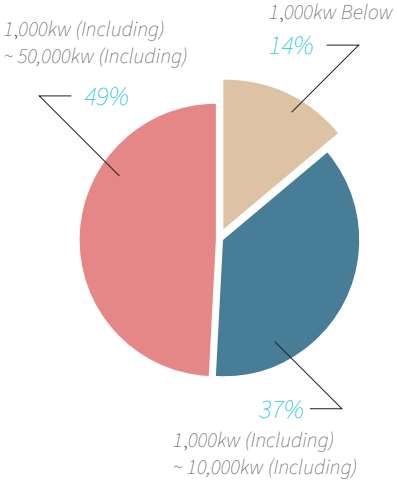
Chapter 10

Small Hydropower

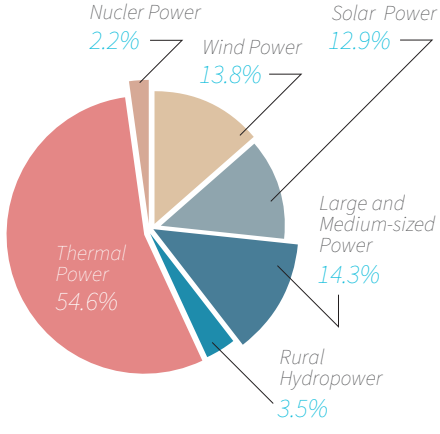
1 Overview

Small hydropower refers to hydropower stations with an installed capacity of 50,000 kWh or below and their matching grids. China ranks first worldwide in terms of small hydropower resources. The technically exploitable potential of small hydropower in mainland China is 128 million kW. The annual power generation is over 535 billion kWh and small hydropower stations are distributed in 1,700 counties (cities) across the country in 30 provinces (autonomous regions and municipalities directly under the central government). At the end of 2021, there were over 42,785 small hydropower stations in operation with a total installed capacity of 82.9 million kW, and a total annual power generation of 224.1 billion kWh, which accounted for 21.2% and 16.7% of national hydropower installed capacity and annual power generation.

Installed Capacity Structure Diagram of Water and Electricity by Year-end 2021 in Rural Areas



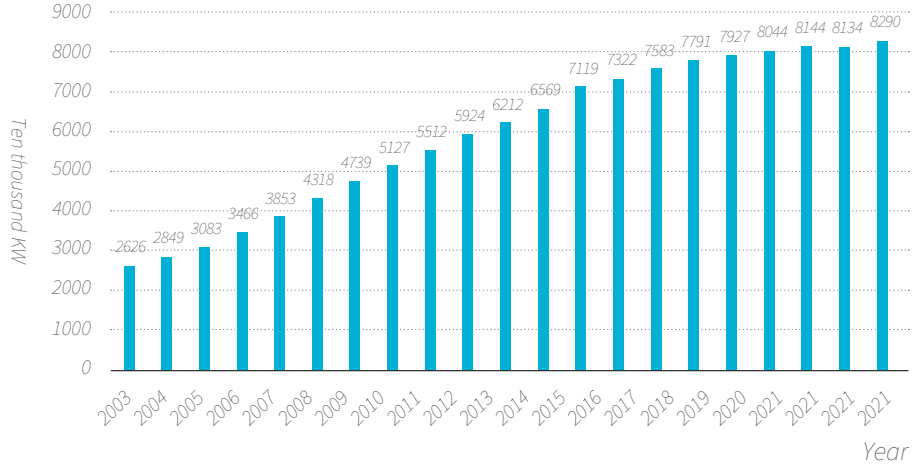
Installed Capacity Structure Diagram of National Power Supply in 2021



2 Major Achievements

In the process of developing small hydropower, China has built up a technical standard system that covers multiple aspects of small

Installed capacity growth of China's small hydropower (2001-2021)



hydropower including planning and design, construction and installation, operation and maintenance, safety evaluation, and electro-mechanical equipment and material testing. As of 2021, there have been currently 43 valid standards, including 18 national standards and 25 water conservancy industry standards.

2.1 Small Hydropower, Big Role

2.1.1 Solve the Problem of Electricity Consumption for More Than 300 Million People without Electricity

In 1983, the Chinese government initiated a campaign to enable its rural areas to get access to electricity through the development of hydropower. 653 counties accomplished preliminary hydro-powered rural electrification between the "Seventh Five-Year Plan" and the "Ninth Five-Year Plan" period. 621 counties accomplished hydro-powered rural electrification with higher standards between the "10th Five-Year Plan" and the "11th Five-Year Plan", and 316 more counties implemented hydro-powered rural electrification programs during the 12th Five-Year Plan period. The ratio of rural households with access to electricity grew from less than 40% in 1980 to 99.8% in 2015, along with a marked improvement in the quality and reliability of power supply, which basically resolved the problem of difficult access to electricity in mountainous rural areas.

Jingrun Small Hydropower Station in Jingning County, Zhejiang Province

2.1.2 Drive Forward Social and Economic Development in Rural Areas

The development pace of the counties enjoying access to preliminary hydro-powered rural electrification between the 7th Five-Year Plan and 9th Five-Year Plan periods was remarkably higher than the national average. Those counties have basically achieved the targets of doubling their Gross Domestic Product (GDP), fiscal revenue, per capita net income of farmers, and per capita power consumption every 5 years, and quadrupling those figures every decade. In counties with access to hydro-powered rural electrification during the 10th-11th Five-Year Plan periods, their power consumption per capita and power supply reliability increased remarkably. During the 12th Five-Year Plan and the 13th Five-Year Plan periods, efficiency improvement and expanding capacity of the rural hydro-powered stations was supported by the central government, with a total allocation of 13.4 billion yuan (including 4.6 billion yuan in the 13th Five-Year Plan). 6,526 hydro-powered stations before 1995 and those put into operation before 2000, with an installed capacity of 50,000 kilowatts or less, were transformed in two batches. After the transformation, the annual power generation increased by 43% compared with that before. In particular, during the 13th Five-Year Plan period, the efficiency and expanding capacity were implemented by taking rivers as units, and ecological transformation was carried out simultaneously on the basis of increasing the efficiency and expanding capacity of power stations. In

Small Hydropower Station in Chaling County, Hunan Province

total, more than 1,000 rivers were preliminarily harnessed, and more than 3,000 km dehydrated sections of rivers were recovered, playing an active role in improving the water ecological environment, ensuring water use for tourism and landscape, and promoting the construction of a beautiful countryside.

2.1.3 Improve Farmers' Living Standards and Production Conditions

In many areas, the development of small hydropower plants helps improve local infrastructures, and promotes the development of public welfare. Isolated mountain villages have gained access to electricity, water supply and roads, and renovated their kitchens. Science and technology have been disseminated in rural areas. All these have brought enormous improvements to the spiritual outlook of rural residents in mountainous areas. In many villages with hydropower, the revenue from it helps fund culture, education, communications, medical treatment, social security and other public-good undertakings for the whole village. Seniors at and over the age of 60 are eligible for a "pension subsidy".

2.1.4 Contribute to Energy Conservation and Emission Reduction

In 2021, small hydropower of China generated more than 224.1 billion kWh, equivalent to saving about 68 million tons of standard coal and reducing carbon dioxide emissions by nearly 220 million tons. The

ecological protection project of replacing fuel with small hydropower implemented from 2003 to 2015 has solved the problem of 3.2 million farmers' living fuel needs and reduced the annual consumption of fuelwood by 5.7 million m^3. Forest protection areas were 733,300 hm^2. During the 13th Five-Year Plan period, the cumulative power generation of small hydropower stations in five years was 1.26 trillion kWh, replacing 400 million tons of standard coal, reducing carbon dioxide emissions by more than 1.2 billion tons, sulfur dioxide emissions by 33,000 tons, and nitrogen oxides by 300,000 tons. The benefits of energy saving and emission reduction are enormous.

2.1.5 Safeguard Emergency Power Supply

When South China suffered freezing rain and snow storms in the beginning of 2008, small hydropower supplied starting power to a number of large power plants, and served as a secure source of electricity to over 200 counties and 2,000 townships during the Spring Festival for their power consumption. In addition, it provided power supply when the main power grids were in restoration. Small hydropower also helped to keep the major railway lines including Beijing-Kowloon, Yingtan-Xiamen, Chongqing-Huaihua, and Hunan-Guizhou uninterrupted. After the Wenchuan earthquake in Sichuan Province and Yushu earthquake in Qinghai Province, people in quake-stricken areas were able to quickly receive power supply in many counties and areas by restoring their small hydro-powered stations.

2.2 Strong Supervision, Green Development of Small Hydropower with a New Pace

2.2.1 Carry out Investigation Evaluation of Hydro-powered Resources and Compilation of a Hydro-powered Resources Development Plan in Small and Medium-sized Rivers

In 2006, an investigation and evaluation of rural hydro-power resources was initially carried out in China. The relationship of more than 16,500 rivers in the river basin and water system was comprehensively and systematically sorted out. In 2012, the Ministry of Water Resources organized the revision of the hydro-power resources development plan for more than 3,200 small and medium-sized rivers in the country and

Improved Eco-environment Thanks to Small Hydro Replacing Wood Fuel Project

optimized the distribution of rural hydro-power resources in accordance with the principle of improving river ecology. This achieved good results.

2.2.2 Reinforce Rural Small Hydro-power Safety Supervision and Ensure People's Lives and Properties

In recent years, the safety supervision of small hydro-powered stations has been continuously strengthened, a series of safety production supervision documents and technical standards for small hydro-powered stations have been formulated, the main responsibility, supervision responsibility and administrative responsibility for safety production of

Shimenqiao Small Hydropower Station in Guangxi Zhuang Autonomous Region

small hydro-powered stations have been implemented. The investigation and management of safety risks of small hydro-powered stations have been organized. Besides, the dam safety management of small hydro-powered stations has been strengthened, and the standardization of safety production has been promoted. In 2022, the government organized the investigation and rectification of safety risks of small hydro-powered stations nationwide, and implemented three responsible people station by station. 14,000 small hydro-powered stations were included in the key supervision list of provincial, municipal and county safety production, realizing differentiated supervision. Since the standardization of safety production was promoted in 2013, 4,700 power stations have been built nationwide, and the situation of safety production has been generally stable and the level of safety management has been continuously improved.

2.2.3 Positively and Stably Promote Rectification of Small Hydropower in Classification and Restore Healthy Life of Rivers

In 2018, seven departments, including the Ministry of Water Resources, organized 10 provinces and cities in the Yangtze River Economic Belt to carry out cleaning up and rectification of small hydropower. Taking rivers or county-level areas as units, the rectification was promoted through problem verification, comprehensive evaluation and classification, one policy for one station rectification, as well as removal from the rectification list after the acceptance test. By the end of 2022, the cleaning up and rectification of small hydropower in the Yangtze River Economic Belt has been fully completed. 21,000 power stations have been rectified, reserved power stations have implemented ecological flow, and the connectivity of more than 90,000 km reaches has been restored. The problem verification of more than 2,700 power stations in the Yellow River Basin has been completed, basically completing the comprehensive evaluation and classification and clearly defining the classification list of "exiting, rectifying and retaining" power stations. In other areas, the classified rectification of small hydro-powered stations has been promoted in an orderly manner. Guangdong has issued a policy of rectifying, rewarding and compensating, and Fujian has included the achievements of rectification into the indicators of local party and government's ecological target responsibility and the assessment indicators of River Chief Office.

2.2.4 Implement Green Transformation of Small Hydropower and Promote the Modernized Management Level

Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan and other provinces have adopted the method of combining the efforts of the government and the market, and explored new modes of green transformation of small hydropower, such as the integration of assets acquired by the government, the establishment of platforms for industrial associations, the trusteeship of third-party institutions, the decentralized enterprise implementation on the base of unified government planning, and the promotion of hydropower group companies according to the basin. At present, more than 30 centralized control centers of small hydropower have been put into operation, and over 3,000 power stations have realized intelligent transformation, intensive operation and property trusteeship, which has greatly reduced operating costs, eliminated potential safety hazards and increased clean electricity. A great number of power stations used power generation income to feed back ecological protection and restoration of rivers, achieving multiple economic, social, and ecological benefits.

2.2.5 Reinforce Top Design and Promote Green Development of Small Hydropower for Transformation and Upgrading

In 2006, the *Administrative Measures for Environmental Protection of Rural Hydropower Construction Projects* and the *Code for Environmental Impact Assessment of River Basin Planning* were issued. In 2016, the Ministry of Water Resources issued the *Guiding Opinions on Promoting the Development of Green Small Hydropower and* the *Evaluation Criteria for Green Small Hydropower*. Since 2018, together with relevant departments, the Ministry of Water Resources has issued guidance documents on *Cleaning up and Rectification of Small Hydropower Stations in the Yangtze River Economic Belt*, *Notice on Strengthening the Supervision of Ecological Flow of Small Hydropower Stations in the Yangtze River Economic Belt, Implementation Plan for the Withdrawal of Small Hydropower Stations in the Yangtze River Economic Belt*, and *Guidance on the Work of Cleaning up, Rectification, Acceptance and Removal*, clarifying the objectives, tasks and requirements and ensuring the orderly progress of cleaning up and rectification. In order to solve the problems existing in cleaning up and rectification in some areas, in 2021,

the Ministry of Water Resources and other seven departments jointly issued *Opinions on Further Improving the Classification and Rectification of Small Hydropower Stations*, unifying the evaluation and classification standards and rectification requirements. In 2018, Fujian Province issued the first *Measures for the Management of Ecological Electricity Price of Hydropower Stations (Trial)*, and carried out the on-grid electricity price reward and punishment policy depending on the implementation of ecological flow. Jilin, Hainan and other provinces promoted the reform of the on-grid electricity price of small hydropower stations, and gave incentive electricity prices to standardized power stations for safe production and green, small hydropower demonstration stations. By the end of 2022, over 34,000 small hydropower stations have discharged ecological flow as required, playing an important role in restoring river connectivity, reviving the ecological environment of rivers and lakes, and promoting the construction of high-quality rivers and lakes. Since 2017, 964 small, green hydropower stations have been built in 25 provinces across China, playing a leading role in protecting and restoring river ecology, reviving the ecological environment of rivers and lakes, improving people's livelihood and well-being, and standardizing safety production.

3 Work Goals and Main Tasks

3.1 Development Goals

Coordinate ecological protection, green development and improvement of people's livelihood, and strive to build modern small hydro-powered stations with reasonable layout, green safety and intensive intelligence.

3.2 Main Tasks

3.2.1 Revive the Ecology of Rivers and Lakes and Promote Rectification of Small Hydropower in Classification

In accordance with the overall requirements of restoring the ecology of rivers and lakes, it is essential to scientifically and reasonably carry

Shilongba Hydropower Station in Kunming City of Yunnan Province, Constructed in 1911 (the First Hydropower Station in China)

out the evaluation and classification of "withdrawal, rectification, and retention" according to laws and regulations, actively and steadily promote the classification and rectification of small hydropower stations, with the goal of restoring river connectivity and proper disposal, so as to ensure the orderly withdrawal of power stations. It is essential to confirm that the problems are truly rectified by focusing on ensuring ecological flow and engineering safety, include power stations of retention and power stations of passing rectification into the daily supervision, effectively eliminate the adverse effects of disorderly development and over-exploitation on river ecosystems and maintain the healthy condition of rivers.

3.2.2 Focus on the Bottom Line of Safe Production and Reinforce the Safety Management Level of Small Hydropower

It is essential to strengthen the rectification of potential safety hazards of small hydropower stations, follow the three responsible people for safety production, and strengthen dam safety management. All power stations above the scale of small reservoirs should carry out dam safety registration and safety appraisal, and those below the scale should carry out dam safety assessment, continue to promote the standardization of safe production and operation management of small hydropower, strengthen forecasting, early warning, rehearsal and pre-planning measures, implement various measures for safe flood control,

comprehensively improve the intrinsic safety level of small hydropower and safeguard public safety.

3.2.3 Match with Development Goals of High Quality and Construct the Modernized System of Small Hydropower

It is necessary to assist carbon emissions peak and carbon neutrality, implement the green transformation and modernization of small hydropower stations, eliminate potential safety hazards, improve the utilization efficiency of hydropower resources, enhance the scale benefits of small hydropower stations, use up the clean energy and flexibly regulate power supply.

4 International Cooperation and Exchanges

4.1 Establishment of International Organizations

In 1981, the Asia Pacific Small Hydropower Research & Training Center was established under the auspices of the UNDP and the then PRC Ministry of Foreign Trade and Economic Cooperation (MOFTEC). In 1992, following a joint initiative by international organizations including the UNDP, UNIDO and UNESCO, relevant countries and the Chinese government, the International Network on Small Hydropower (INSHP) was established in 1994 with a membership of over 60 countries. In addition, the International Center for Small Hydropower was established in 1999 with Hangzhou as its headquarters. At present, over 480 members from 80 countries and regions in the world have joined INSHP. Hitherto, the INSHP has established 3 regional sub-centers in Asia, Africa, and South America respectively, and 5 international small hydro demonstration bases in Zhangye of Gansu Province, Changsha of Hunan Province, Chenzhou of Hunan Province and Jinhua of Zhejiang Province.

4.2 Construction of Platforms for International Small Hydropower Exchanges

Since 2005, the INSHP has successfully organized "Hydropower for Today Forums" 7 times, featuring various themes such as Asia-Africa Small Hydropower Cooperation, Developing & Managing Small Hydropower in Africa, Small Hydropower and Improvement of Living Standards, and Small Hydropower and Green Development. The forum held the Ministerial Seminar on Water Resources & SHP for Developing Countries and the Workshop on Water Resources Management & Planning for Developing Countries in Hangzhou in 2011 and 2015 respectively. In 2013, the International Center on Small Hydropower and UNIDO jointly launched the first English version of *the World Small Hydropower Development Report 2013*, and the second edition was released in 2016. The publication of SHP News, a special English journal on small hydropower and an INSHP Newsletter, the English journal of INSHP, further diversified such exchange platforms.

4.3 Engagement in International Cooperation and Technical Exchanges

Under the auspices of the United Nations and other international organizations, China has carried out international small hydropower cooperation programs in collaboration with the World Bank, the UNDP, the UNIDO, the Group of 77, the Global Environment Facility and other international organizations and international assistance agencies from developed countries. These programs were in the fields of rural energy, environmental protection and poverty reduction. They have helped promote and demonstrate small hydropower technologies, and enabled Chinese experiences, wisdom and technologies to benefit other developing countries. By engaging in inter-governmental technical cooperation programs, including the comprehensive development of small hydropower in the developing countries of Asia, Africa and Latin America, China-Africa renewable energy cooperation and "Sino-Pakistan Joint Research Center for Small Hydropower Technology", China has provided effective and practical assistance to developing countries in their use of small hydropower resources. The "Lighting-up Africa" Program has been developed. Small hydropower equipment developed and manufactured by China has been exported to more than 50 countries/regions, with some EU member states included. Services ranging from planning, designing and consulting to supply and installation of complete sets of equipment have been rendered to hundreds of small hydropower stations in developing countries.

The INSHP and Small Hydropower Research Training Center in the Asian-Pacific Region have provided small hydropower technical training, technical information exchange and scientific-technological cooperation for developing countries. 109 training sessions of small-sized hydropower technology have been carried out for countries participating in the "Belt and Road" Initiative. The number of trainees is over 2,500. Also, Vietnam, Guyana and Cuba or other Asian, African and Latin American countries have been assisted to construct a batch of small hydropower station projects. Planning, designing, consulting and complete equipment sets in hundreds of small hydropower station plans have been provided for more than 60 countries, including Mongolia, Rwanda, Brazil and Vanuatu.

In July 2016, Ban Ki-moon, Secretary General of the United Nations at the time, visited the INSHP to fully affirm the contributions of Chinese small hydropower stations in tackling climate change and developing

small hydropower stations worldwide, as well as an important role in international exchanges.

On April 27, 2019, the "International Standard Compilation of Small Hydropower", an important achievement of international cooperation under "the Belt and Road Initiative", was included in the achievement lists of the 2nd International Cooperation Summit Forum of the "Belt and Road".

On April 27, 2019, as an important achievement of international cooperation under the Belt and Road initiative, the compilation of international standards for small hydropower was included in the list of achievements of the second "Belt and Road" initiative International Cooperation Summit Forum. The International Small Hydropower Federation and the United Nations Industrial Development Organization jointly compiled and published the International Standard for Small Hydropower, *Technical Guidelines for Small Hydropower* (English and Chinese versions), the first systematic and complete international standard for small hydropower industry in the world. On this basis, the International Small Hydropower Center has further promoted the formulation of international standards for small hydropower. ISO has successively issued three international standards of *Technical Guidelines for Small Hydropower* (ISO/IWA 33) by means of international seminar agreement, which was the first time that China has formulated ISO standards by means of international seminar (IWA) and has been successfully approved.

Since 2021, the International Small Hydropower Center has actively planned and promoted the establishment of the secretariat of the ISO Small Hydropower Technical Committee. On May 18, 2022, the Technical Management Bureau of the International Organization for Standardization (ISO/TMB) formally adopted the proposal of establishing the ISO Small Hydro Power Plants by Resolution No.42 of 2022(ISO/TC339 Small Hydropower Plants), and the secretariat of the ISO Small Hydro Power Plants was located in China.