Briefing material

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Development of Pumped Storage Power Station in China

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Pumped storage power stations have become an important component for guaranteeing the secure, economic and stable operation of the power system due to its rapid response and flexible operation as well as two functions of pumping water and generating power. The Chinese government has set a goal to provide at least 15% of primary energy consumption by 2020 from non-fossil energy, and 20% by 2030, and this proportion will continue to increase. In order to ensure the realization of the above goal, China will actively develop nuclear power and new energy power generation (including wind and solar power) while controlling the total energy consumption. The increase in the proportion of nuclear power and new energy power generation also requires the cooperative operation of pumped storage power stations. In this briefing, the author introduces the development of pumped storage in China according to three aspects.

1. Construction of Pumped Storage Power Station in China

In China, pumped storage power station, as a late starter, began to develop in the late 1960s. In 1968, the Hebei Gangnan Mixed Pumped Storage Power Station was completed with an installed capacity of 11MW. After preliminary exploration, in-depth research and demonstration, comprehensive planning and design, the country gradually entered an era of larger scale development in the 1990s. From the late 1990s to the beginning of the 21st century, a large number of large-scale pumped storage power stations were successively constructed and commissioned in China.

By the end of 2016, China has 26 pumped storage power stations in operation with the total installed capacity of 26,690MW. In 2016, the country added a further 3,660MW of pumped storage capacity to the national grid. Recently completed pumped storage stations in 2016 include the Zhejiang Xianju (1,500MW), Jiangxi Hongping (1,200MW), and Guangdong Qingyuan (960MW).

As of the end of 2016, a further 26 pumped power storage stations were under construction in China with the total installed capacity of 32,110MW.

At the end of 2016, the Hebei Fengning Pumped Storage Power Station (3,600MW) is the largest pumped storage power station under construction. The Guangdong Guangzhou Pumped Storage Power Station (2,400MW) and Guangdong Huizhou

Pumped Storage Power Station (2,400MW) respectively boast the largest installed capacity currently in operation. The station with the largest pump-turbine under construction is Guangdong Yangjiang Pumped Storage Power Station (400MW). The Zhejiang Xianju Pumped Storage Power Station (375MW) boasts the largest pump-turbine currently in operation. Zhejiang Changlongshan Pumped Storage Power Station has the highest head under construction with rated head of 710m, while the operational Shanxi Xilongchi Pumped Storage Power Station has a rated head of 624m).

During the 13th five-year plan period (2016-2020), China will optimize the regional distribution of pumped storage power stations and accelerate the development and construction of pumped storage power station to meet the requirements of its electric power system and to realize its energy-efficiency and emissions reduction targets. It is predicted that the 13th five-year plan period will witness the start of construction of a total of 60,000MW of pumped storage, while some 17,000MW pumped storage will enter operation. According to the plan, the total installed capacity of pumped storage power station to be build up will reach 40,000MW by 2020 and about 90,000MW by 2025.

2. Pumped Storage Power Station Conducive to the Operation of Power Supply and Power System

During the peak load periods, pumped storage power stations can work as conventional hydropower stations to run as per working conditions of power generation to bear the system peak load. During periods of excess supply, pumped storage can also be used to pump water by reduce the difference between peak and valley load. Therefore, coal-fired thermal power and nuclear power could operate within their respective economic range with less output decrease of the former and no output decrease of the latter, which would increase the utilization hours of thermal power generation and save coal consumption. For power grids requiring start and stop for peak regulation of units, it could reduce the cost of starting and stopping units and the impact on the service life of units, maintain the smooth operation of units, and improve operation conditions of thermal power and nuclear power of the system. The dual function of peak regulation and valley filling marks a unique function of pumped storage power station, which cannot be replaced by other types of power supply.

Pumped storage power station and new energy power generation (wind power and solar PV) feature complementary operation, mainly manifested in two cases:

The first case: In the power system that accepts new energy power generation, after new energy power generation is connected to grid, it will increase the peak regulation

load of the power grid. Pumped storage power stations, with double-peak regulation role of pumping water and generating power, can greatly improve the grid-connected operating conditions of new energy power generation. As new energy power generation features output intermittency, random volatility and uncontrollability, pumped storage power station and new energy power generation could work with each other to use the new energy power that cannot be consumed to pump water from lower reservoir to upper reservoir for storage so that it could generate power during the power consumption peak period when the output of new energy power generation is relatively small, improving the utilization of new energy power generation.

The second case: At large-scale power sending end of wind power and PV power bases, new energy power could be bundled with that from pumped storage power station for delivery. China's northwest region is rich in wind power and photovoltaic resources, a small part of which can be consumed locally while the majority will be sent to central China and east China which short of energy resources through UHV or large-scale long-distance transmission. UHV DC transmission is one of the transmission modes. Due to random fluctuations of new energy power output, the delivery of pure new energy power generation with low utilization hours will increase long-distance transmission system investment. If the sending end of new energy power generation is equipped with adequate regulated capacity, with mutual adjustment, combined power generation and bundled sending of new energy power station and pumped storage power station, pumped storage power station will pump water to store energy when the new energy power output is high, while it will generate power when new energy power output is low. Thus, it could increase utilization hours of power transmission system and reduce long distance power transmission scale and investment accordingly.

Through cooperative operation, pumped storage power station and new energy power generation could stabilize the output amplitude and variability of new energy power, and reduce the negative impact of new energy on the converter of UHV DC transmission system, frequency of transmission system and reactive voltage. Therefore, it could maintain the power grid frequency and voltage stability and protect the normal operation of new energy generating units, which is conducive to the utilization of new energy power generation.

3. China's Policies for Pumped Storage Power Station

China's policies for pumped storage power station include the planning, preliminary work, construction and operation of pumped storage power station.

In terms of planning, the Chinese government has developed site selection planning

requirements mainly based on provincial power grid or regional power grid, so as to guarantee the reasonable layout of pumped storage power station and the economic and environment-friendly rationality of proposed pumped storage power stations. According to policies, only proposed sites are allowed to carry out preliminary work and approved for construction.

In terms of preliminary work, China has determined four survey and engineering stages for pumped storage power stations, including pre-feasibility study, feasibility study, tender design and construction drawing design, and developed technical requirements of rules and regulations for each specialty and rules for the management of review and approval of results at four survey an engineering stages, so as to ensure the feasibility of pumped storage power station construction program in technical, environmental, social and economic aspects.

In terms of construction, China has stipulated to encourage investing social capital in the construction of pumped storage power stations, including power grid operators, power supply construction enterprises, and other private companies. Pumped storage power station should be approved for construction by provincial energy authorities. In accordance with the requirements of project construction, 20% of total investment is self-raised while the remaining 80% is bank loan. In the construction process, there are supporting management procedures, which stipulate the separation of duties for construction quality, duration, investment, safety, risk control and others.

In terms of operation, it's stipulated that pumped storage power station adopts two-part electricity price, that is, capacity price and electricity price, and the scheduling operation principle of pumped storage power station.

All in all, China has formulated rather comprehensive policies which have guaranteed the construction and operation of pumped storage power stations.