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Accelerating the smart green transformation of energy and power system with dual carbon targets in China

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2 China's goal setting in achieving energy transition and tackling climate change

The target of carbon intensity: Carbon emissions per 10,000 yuan of GDP is reduced by 17% compared to 2010

The development goal in "Twelfth Five-Year"

The target of carbon intensity: Carbon emissions per 10,000 yuan of GDP is reduced by 40-45% compared to 2005.

The development goal in "Thirteenth Five-Year"

The target of carbon intensity: Carbon emissions per 10,000 yuan of GDP is reduced by 60-65% compared to 2005.

The goal of Carbon Peak: Carbon emissions will reach a peak around 2030, and we will strive to reach the peak ASAP.

Targets in 2030

The goal of Carbon Peak: Strive for carbon emissions to peak by 2030.

The goal of carbon neutrality: Strive to achieve carbon neutrality before 2060.

Targets in 2030/2060

The national carbon emission control targets are getting stricter!

Strategic Goals for China's Energy Transition

New Energy Security Strategy

General Secretary Xi Jinping made an important speech in June 2014, proposing a new strategy for China's energy security **by promoting a revolution in energy consumption, energy supply, energy technology, energy systems and mechanisms, and strengthening international cooperation on all fronts.**

30-60 Double Carbon Targets

In September 2020, General Secretary Xi Jinping announced at the 75th General Debate of the United Nations General Assembly: China would increase its autonomous national contribution by adopting stronger policies and measures **to strive to peak CO2 emissions by 2030 and achieve carbon neutrality by 2060.**

Strategic Goals for China's Energy Transition

Core Indicators for 2030

In December 2020, at the Climate Ambition Summit, General Secretary Xi proposed: "By 2030, China's carbon dioxide emissions per unit of GDP will drop by more than 65% compared to 2005, the share of non-fossil energy in primary energy consumption will reach about 25%, the forest stock will increase by 6 billion cubic metres compared to 2005, and **the total installed capacity of wind and solar power will reach more than 1.2 billion kilowatts**".

Building Two Systems

In March 2021, General Secretary Xi Jinping clarified that the 14th Five-Year (2021-2025) is a critical period for reaching the carbon peak and several important measures need to be implemented, including "**building a clean, low-carbon, safe and efficient energy system**, controlling the total amount of fossil energy, focusing on improving energy efficiency, implementing renewable energy substitution, deepening the reform of the power system, and **building a new power system with new energy as the mainstay**"

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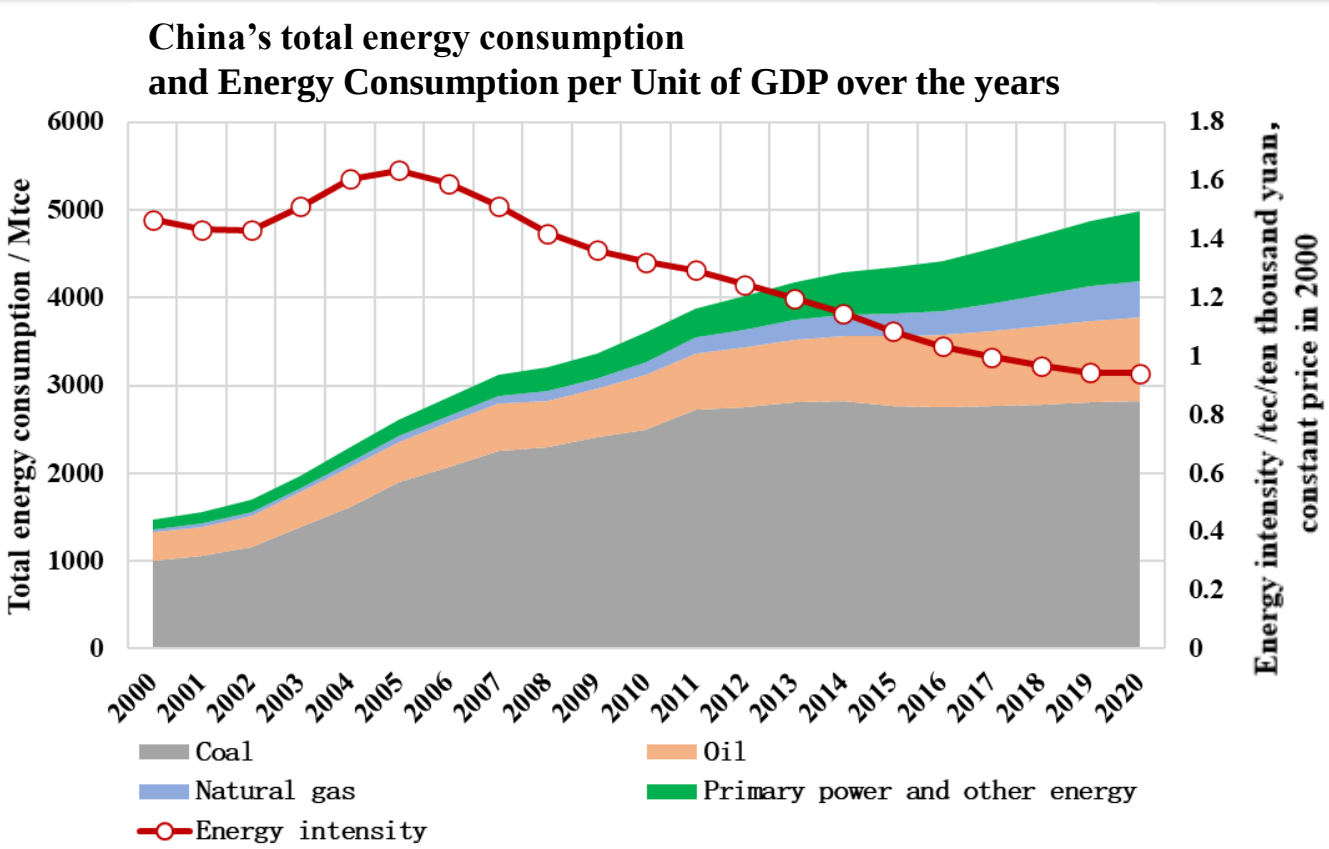
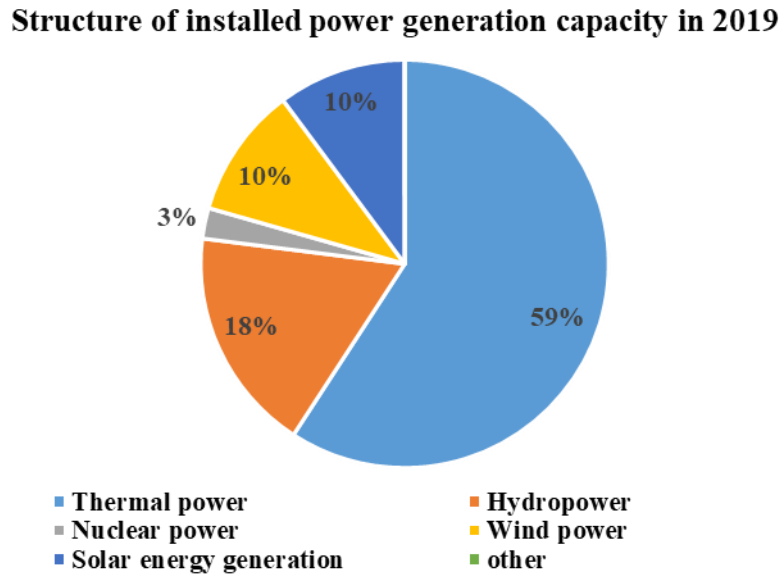
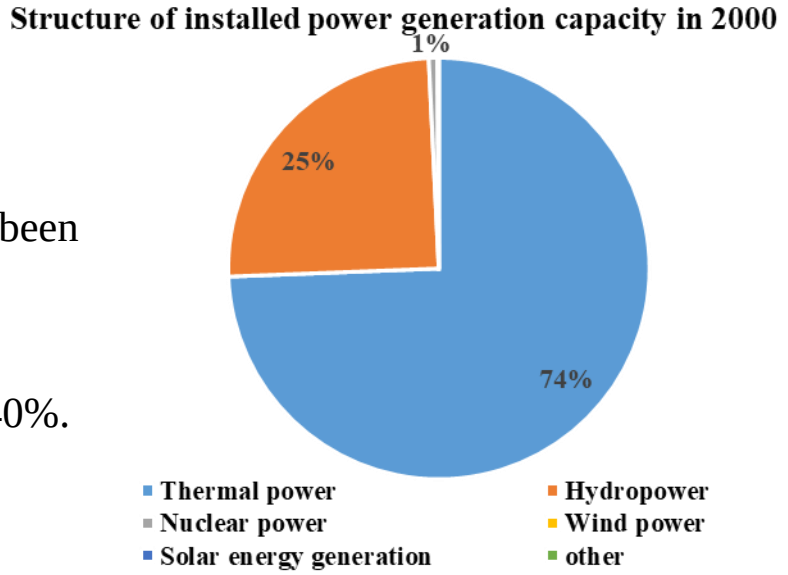
Continuing to Optimize the National Energy and Power Structure





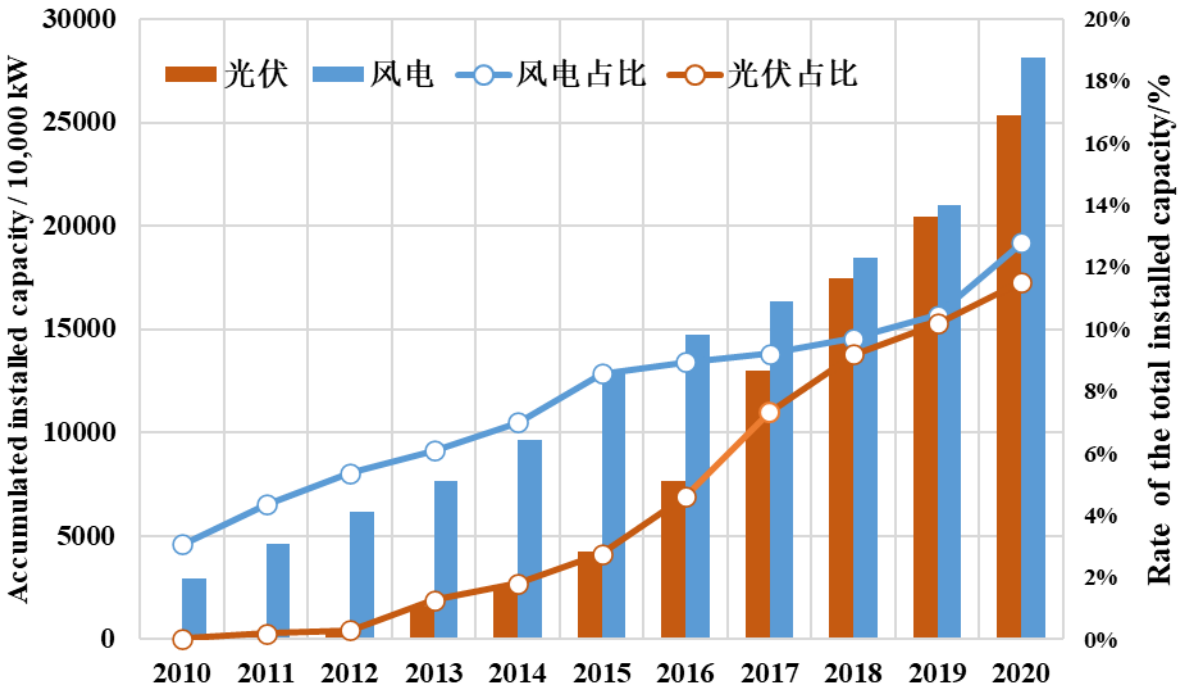


- Total energy consumption is still growing, but the growth in coal consumption has been significantly contained and the share of clean energy consumption is increasing.
- Energy consumption per unit of GDP has been decreasing year by year.
- The share of non-fossil energy in the electric power installation structure exceeds 40%.

Data source: China Statistical Yearbook

Installed Wind and Photovoltaic Capacity Continues to Grow

Share of installed wind power and photovoltaic power in total installed power in China



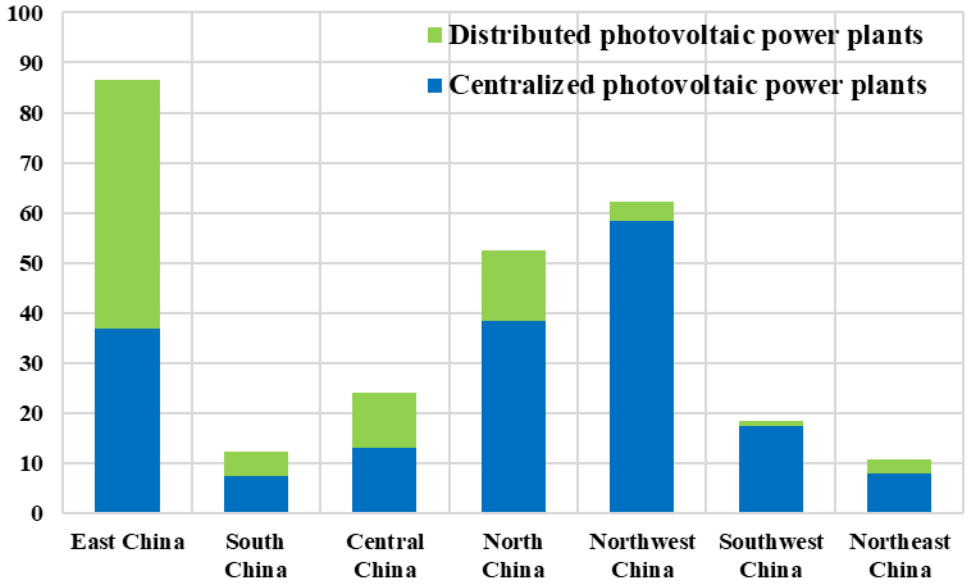
- The nation's installed wind and photovoltaic capacity keeps to grow.
- In 2020, the wind power had an additional installed capacity of 71.67 million kilowatts, up 178.7% year-on-year; the photovoltaic power had an additional installed capacity of 48.2 million kilowatts, up 81.7% year-on-year.
- China is currently the fastest growing country in terms of power grids, with the world's largest installed capacity of renewable energy generation. By the end of 2020, the installed capacity of wind power and photovoltaic power generation accounted for 24%, with a green power market size of trillions.

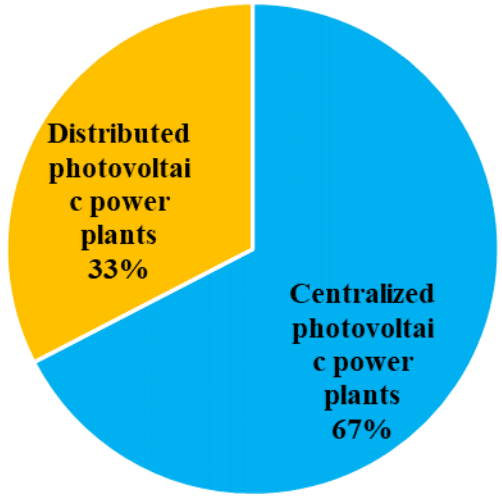
Data source: China Statistical Yearbook

Photovoltaic Power Generation Gains Strong Momentum and the Distributed PV Speeds Up

- The existing PV installation is still dominated by centralized PV, accounting for 67% of the cumulative grid-connected capacity of PV installations.
- The growth rate of the cumulative grid-connected capacity for centralized PV installations from 2015 to 2020 is 36.3%, while the distributed PV acts faster than the centralized PV, with its cumulative grid-connected capacity growing at a rate of 67.3%.
- Existing PV installations are mainly located in East China, North China and Northwest China, which have rich solar energy and land resources; the distributed PV is mainly in East and Central China.

Regional distribution of cumulative PV grid-connected capacity nationwide as of June 2021 / GW

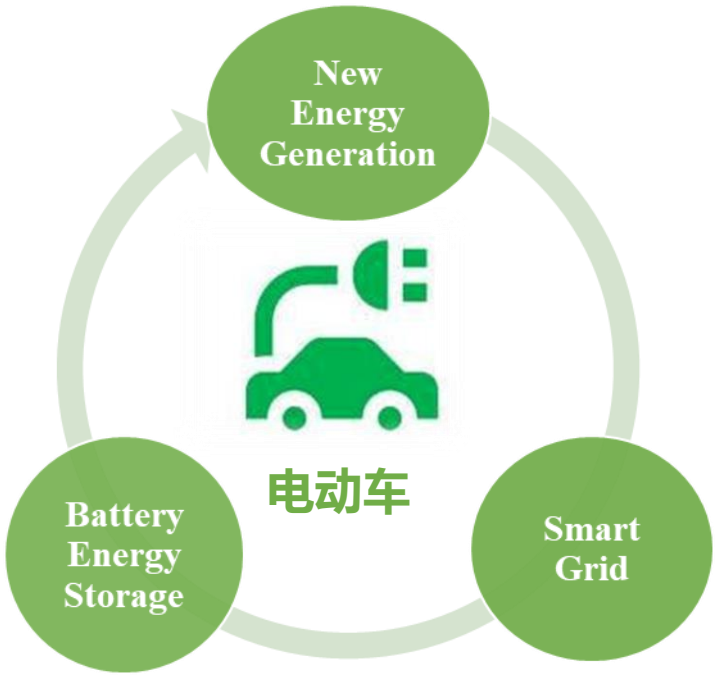




Cumulative PV grid-connected capacity nationwide as of June 2021

Data source: NEA webpage

Accelerating in Traffic Electrification and Rapid Growth in the Ownership of Electric Vehicle

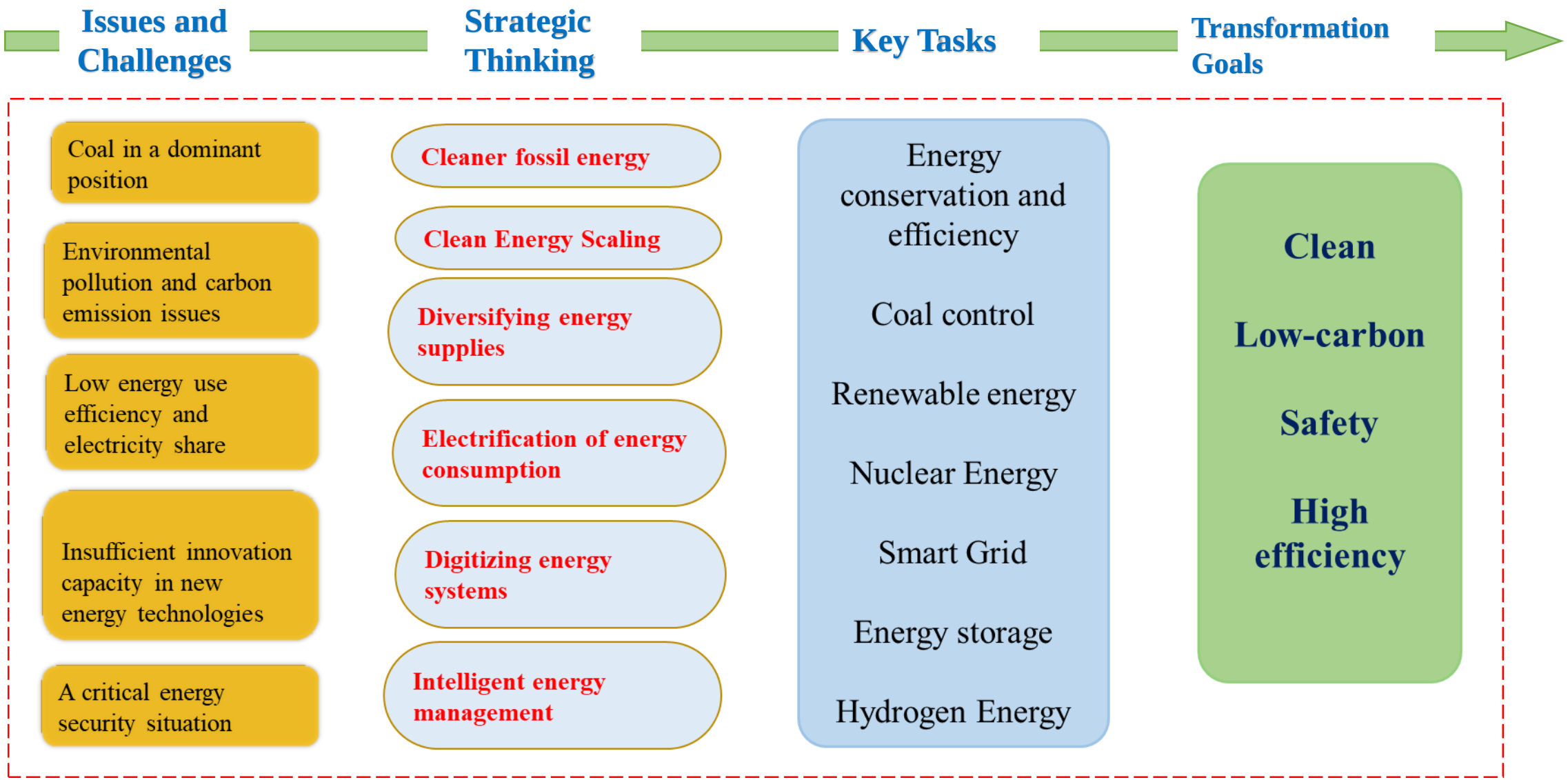


China has the largest market share of electric vehicles in the world, with 6.03 million new energy vehicles nationwide by the end of June 2021, accounting for 2.1% of the total vehicle fleet. Of these, 4.93 million were pure electric vehicles, accounting for 81.7% of the total number of new energy vehicles.

By 2030, a passenger car with a range of 600 km (with an 80kWh battery) could provide more than 12,000 kWh of energy storage capacity per year without compromising battery life and normal driving.

In 2030 it is assumed that 50% of the models have V2G conditions, which will have an energy storage scale of 5000 GWh, equivalent to 4 times the national pumped storage resource potential, implying 100 billion kWh energy transactions and 100 billion RMB transactions per year, as measured by 100 million electric vehicles.

The Direction, Challenges and Key Tasks of China's Energy Transition



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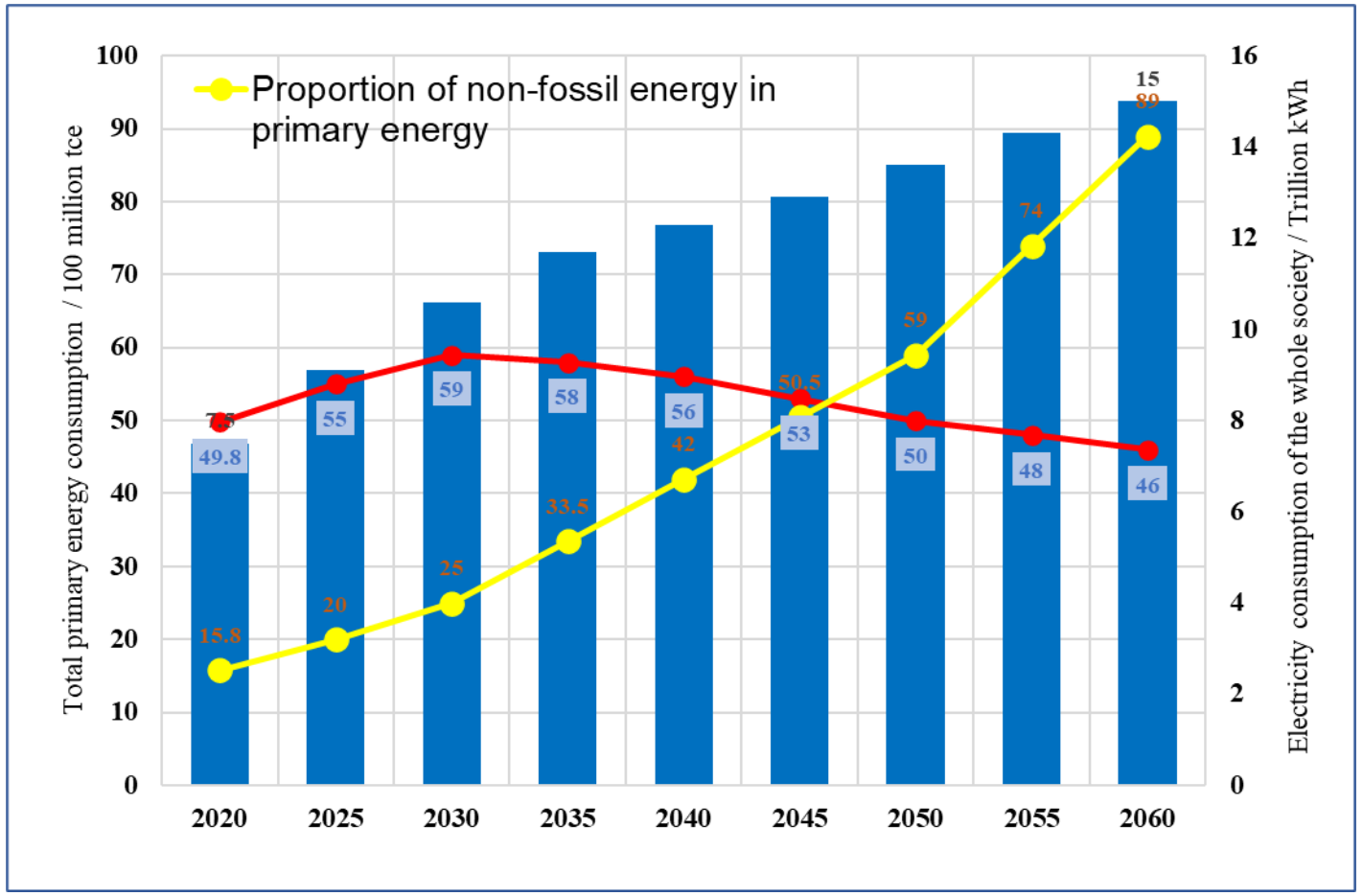
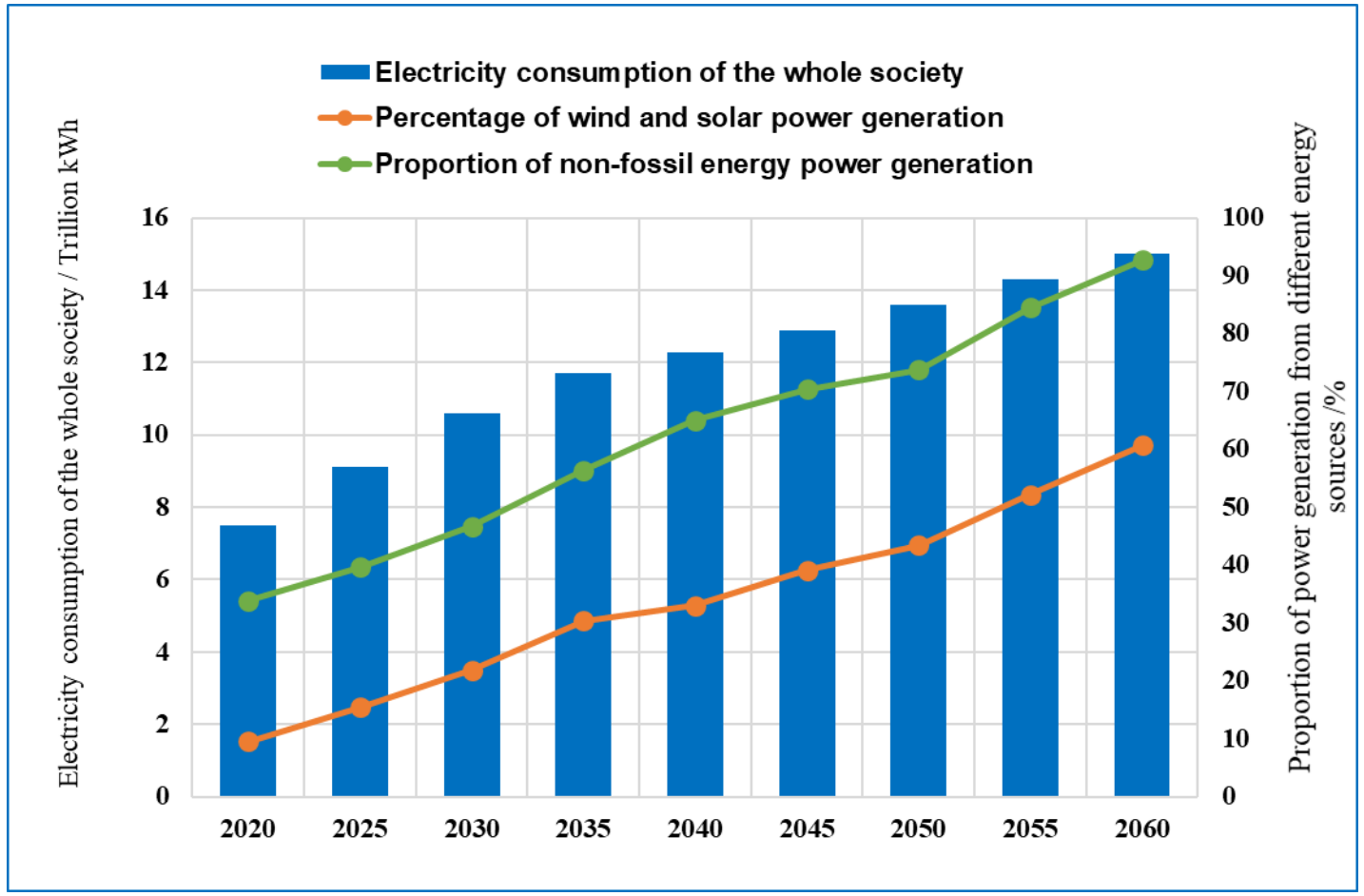
Development Scenario of Energy and Power Systems of China in 2030



- Increased energy consumption is achieved by developing non-fossil energy sources by 2030.
- After reaching the carbon peak in 2030, the existing energy supply strives to be gradually replaced by non-fossil energy sources to achieve a steady reduction in carbon emissions.
- The total power consumption of the whole society continued to grow.

Data source: "2030 Analysis of Electric Power System Development Situation and Energy Storage Demand in China" report delivered by Zhou Xiaoxin, academician of Chinese Academy of Sciences

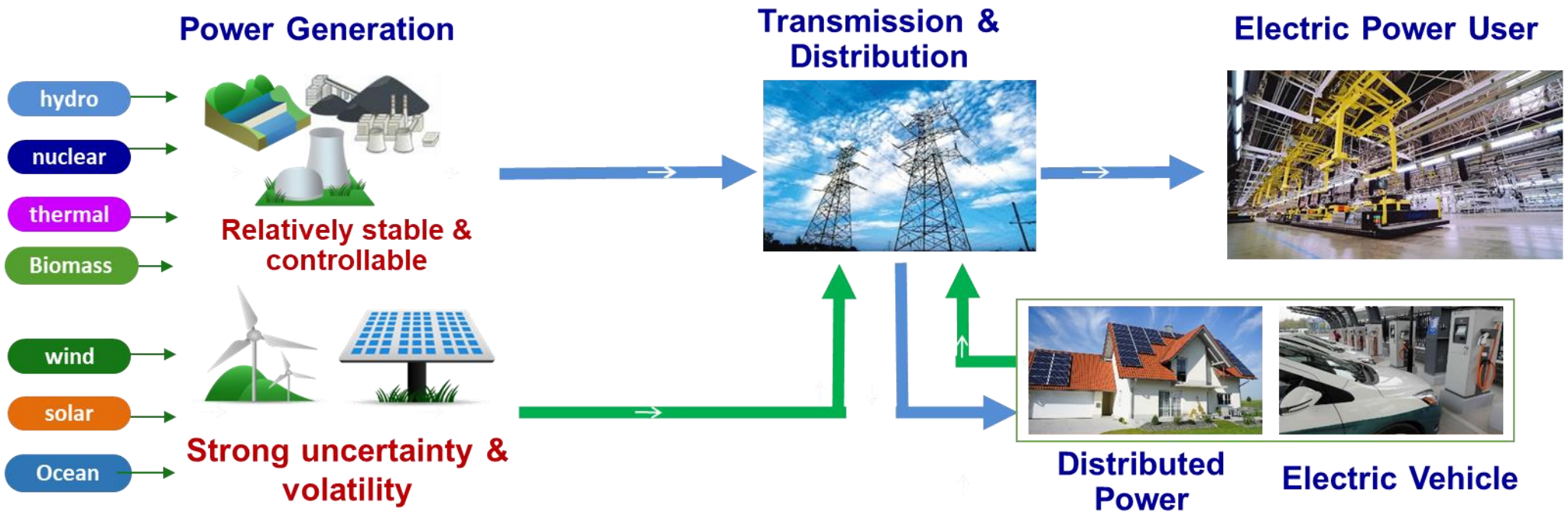
Development Scenario of Wind and Solar Power of China in 2030



- Non-fossil energy generation will have reached 74% by 2050.
- Among them, the percentage of wind and solar power generation will reach 43% by 2050, and over 60% by 2060
- In addition, there will be a certain proportion of thermal power generation with CCUS in 2050, and power system will achieve carbon neutralization before 2060,

Data source: "2030 Analysis of Electric Power System Development Situation and Energy Storage Demand in China" report delivered by Zhou Xiaoxin, academician of Chinese Academy of Sciences

Development Forecast of Wind and Solar Power of China in 2030



With large-scale renewable energy power integrated to grids, power system needs to realize the power supply and demand balance with random fluctuations of the power demand and random fluctuations of the power supply. Its structure, control operation mode as well as planning and management will undergo fundamental changes. There is need to build a new power system that the high penetration of renewable energy in power production, transmission and consumption will take as as the main body.

Reference: Speech of "New Energy and Power System and Reelectrification" delivered by Academician Liu Jizhen, Chinese Academy of Sciences，2020.9

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Challenges of Building a New Power System

Uncertainty of renewable energy power generation

lead to unstable supply of power grid.

Spatial differences in power supply capacity and consumer demand

Long-distance delivery, increases costs and safety risks

Random integration to grids with large-scale electric vehicles

Source and charge imbalance of random electromechanical charging system in large-scale electric vehicles.

Through vehicle network interaction, V2G technology shall become a mobile energy storage resource.

Difficulty of coordinated operation for urban energy facilities increasing

The coupling degree of electric power, transportation, heat, water, natural gas and others for urban lifelines becomes closer, forming a complex energy system, which requires power grid's function to be greatly upgraded.

Operation Requirement

- **Improve the resilience and intelligence of electric power systems**
- **Realize the overall coordinated optimization of system planning and operation**
- **Functions with intelligence, flexibility, robustness and reliability**

Perception → *Defence* → *Coordination*

Flexibility → *Recovery* → *Learning*

Developing Offshore Wind Power as an Important Task to Expand the Scale of Wind Power

- Offshore wind power has a great potential resource. The development of offshore wind power will become an important strategic support of China's energy structure transformation
- At present, China's economic development focus is concentrated in the coastal areas. The development of offshore wind power close to the load center is the potential and main driving force for expanding green electric power in China's coastal areas.
- According to the provincial plans, China's offshore wind power installed capacity will reach about 130 million kilowatts by 2035.
- Further drive the development of China's offshore wind power manufacturing, construction, operation and maintenance industry, and promote the development of Marine economy.

In 2019, the first large megawatt offshore wind power project in Guangdong Province was fully integrated to the grid for power generation

Explore New Technologies and Models to Expand the Scale of Solar Power Generation

- Carry out the research of high-efficiency and low-cost solar cell materials and equipment, such as copper indium gallium selenium films, silicon films, perovskite batteries, new laminated batteries, and antimony selenide batteries;
- Develop the centralized solar photovoltaic power stations in base mode and the distributed photovoltaic power generation in areas with concentrated loads, so that green electricity can come from the neighborhood and intensify efforts to expand the scale of photovoltaic power generation.

Centralized Photovoltaic Power Station

Distributed photovoltaic power generation, residential buildings

Distributed photovoltaic power generation on factory roofs

National Rooftop PV Project

In April 2021, the National Energy Administration organized a pilot of rooftop photovoltaic development in the whole county (city, district) to integrate distributed resources to enhance the PV development. There have 676 national pilot projects identified by far.

- beneficial to reducing the power spike load
- beneficial to saving and optimizing the distribution grid investment
- beneficial to guideing residents to conduct green energy consumption
- beneficial to optimizing the operation and management of photovoltaic projects

Accelerate the New Energy Storage Development and Improve Capacity for Consumption and Regulation

In April 2021, the National Development and Reform Commission and the Energy Administration issued the “Guiding Opinions on Accelerating the Development of New Energy Storage (Draft for Comments)”.

The document proposes that pumped storage and new energy storage are important technologies and basic equipment to support the new power system. In order to achieve the goal of carbon peak and carbon neutrality, the development of new energy storage will be taken as an important measure to improve the adjustment capacity, comprehensive efficiency and safety guarantee capacity of the energy and power system, and support the construction of the new power system.

2025

- ✓ Realize the transformation of new energy storage from the initial commercialization stage to large-scale development.
- ✓ The independence level of core technologies and equipment be significantly improved. The standard system will be further improved. The industrial system is increasingly complete. The market environment and business model will be more mature, and the installed capacity will reach over 30 million kilowatts.

2035

- ✓ The installed capacity basically will meet the corresponding needs of the new power system.

Electric Vehicles as Mobile Energy Storage to Provide Power Services

Near and Mid-Term

- Participate in the regional power grid peak regulation through demand response
- Mainly used to the power adjustment

Mid and Long-Term

- Electric vehicles and the distributed micro-network constitute the mobile energy internet
- With power and energy adjustment function, the battery has deep charge and deep discharge

New energy vehicles connected with V2G technology accurately and quickly adjust the power grid, cut the overall electricity peak demand and fill the valley, and effectively reduce the cost of power grid operation.

✓ China encourages electric vehicles to provide energy storage services and gain revenue through power ancillary service.

2018 → 2035

✓ While strengthening V2G operation and systems, promote the efficient coordination of new energy vehicles and renewable energy, and encourage local governments to carry out V2G demonstration applications.

Build a Green Smart Grid Serving Dual-Carbon Goals

Advance the development of regulated power supplies.

Peak gas power, transform coal power to be more flexible

Strengthen demand-side management, comprehensive energy services

Collaborative planning of supply-transmission-storage-demand system

Promote digital and intelligent regulation of power grids

Improve the safety level

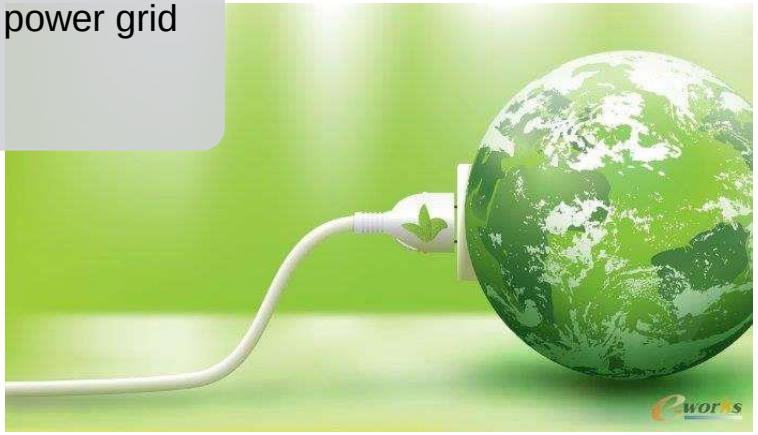
Accelerate the large-scale development of energy storage

Pumped storage, compressed air energy storage

Build modern power grid

Improve the cross-regional optimization capacity of clean energy and resources

Reduce carbon emissions of power grid and enterprise



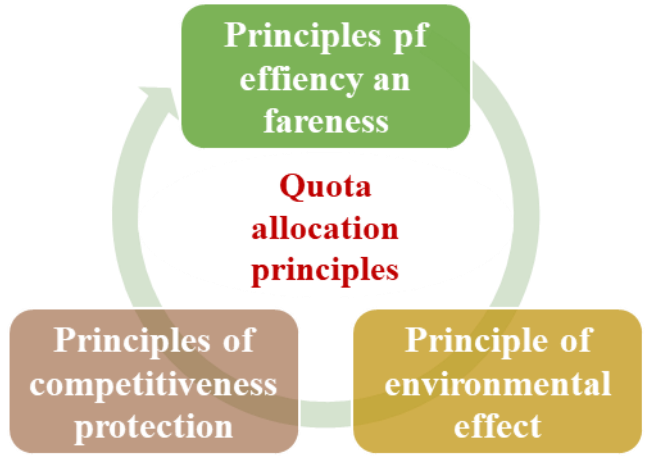
Power Generation Industry First Included in the National Carbon Market

The national carbon emission trading market was launched on July 16,2021, and the power generation industry became the first industry to be included in the national carbon market, with 2,225 key emission units in the power generation industry.

According to the statistics of the Ministry of Ecology and Environment, the first carbon market covered carbon emissions of over 4 billion tons of carbon dioxide.

Inclusion Standards: enterprises in the power generation industry (including self-owned power plants in other industries) that discharged 26,000 tons of carbon dioxide equivalent (comprehensive energy consumption of about 10,000 tons of standard coal) or above from 2013 to 2019.

Allocate quotas by benchmethod.



Promote the Pilot Work of Conducting Green Electric Power Transactions

The National Development and Reform Commission and the State Energy Administration officially returned to the State Grid Corporation and the China Southern Power Grid Corporation to promote the pilot work of green power trading.

The technical characteristics of new energy power generation and other instability, leading to the consumption of power system and operating costs will rise significantly.

To achieve the multiple goals of low-carbon transformation, safety and reliability, and economic affordability, we must deepen the reform of the power system.

Distinguish some users willing to assume more social responsibilities, who can trade directly with wind power and photovoltaic power generation projects. The green power income will be used to support the development and consumption of green power, thus better promoting the construction of new power systems.

Deepen Reform of Electricity Prices, Improve and Optimize the Time-of-Use Electricity Price Mechanism

Meet the needs of large-scale development of new energy and the changes of peak and valley characteristics in power systems. Give full play to the role of market in price determination. Form the effective market-based electricity price signals. Guide users to cut peak and fill valley. Improve power supply and demand. Promote the consumption of new energy.

Improve the electricity price mechanism for peaks and valleys	Establish a peak electricity price mechanism	Improve the seasonal electricity price mechanism
• Reasonably determine the difference between peak and valley electricity prices • Reasonable division of peak and valley time periods	• Based on the peak and valley electricity price • Combined with the local actual situation • Fully tap the demand-side adjustment potential	• Areas with significant seasonal differences in power load • Overall consideration of the scenery and water can be complementary • Encourage the north to adopt a seasonal price mechanism for electric heating

The latest News: Guangdong Province peak electricity price policy will begin to implement on Oct. 1,2021, The peak electricity price rises by 25% compared to the peak segment electricity price of the original peak-and-valley electricity price

Final Words

Forward-looking: Clean, high-efficient and low-cost hydrogen whole chain technology is a key technology with global influence in the construction of a new power system with renewable energy as the main body.

Forward-looking: Renewable energy electric hydrogen production and liquid fuel technology is effective measures to deal with the volatility and intermittent of wind power and photovoltaic power generation, and also is an energy storage medium to deal with long-cycle energy power supply fluctuations.

Feature: The new-generation power system will realize multi-source complementarity, supply-transmission-storage-demand coordination, flexibility and robustness. Integrate theories and technologies in energy, power, chemical, digital, information and other fields as the support base.

Vision: Promote the green and intelligent transformation of the power system, to fully support China to achieve carbon peaks in 2030 and carbon neutrality in 2060.

Thanks for your attention!

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