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Small hydropower in China: The survey and sustainable future

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ABSTRACT

Small hydropower is a green and renewable energy resource. China has very rich small hydropower resources with a total technically utilizable installed capacity of 128 gigawatts (GW). Developing small hydropower is of great importance to speed up the economic growth of rural areas and alleviate the environmental pollution in China in the 21st century. This paper provides a survey of small hydropower exploitation in China. Over the last six decades, China's small hydropower has developed rapidly. The installed capacity of small hydropower exceeds 59.24 GW at the present time. Fifteen large-scale small hydropower bases have been completed, and more bases are still under construction. The small hydropower for fuel project has been in operation. It not only provides cooking fuel for peasants, but also protects the eco-logical environment. The rural electrification construction based on small hydropower has lasted for 25 years, and 412 counties had realized rural electrification by 2010. The reasonable exploitation of small hydropower will accelerate the harmonic development of resources and the environment in China.

Contents

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1. Introduction

The demand of energy resources increases with the economic development. Excessive exploitation of non-renewable energy resources and excessive reclamation of forest land will result in water and soil losses and destruction of the ecological environment. This cannot ensure the sustainable development of our economy. Developing small hydropower is an important way to cope with energy resource and environmental problems.

1.1. Naissance of the hydropower station in China

In 1912, the first hydropower station in China was completed in Shilongba, Yunnan Province. Two 240 kW (kW) hydro generators were put into operation. The construction of this small hydropower station initiated the history of the hydropower development in China. After seven extension projects, its installed capacity had reached 6000 kW by 1958. This hydropower station is still in normal operation now [1].

But the total installed capacity of small hydropower in China was only 3.7 MW (MW) until 1949. After the establishment of the People's Republic of China, the government pays great attention to the development of hydropower, especially small-hydropower. It positively helps the mountainous areas to build numerous small hydropower stations based on the local water conservancy construction.

1.2. The definition of small hydropower in China

There is no unified definition of small hydropower in the world. Each country has its own standard according to its national conditions. In China, the small hydropower means the hydropower stations have an installed capacity of not more than 50 MW [2,3].

The capacity limit of small hydropower is closely related to the development of Chinese National Economy, especially the rural economy and the electricity consumption level of rural areas. The definition of small hydropower in China has experienced five stages [4].

- In the 1950s, the capacity of small hydropower stations was less than 500 kW.
- To the 1960s, the value rose to 3 MW, and in some areas, miniature power supply lines combined by several small hydropower stations appeared. They were the embryonic form of local power network in China.
- To the end of the 1960s, the capacity limit went up to 12 MW. The county power network with centralized power dispatching was formed, whose voltage level was less than 35 kV (kV).
- To the 1980s, the limit was raised to 25 MW. The construction scale of small hydropower expanded rapidly, and local power networks with voltage level of 110 kV were constructed.
- After the 1990s, the limit reached 50 MW. And the voltage level of local power networks increases correspondingly.

2. Advantages of small hydropower

As a green and renewable energy resource, small hydropower has a lot of advantages, and some of them are unique in China. The main are as follows [4–6]:

(1) *It is clean and green.* The small hydropower station is generally built on medium or small rivers with a small basin area and without water concentration. It doesn't change water quality and volume, and basically has no effect on the survival and reproduction of biological species of the rivers. Exploitation of small hydropower doesn't produce greenhouse gas and other noxious gases, and thus won't pollute the environment.
(2) *The small hydropower technology is very mature*. The power station can be designed and completed within one or two years, and has a long lifetime. The dam and related control engineering can work over 100 years with simple maintenance. Moreover, with technology development the turbine efficiency is getting higher and higher, and some can even reach 90%.
(3) Small hydropower plays a very important role in resisting natural disasters, emergency service and disaster relief because it supplies power distributedly. So that it can provide power rapidly in isolated regions when the main power network splits and cannot recover in time.
In January, 2008, the disaster of snow rainfall and freezing happened in South China, which was rare in history. It led to large area blackout in the main power network, severely affecting local people's production and life, and even the economical development. At this time, small hydropower quickly recovered to supply power, effectively reducing disaster loss [4].
In May, 2008, the large earthquake occurred in Wenchuan, Sichuan province. The small hydropower fully took the advantage of isolated operation, which was vital to the disaster rescue [4].
(4) The electricity price of small hydropower for fuel is relatively low, which is very beneficial to reduce the peasants' burden in China. This advantage is very obvious especially in China [7].

According to the planning data and typical investigation, the average investment of small hydropower is about ¥6000 per kW h, and the comprehensive network power price is about ¥0.25 per kW h. With national support, the average consumer price can decrease to ¥0.23 per kW h, which is much lower than the mean consumer price of ¥0.56 per kW h in the rural areas around the country at the present time.

3. The development course of small hydropower in China

The small hydropower of China has experienced three exploitation stages since its naissance [8–10].