JANUARY 2023

CHINA ENERGY POLICY
NEWSLETTER

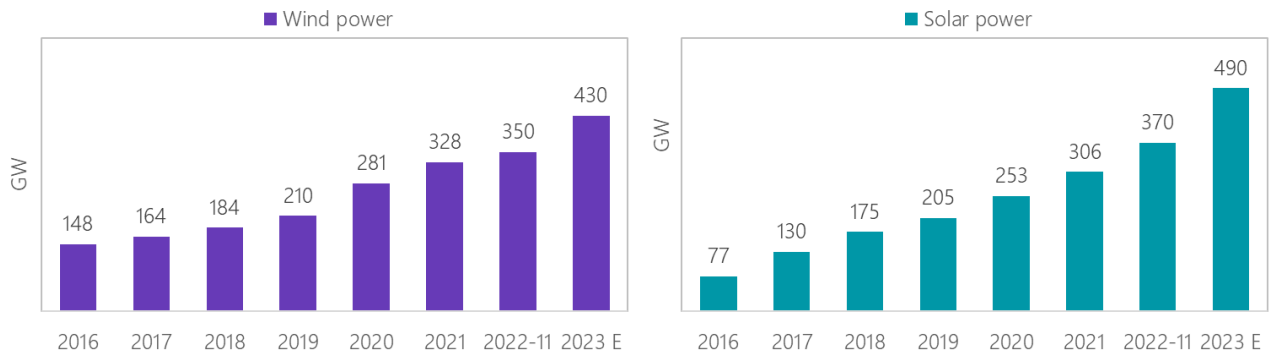
China Energy Transformation Programme

1. China energy transition updates

The installed capacity of wind power and solar PV aims to reach 920 GW in 2023

Recently, at the 2023 National Energy Work Conference, the National Energy Administration (NEA) proposed 2023 installed capacity targets for wind power, solar PV, hydropower and nuclear power, aiming to continue to adjust and optimize energy structure. According to forecasts, the newly installed capacity of wind power and solar PV is expected to reach more than 120 GW in 2022, with a year-on-year growth rate of nearly 19%. In 2023, as three batches of large-scale wind power and solar PV bases start construction, it is expected that the newly installed capacity of wind power will further reach more than 160 GW, with a year-on-year growth rate of 33%. According to the goal set by NEA, by the end of 2023, solar power will become China's largest renewable energy power source, with a total installed capacity of 490 GW; wind power will rank second, with a total installed capacity of 430 GW. [1]

Total installed capacity and forecast of wind power, solar PV, hydropower and nuclear power from 2016 to 2023



[1] "2023年能源工作安排来了，风光累计装机将达9.2亿千瓦," National Energy Administration, 31 December 2022, accessed at https://www.jiemian.com/article/8669261.html.

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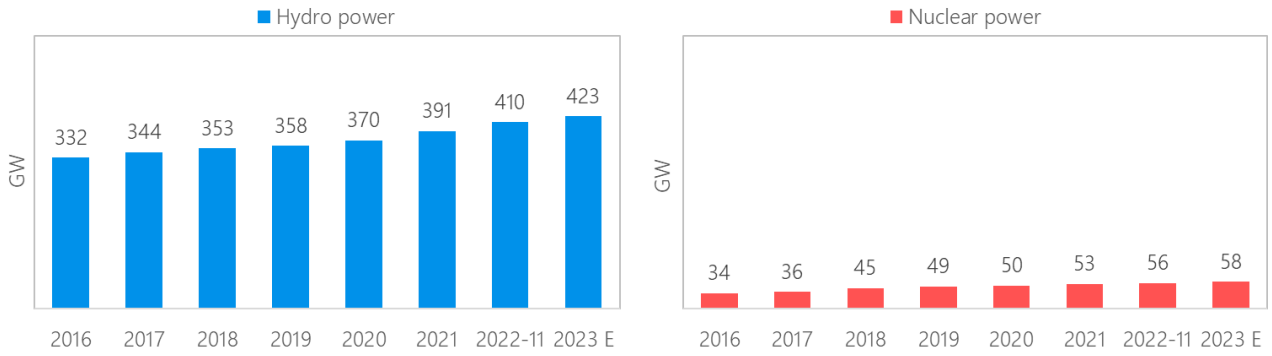


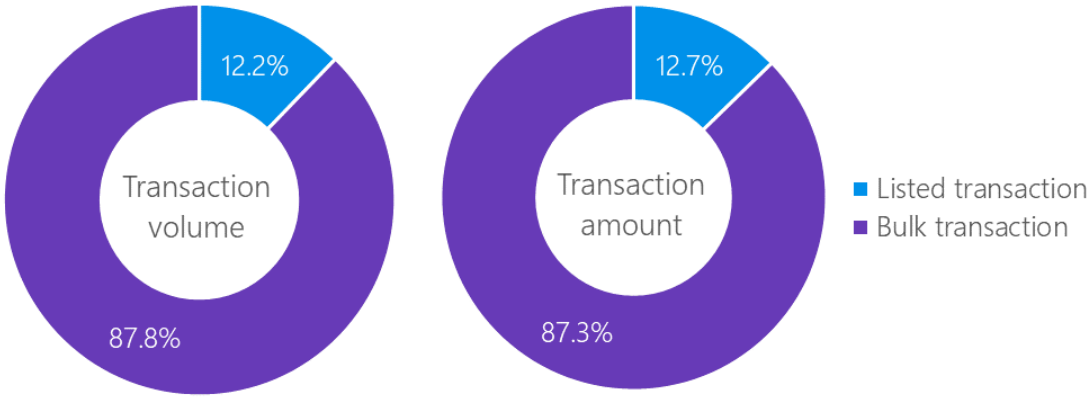
Source: National Energy Administration (NEA), China Electricity Council (CEC), accessed in January 2023

2022 national carbon market trading data released

In 2022, the annual transaction volume of China's national carbon market reached 50.89 million tons, with an annual transaction amount of RMB 2.81 billion. In November, the Ministry of Ecology and Environment (MEE) successively released a number of important policy documents, such as the *Letter on Public Solicitation of Opinions on the 2021 and 2022 Implementation Plan for the Total Settlement and Distribution of National Carbon Emissions Trading Allowances (Power Generation Industry) (Draft for Comments)* (See the November 2022 newsletter for details). The government has further improved the market mechanism of the national carbon market to boost market confidence. Therefore, the combined volume of transactions in November and December accounted for 66%.

- Listed agreement transaction: The daily closing price is between 55-61.4 RMB/ton; the closing price on December 30, 2022 was 14.6% higher than the opening price on the first day of the launch of the national carbon market (July 16, 2021).
- Bulk agreement transactions: the average daily transaction price is between 42.5-62.5 RMB/ton, and the annual average transaction price is 55.0 RMB/ton.

The proportion of annual transaction volume and annual transaction amount of listed transactions and bulk transactions in the national carbon market in 2022

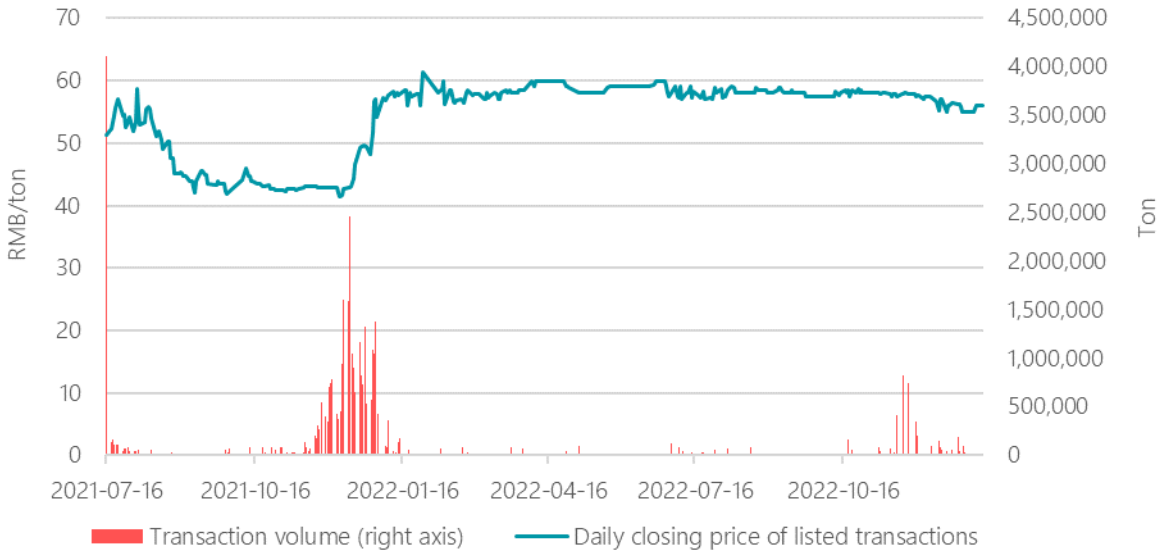


Source: Shanghai Environment and Energy Exchange, January 2023

Since the launch of the national carbon market in July 2021, the cumulative transaction volume has reached 230 million tons, and the cumulative transaction amount has reached 10.46 billion RMB. The daily closing price is between 41 and 62 RMB/ton, and the average transaction price is 45.6 RMB/ton. [2]

[2] "2022全国碳市场运行情况一览," Shanghai United Assets and Equity Exchange, 2 January 2023, accessed at https://m.thepaper.cn/baijiahao_21397390.

The daily closing price and transaction volume of listed transactions in the national carbon market (July 16, 2021, ~ January 10, 2023)



Source: Refinitiv, January 2023

NEA proposes a timetable for the construction of the new-type power system

In January 2023, the NEA issued the *Blue Book on New-Type Power System Development (Draft for Comment)* (hereinafter referred to as the *Blue Book*), which clarified the timetable for the construction of a new-type power system and key tasks step by step. The *Blue Book* regards 2030, 2045 and 2060 as three important time nodes, and deploys the strategic goals and development paths of power sources, power grids, and loads.[3]

Stage 1 Accelerated transition period (currently ~2030) New-type power system accelerates the clean and low-carbon transition
▪ The proportion of non-fossil energy consumption reaches 25% ▪ Simultaneous development of utility-scale and distributed new energy, industry transfer from the eastern regions to central and western regions ▪ New energy to become the main body of incremental power generation, accounting for more than 40% of installed capacity and more than 20% of power generation ▪ Coal power installed capacity and power generation will still grow moderately, focusing on large-scale new energy bases, load priorities, and important grid node layout ▪ The installed capacity of pumped hydro storage to reach more than 120 GW, and the new-type energy storage can meet the needs of intra-day regulation ▪ Integrate decentralized demand response resources, and the demand-side response capability reaches more than 5% of the peak load ▪ Further expand the scale of the inter-provincial power transmission channel of West-to-East Power Transmission, and the distributed smart grid develops rapidly ▪ Accelerate the electrification of industry, construction, transportation, and other fields, expand the scope of electricity substitution programs, and the electrification rate of end-use sectors reaches more than 35% ▪ The national unified power market system to basically taken shape

[3] "国家能源局综合司关于公开征求《新型电力系统发展蓝皮书（征求意见稿）》意见的通知," National Energy Administration, 4 January 2023, accessed at http://www.nea.gov.cn/2023-01/06/c_1310688702.htm.

Stage 2 Overall shaping period (2031~2045) The overall formation of a new-type power system
▪ Electricity demand will reach the peak around 2045, and electric energy will become the mainstay in end-use energy consumption ▪ New energy to become the main power source, and the growth rate of hydropower and nuclear power installed capacity will slow down ▪ Relying on coal-biomass coupled power generation and CCUS to accelerate the low-carbon transition of coal power ▪ Long-time energy storage (i.e., longer than 10hr) represented by mechanical energy storage, thermal energy storage, and hydrogen energy can meet the needs of daily and longer time-period regulation ▪ Inter-provincial and inter-regional power transmission hits peak plateau
Stage 3 Consolidation and perfection period (2046~2060) The new-type power system has entered a mature stage
▪ With electricity as the core, to establish an energy system that connects electricity and multiple energy sources through power-to-hydrogen, power-to-fuel, etc., ▪ New energy to become the main body of power generation mix and base load power supply ▪ Large-scale promotion of new technologies and new models such as green electricity production of hydrogen, methane, and ammonia, making them become important regulation resources for the power system ▪ Transformation of coal power, gas power, and general hydropower into power system regulation sources ▪ A new generation of advanced nuclear power technology to achieve large-scale application, and nuclear fusion is expected to enter commercial applications ▪ Focus on the development of chemical energy storage and compressed air energy storage based on liquid hydrogen and liquid ammonia ▪ The combination of power storage, heat storage, gas storage, and hydrogen storage facilities support the power system to achieve dynamic balance across seasons ▪ Breakthroughs in new technologies such as low-frequency power transmission and superconducting DC power transmission to support new energy development needs in areas with weak power grids ▪ Create an integrated energy pipeline for power transmission and gas transmission to realize the revolution of energy and power transmission pattern

Source: NEA, January 2023

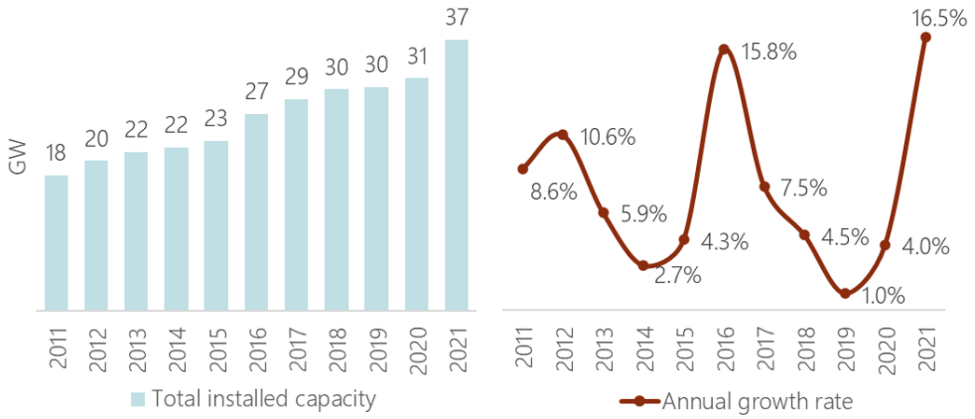
30-60 carbon targets provide new opportunities for China's pumped storage development

With the large-scale development of wind power and solar PV, the government proposes to build a new-type power system with new energy as the main body. Among the flexible green resources of the power system, pumped storage has the advantage of maturity in technology, is economically optimal, and has the greatest potential for large-scale development. The development of the pumped storage industry will be accelerated in an all-around way starting from the 14th Five-Year Plan period (2021-2025).

In 2021, the growth rate of the newly installed capacity of pumped storage nationwide reached 16.5%, which is 10.1 percentage points higher than the average annual growth rate of the 13th Five-Year Plan period (2016-2020). The total installed capacity of pumped storage reached 36.7 GW, accounting for 1.6% of the national total installed capacity and 3.3% of the installed capacity of non-fossil energy power sources. Among them, more than 70% of the installed pumped storage capacity is located in central, eastern, and southern regions, of which Guangdong and Zhejiang together account for 37.1 percentage points.[4]

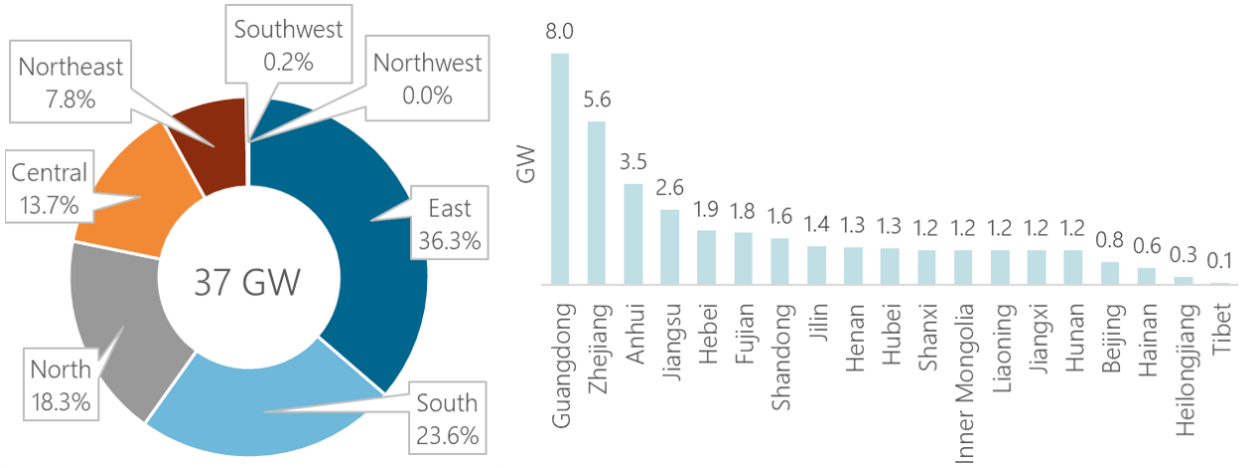
In the meantime, the National Energy Administration (NEA) launched a new round of site selection for pumped storage projects and based on this, proposed the installation targets for 2025 and 2030, as well as a list of medium and long-term project development. The pricing department of the National Development and Reform Commission (NDRC) has also further improved the price mechanism for pumped storage to make full preparations for it to participate in the power market.

Total installed capacity of pumped storage (left) and annual growth rate (right) from 2011 to 2021



Source: China Electricity Council (CEC), accessed in January 2023

Total installed capacity of pumped storage (left) and annual growth rate (right) from 2011 to 2021



Source: China Electricity Council (CEC), accessed in January 2023

The development of pumped storage in China has a history of more than 50 years

China built the country's first pumped storage power station in 1968. Later in the 1980s, the government regarded pumped storage as an important peak-shaving resource for nuclear power plants, so it focused on building pumped storage power stations in coastal provinces such as Guangdong and Zhejiang. In 2004, the NDRC made it clear that power grid enterprises would be responsible for the construction and management of pumped storage projects, and State Grid and China Southern Power Grid established particular enterprises for this purpose. Since then, to meet the needs of peak shaving and renewable energy development, the NEA launched the first round of national site selection for pumped storage projects in 2009, and proposed the goal of total pumped storage installed capacity exceeding 110 GW by 2020. However, the development speed is much lower than expected due to the lack of effective competition and the imperfect price mechanism. By 2020, the total installed capacity was less than 1/3 of the planning target.[5]

Fully accelerating the construction of new projects in the next ten years, and establishing the medium and long-term development goals for 2035

According to the results of a new round of pumped storage site selection in 2021, the resources of pumped storage projects across the country exceed 1,600 GW, while the proportions of projects built and under construction by 2021 were only 2.3% (37 GW) and 3.8% (62 GW), respectively, showing huge potential in development.[6] To promote the medium and long-term development of pumped storage in an orderly manner, in September 2021, the NEA issued the *Medium and Long-term Development Plan for Pumped Storage (2021-2035)*. By comprehensively considering resources, environment, and technical conditions, the government included 726 GW of resources and listed specific projects. Among them, 421 GW of projects have already met the construction conditions and will focus on promoting development in the next 15 years; 305 GW of projects still need to reach the ecological environment standards and are listed as reserve projects. The document also proposes installation targets for 2025 and 2030.[7]

> ***By 2025, the total installed capacity of pumped storage will double to 62 GW compared to 2020, and double again to about 120 GW by 2030.***

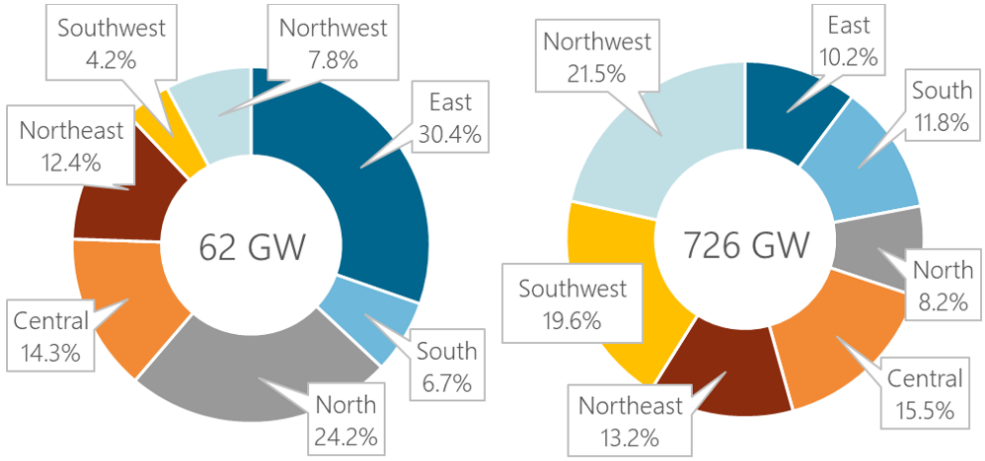
The project development has shifted from east to west, and diversified application scenarios have been built

From 2021 to October 2022, the government approved a total of 45 GW of pumped storage projects (14 GW in 2021 and 31 GW in 2022), which exceeded the total installed capacity in 2021.[8] Central China and eastern China are still the key areas for pumped storage development in the next few years. The “Three Norths” development pace will also be accelerated, accounting for 44.4% of the projects under construction in 2021[9]. At the same time, the development of pumped storage in the south has slowed down, and the concentration of project development will shift to the southwest region.

This series of changes is mainly due to the government's policy to plan and develop nine onshore clean energy bases during the 14th Five-Year Plan period.[10] Northwestern regions will develop large-scale wind power and solar PV bases with deserts and Gobi as key areas, and will use pumped storage as one of the important peak-shaving resources; southwestern will build new large-scale hydro-wind-solar-storage integrated bases, aiming to make full use of the local endowed hydropower resources. The demand for pumped storage projects due to the construction of clean energy bases has become increasingly prominent. In addition, according to the requirements of the *14th Five-Year Plan for Renewable Energy Development*, the central, eastern, and southern regions will carry out demonstration pilots of distributed small and medium-sized pumped storage projects in the future.[11]

Based on the traditional pumped-storage power station model, **a multi-type and multi-scenario pumped storage application pattern will gradually emerge in the 14th Five-Year Plan period**, including hydro-wind-solar-storage integration, supporting pumped storage for wind power and solar PV bases, distributed pumped storage power station, etc.

The capacity of pumped storage projects under construction (left) and medium and long-term planned capacity (right) by grid area in 2021



Source: China Renewable Energy Engineering Institute (CREEI), June 2022

An Independent price policy is established to increase revenue through the power market potentially [12]

In May 2021, the NDRC issued the *Opinions on Further Improving the Pricing Mechanism for Pumped Storage* (hereinafter referred to as *Document No. 633*) [13], which optimised the pricing mechanism for pumped storage and provided a strong guarantee for the economics of the project.

In 2014, the central government made it clear for the first time that the pumped storage power station implements a dual tariff mechanism, which includes two parts: **capacity tariff** and **electricity tariff**. Grid enterprises can recover these costs through electricity sales. After starting a new round of power system reform in 2015, the government stipulated that capacity tariffs are no longer counted as grid costs, which means that grid enterprises cannot recover the cost of capacity tariffs through electricity sales. This move aims to promote pumped storage projects to increase the proportion of electricity tariff income by participating in power market transactions. However, due to the immature construction of the power market, pumped storage projects cannot obtain sufficient profits by charging electricity tariffs. This has directly led to a significant reduction in investment enthusiasm for the pumped storage industry.

Document No. 633 issued in 2021 once again emphasised that **starting from 2023, all pumped storage projects will implement a dual tariff mechanism, and the capacity tariff will be recovered through grid companies' transmission and distribution tariff.** The document clarified the cost recovery mechanism for capacity tariffs and stabilised enterprises' confidence in developing pumped storage projects. The specific content of *Document No. 633* is shown in the table below.

Pumped Storage Pricing Mechanism		Cost Recovery Mechanism
Capacity tariff ▪ Reflect the value of pumped storage to provide ancillary services such as frequency regulation, voltage regulation, system backup, black start, etc. ▪ Recovering other costs other than water pumping and power generation operating costs to obtain reasonable benefits	**Areas without spot power market:** 6.5% internal rate of return (IRR) on capital for a 40-year operating period	Transmission and distribution tariff
	Areas with spot power market: The proportion of installed capacity that obtains capacity tariff is gradually reduced, and costs are recovered by participating in the power market (electricity tariff), mainly in the ancillary service market	Ancillary services market
Electricity tariff ▪ Reflect the value of pumped storage to provide peak shaving services ▪ Recovery of operating costs for water pumping and power generation	**Areas without spot power market:** The on-grid tariff adopts the baseline tariff of coal-fired power generation, and the price of water pumping adopts 75% of the baseline price of coal-fired power generation	Grid enterprises purchase and sell electricity
	Areas with spot power market: The on-grid tariff and water pumping price are both settled according to the spot market price and rules	Spot power market

- **In areas without a spot power market**, the power generation income (electricity tariff) of pumped storage power plants is the same as the water pumping fee. Therefore, the capacity tariff is the primary source of income. *Document No. 633* clarifies the verification method of capacity tariff (IRR=6.5%) and the cost recovery mechanism (transmission and distribution tariff), ensuring that pumped storage projects can obtain stable income every year. The IRR of 6.5% also makes pumped storage attractive for investment, encouraging power generation enterprises to participate in project development actively. They currently account for 15% of the capacity in operation and under construction.

- **In areas with a spot power market**, the proportion of electricity tariff revenue will continue to expand, and the demand for capacity tariff will gradually decrease. The on-grid tariff and the water pumping price will be settled according to the spot market price and rules. When the peak-to-valley price difference is higher than 25% (i.e., the on-grid tariff is 25% higher than the water pumping price), the pumped storage project can obtain additional income. At the same time, each project can directly retain 20% of the electricity market revenue every year, and the income is further guaranteed. After the construction and operation of the spot power market gradually matures and stabilises, pumped storage projects can also obtain revenue by participating in the ancillary service market, and the demand for capacity tariffs will gradually decrease.

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