the ecological environment caused by the rural hydropower development in the county, comprehensively assessed the classification of rural hydropower stations in the counties, and put forward the recommendations by classification, with strong pertinence and operability.

On the basis of comprehensive evaluation, HRC will continue to cooperate with all relevant departments to carry out the implementation plan of "one-station, one-strategy" for rural green hydropower development in rural areas and the compilation of rural hydropower green development planning.

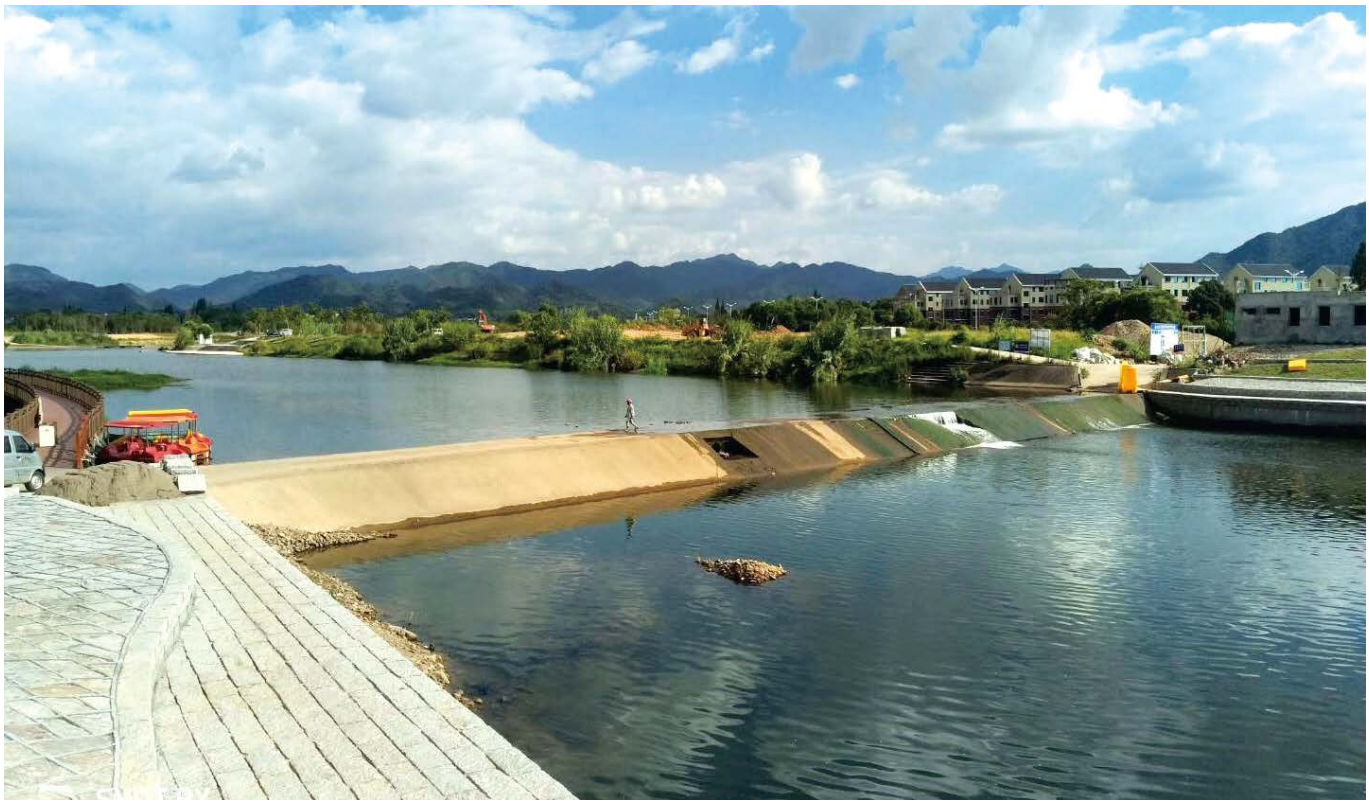
At present, the comprehensive assessment of rural hydropower green development in Qingyuan County has also been completed and

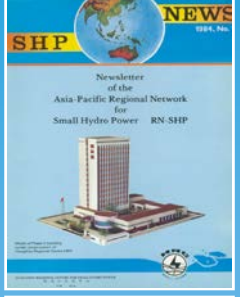
is ready for acceptance. So far, HRC has completed on-site investigation and comprehensive evaluation of 609 small hydropower stations in 7 counties (cities) of Lishui City. That is HRC's another practice and test of turning the technical achievements into the scaled application to other six counties in Lishui City on the basis of the comprehensive assessment of 107 small hydropower stations in Longquan City in May this year.

Lishui City is a large hydropower city in Zhejiang Province. At present, there are 776 rural hydropower stations actually operating in the city, with a total installed capacity of 1.54 million kW, representing 1/4 of numbers in Zhejiang Province and 1/3 of the installed capacity of Zhejiang Province.

Lishui is an important cradle of the idea of General Secretary Xi Jinping's "Lucid waters and lush mountains are invaluable assets". During his working period in Zhejiang Province, the General Secretary came to Lishui eight times and sent encouraging messages "Lucid waters and lush mountains are invaluable assets, and it is especially true for Lishui", "Ambition does not seek easy, but will challenge the difficulty" and so on. On April 26 this year, General Secretary Xi Jinping, in the in-depth promotion of the Yangtze River Economic Belt Development Symposium, fully affirmed and the "praised Lishui" for its 15 years of deep practice of the "eight-advantages & eigh-measures strategy", 12 years of remembering the important entrustment of "especially true", exploring and practicing the conversion of "Lucid waters and lush mountains are invaluable assets". General Secretary Xi Jinping emphasized that: Lishui City of Zhejiang Province has adhered to the green development road for many years, and unswervingly protected the 'Golden Rice Bowl' of lucid waters and lush mountains, and strived to transform the value of ecological products contained in lucid waters and lush mountains into invaluable assets. The quality of ecological environment, the index of progress process and the income growth of the farmers have all ranked the first in the province for many years, achieving the coordinated advancement of building ecological civilization, poverty alleviation and the revitalization of towns and villages.

(*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, 96 issues of "SHP News" have been edited, published and disseminated to more than 30,000 readers in about 113 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 2000 technical persons participated in 106 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**

Front cover: The FengHuang reservoir in Anji county, Zhejiang province, China. This reservoir is a multi-purpose utilization project that focuses on flood control, combined with water supply, power generation and improvement of urban water environment. The total storage capacity is 20.95 million cubic meters.

Photo by: *Mr. Nan Hu & Mr.Chao Li*

Back cover: The dam across Fox River in Appleton, WI, the United States, the site of the first commercial hydroelectric power plant in the world. The site was dedicated as an ASCE National Historic Engineering Landmark, jointly designated with ASME and IEEE.

Photo by: *Mr.Jianda Zhao*