



The changing role of hydropower to achieve carbon peak and neutrality goals in China

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1. Carbon peak and neutrality goals in China

How China plans to achieve carbon peak and carbon neutrality?

- At a UN General Assembly in September 2020, China aims to reach carbon peak by 2030 and carbon neutrality by 2060. China will have fully established a green, low-carbon economy.
- To achieve the couple goals, China needs to address the challenge of the large and still growing CO₂ emission. Carbon neutrality may be achieved by **reforming current production systems** to minimize greenhouse gas emissions and increase CO₂ capture.
- China is accelerating its push towards renewable energy.



Natural Gas

Natural Gas Has Become A Strategic, Growing & Valuable Business Of Oil Companies, and It Is Necessary to Improve Natural Gas-Related Equipment Manufacturing & Engineering Service Capabilities through Technological Innovation and Management Innovation.



Environmental Protection

Continue to Improve the Core Technology, Equipment Performances, and Engineering Service Capabilities within Fields of Oil & Gas Field Environmental Protection, and Municipal Environmental Protection.



CCUS

CCUS Takes into Account Both Energy Structure and Energy Security, Providing An Important Technological Choice for the Transition from Traditional Energy to Clean Energy, and Is Expected to Realize Large-Scale Low-Carbon Utilization of Fossil Energy.



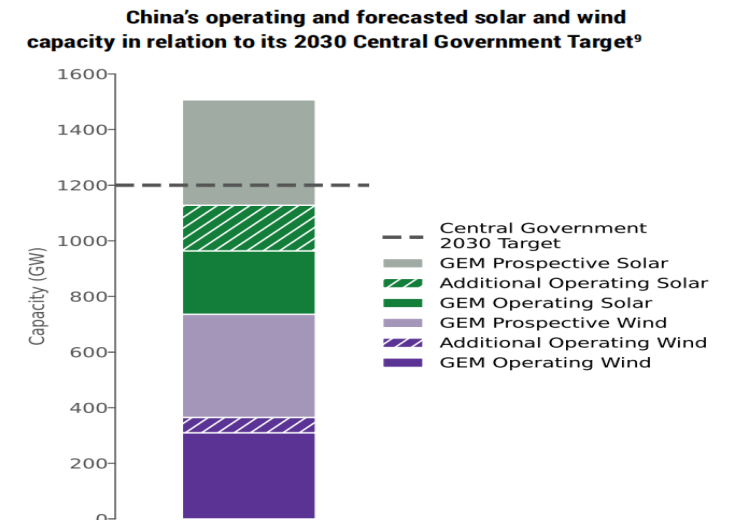
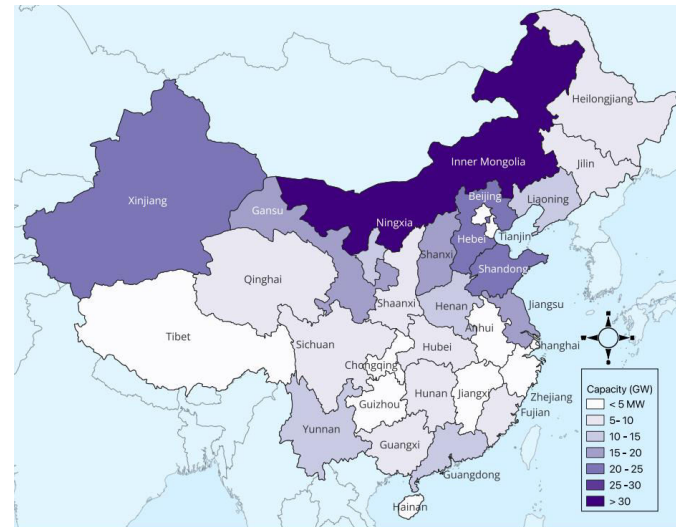
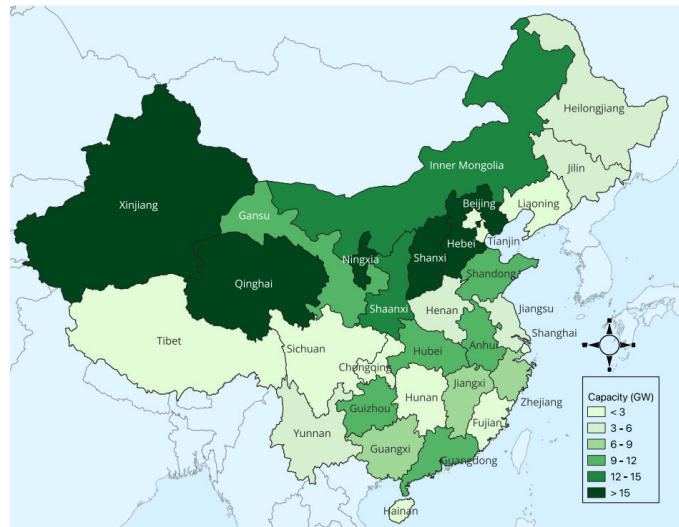
New Energy

Focus on Renewable and Clean Energy, Such as Photovoltaic Power Generation, Wind Power and Hydrogen Energy, Steadily Promote the Scale of Industrialization, Engineering Services, and Equipment Manufacturing Capabilities, and Build the Core Competitiveness Of Enterprises at the Era of Green Circular Economy.

2. Wind, solar, and hydropower development in China

Key trends and developments:

- According to information from China's NEA, around **87.4GW** of solar and **37.6 GW** of wind were deployed in China in 2022. China's installation target for 2022 was 120 GW of wind and solar capacity, combined.
- China aims to add 160GW of wind, solar capacity in 2023. It added that it expects the country's cumulative solar capacity to reach 530 GW by the end of 2023, and 430 GW of wind power. A total of wind and solar installed capacity in 2023 will reach **960GW**.
- China will likely achieve and potentially surpass its 2030 target of **1,200 GW** of cumulative wind and solar capacity five years ahead of schedule.

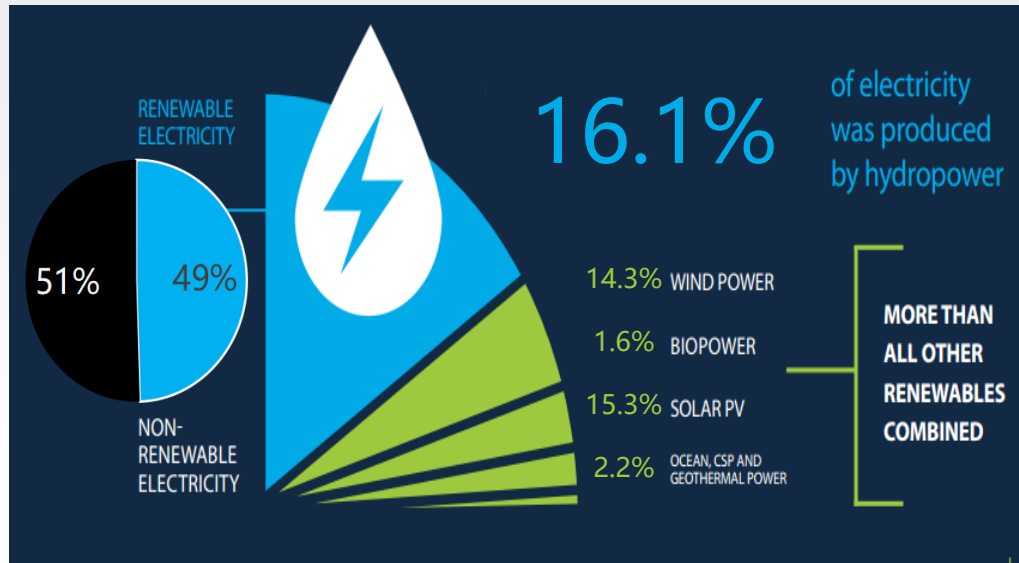


Operating large utility-scale solar capacity in China

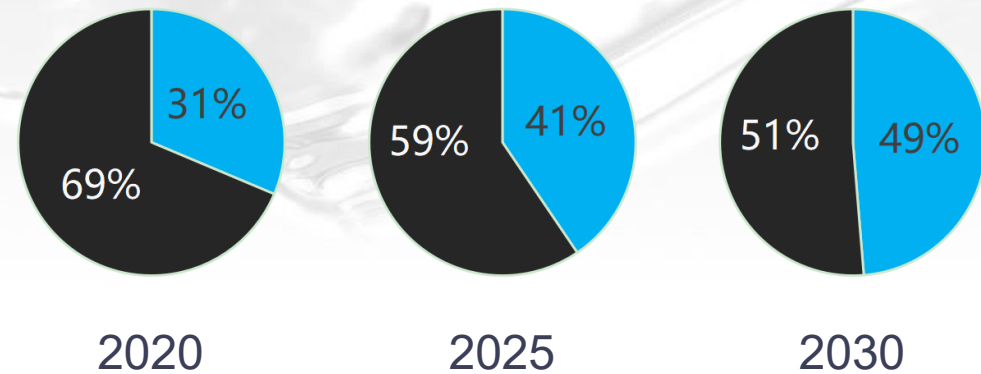
Operating wind capacity in China

01

National hydropower capacity overview



Share of installed capacity in renewable electricity



Key trends and developments:

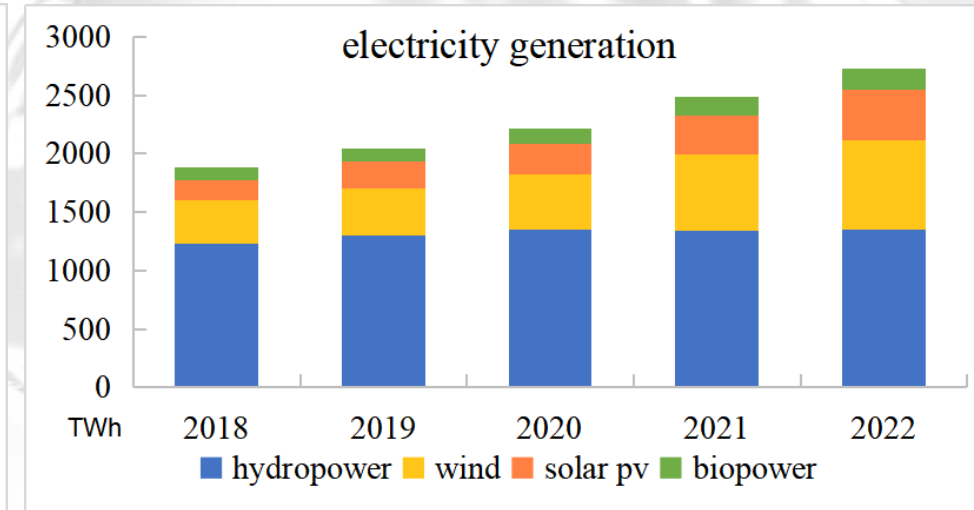
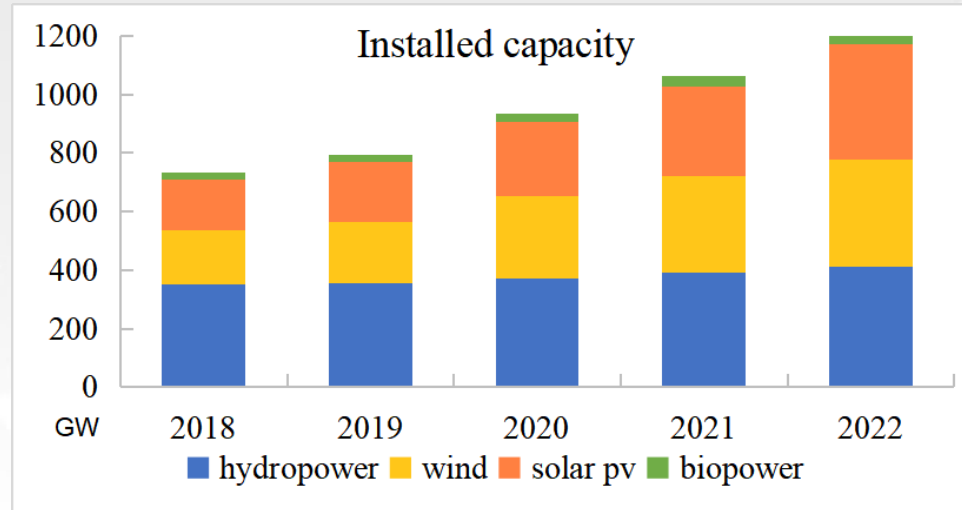
- Hydropower is the single largest source of renewable energy on the planet.
- Something like 33% percent of the renewable or low carbon energy that we have electricity is coming from hydropower.
- **16.1%** of the total electricity was produced by hydropower in China in 2022.
- Hydropower is going to play an important role in China's energy futures.

413.5 GW

China's hydropower installed capacity in 2022

1,352 TWh

China's hydropower electricity generation in 2022



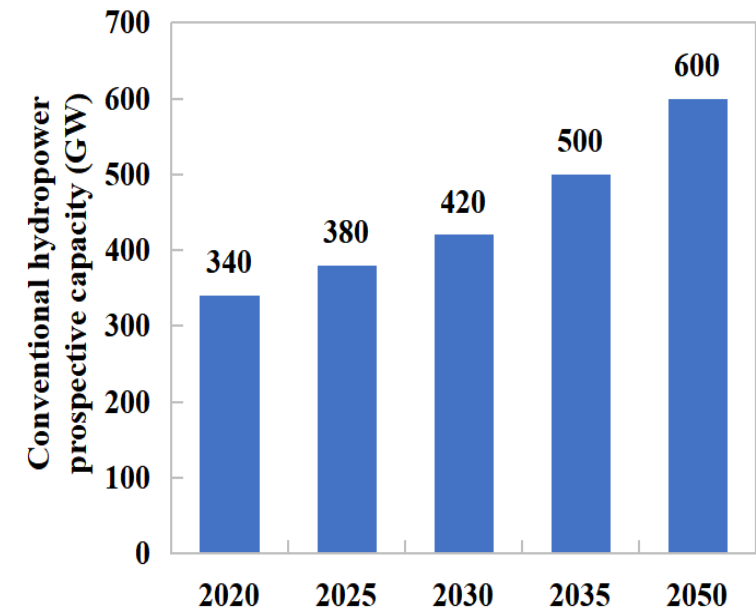
Key trends and developments:

- A total of **22.6GW** of hydropower capacity was put into operation in 2022, including pumped storage, bring the China's total installed capacity to **413.5 GW**.
- Electricity generation from hydropower reached an estimated **1352 TWh** in 2022, the highest ever contribution from a renewable energy source.

—Data from China's National Energy Administration (NEA)

02 Conventional hydropower development in China

- China use hydropower to provide low-cost, low-carbon, renewable energy electricity, to reduce carbon emissions and mitigate climate change.
- **Totally, about 200GW installed capacity of conventional hydropower will be developed by 2050 in China. Most of them are still located in Southwest China.**
- **According to China Government, China's installed capacity in conventional hydropower is expected from 340GW in 2020 to about 380GW by 2025, 420GW by 2030, and 600GW by 2050, respectively.**



—Data from China's NEA

03 PSH development as energy storage in China

2025

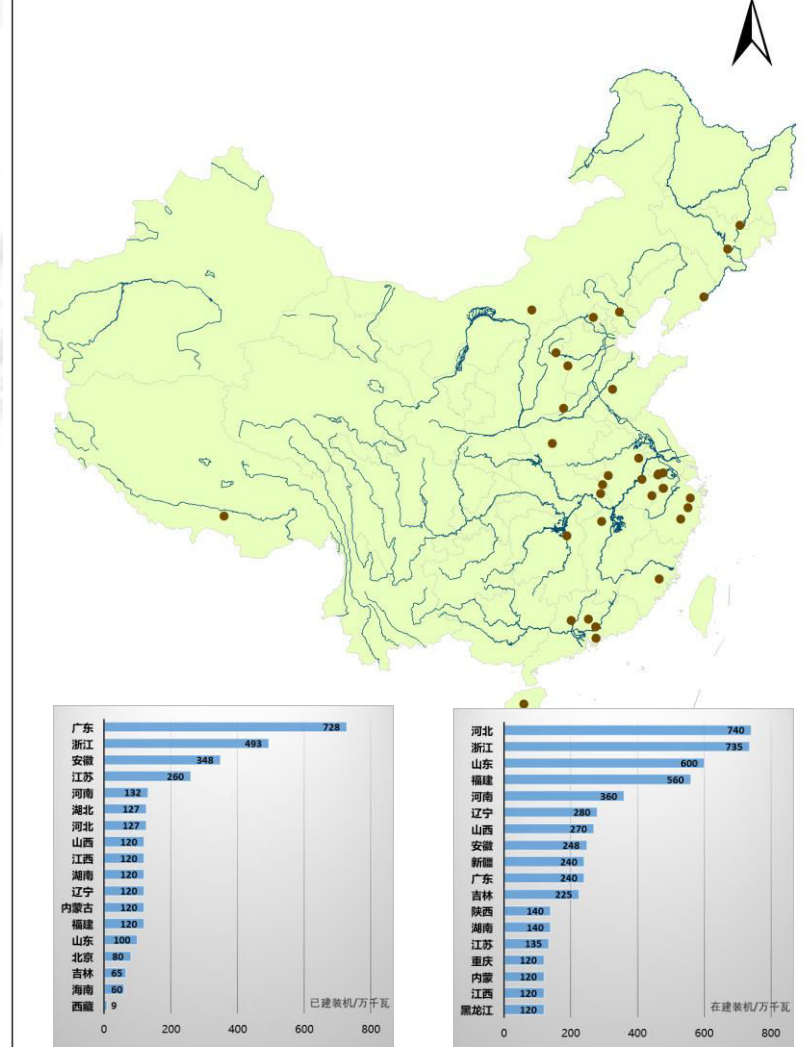
installed capacity put into operation
More than 62GW

2030

installed capacity put into operation
120GW

- *The Medium- and Long-Term Plan on the Development of Pumped Storage* is issued by China's NEA in 2021.
- Pumped hydro is the currently the mainstream and the most mature technology for large-scale energy storage in China. It is **90%** of China's energy storage in 2021.
- China's pumped hydro could grow from **32 GW** in 2020 to more than **62 GW** in 2025, **nearly 120GW** in 2030.
- The new added capacity in 2030 of **88GW**, equals to **4 times** of the total PSH installed capacity of China in 2020.

Distribution of operational PSHs in China



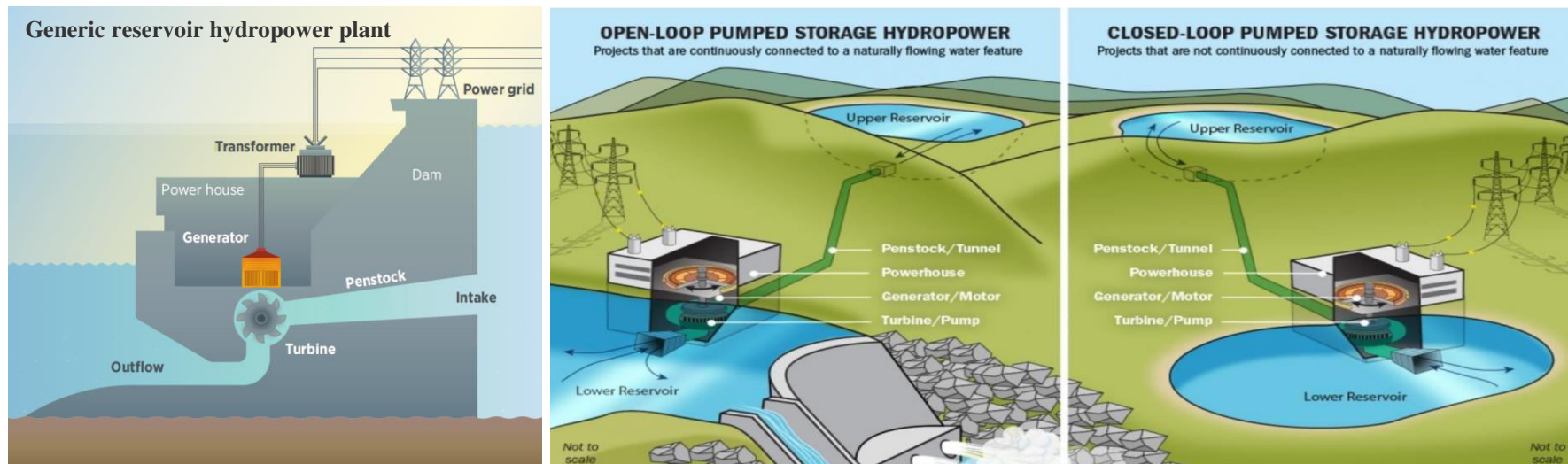
3. The role of hydro for helping to bring wind and solar in the grid

Why is hydroelectricity important?

- Hydropower currently generates more electricity than all other renewable technologies combined and is expected to remain the world's largest source of renewable electricity generation into the 2030s. Thereafter, it will continue to play a critical role in decarbonising the power system and improving system flexibility.

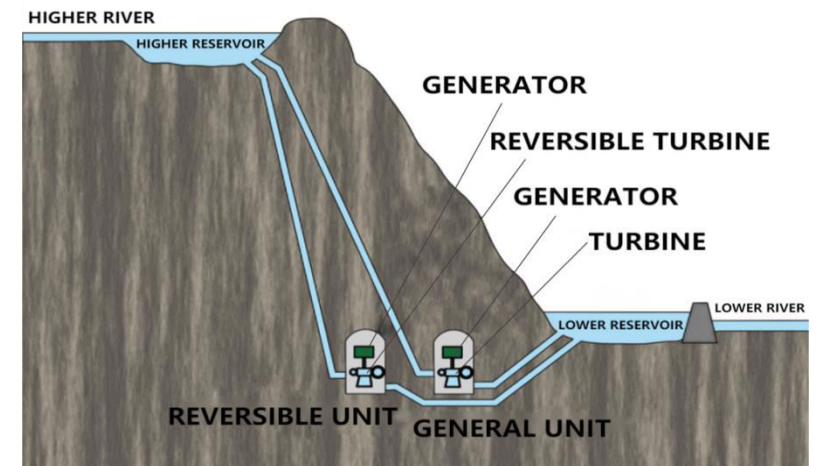
What is the role of hydroelectricity in clean energy transitions?

- While hydro is expected to be eventually overtaken by wind and solar, it will continue to play a key role as a dispatchable power source to back up variable renewables. Pumped storage could also potentially play a major role in balancing out variations in solar and wind generation.



Key trends and developments:

- Depending on the natural assets and the configuration of the power system, hydropower plants can provide considerable amounts of flexibility. In future, flexibility requirements will increase further still.
- China will try to add **reversible units** in the existing conventional hydropower stations to provide more flexible grid support services. Totally, the new added capacity of reversible units in the whole of China will reach about **100GW**, as preliminary estimated by China's NEA.
- PSH is another way to meet a given grid flexibility. By 2035, China aims to reach a **300GW** pumped storage capacity to balance solar and wind power coming online.



4. Challenges facing by China's Hydro to the couple C goals

- We need innovative technologies to explore the combined **production and operation of the hybrid system in a river basin**, for the best challenge of energy storage flexibility, reliability, and sustainability. To this end, we may change current grid operational principles.
- It's much more important to think about the **strategic development of mixed PSHs** with a total capacity 0.1 billion in China, and how to build, where to build, how to operate, and how they fit into sustainable development. We really need lots of research work and the Plan.
- PSH's use is mainly restricted by who pay for its large initial investment and operational costs as providing flexible grid services, if both on-grid price of production systems and the electricity prices for consumers remain stable. We need to remove the market barriers to **support PSH's development by the price and finance system**.

What are the challenges?



Thanks for your attention!

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