

An Overview of Chinese Energy Market

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Abstract. *This article provides a comprehensive overview of the current situation, development trends and challenges facing China's energy market. It begins with an overview of the historical evolution and current structure of China's energy market, followed by a detailed analysis of the major energy sectors, including coal, oil, natural gas, renewable energy and electricity. It then discusses the energy policy and regulatory framework, market reform and liberalization, technological innovation, and international cooperation. Finally, the article looks at the future development trend of China's energy market and proposes strategies to address the challenges. The study shows that China's energy market is in a period of rapid transition, facing multiple challenges such as energy security, environmental protection, and sustainable development, and requires the joint efforts of the government, enterprises, and the society to optimize the energy structure and improve the efficiency of energy use.*

Keywords: China's energy market; energy structure; renewable energy; energy policy; market reform; technological innovation; international cooperation.

Introduction

As the world's second largest economy and largest energy consumer, the development of China's energy market has an important impact on the global energy landscape and climate change. In recent years, China's energy market has experienced rapid development and profound changes, with the energy structure being continuously optimized, the proportion of clean energy continuing to rise, and the efficiency of energy use significantly improved. However, China's energy market still faces many challenges, such as energy security risks, environmental pollution problems, and carbon emission pressure. The purpose of this paper is to comprehensively analyze the current situation, development trend and challenges faced by China's energy market, and to provide reference for policy makers, industry practitioners and researchers.

This article will start by reviewing the historical evolution of China's energy market, followed by an analysis of its current structure and key players. It will then examine the present status and development trends of major energy sectors, including coal, oil, natural gas, renewable energy, and electricity.

Building on this analysis, the article will assess China's energy policies and regulatory framework, discussing the processes of market reform and liberalization, as well as the roles of technological innovation and international cooperation in advancing energy market development. Finally, the article will explore future trends in China's energy market and propose strategies to address the associated challenges.

Literature review

The analysis of China's energy market has attracted significant interest from both domestic and international scholars. Researchers in China have primarily focused on the structure of energy consumption, energy security, the development of renewable energy, and market reforms.

In the book *World Energy Outlook China Special Report* (2017.) analyzed the trend of the evolution of China's energy consumption structure, pointing out that the proportion of coal consumption continues to decline and the proportion of clean energy continues to rise. Wang Anjian and Wang Chunhui (2024.) discussed the challenges facing China's energy security and put forward the idea of building a diversified energy supply system.

Foreign scholars are paying more attention to the impact of China's energy market on the global energy landscape and climate change. Dr. Fatih Birol (2021), Director of the International Energy Agency (IEA), said, "China is a major player in clean energy development, playing a leading role in many existing success stories, from solar power to electric vehicles. China's efforts to meet its carbon neutrality targets will facilitate the flourishing of a wider range of low-carbon technologies and drive significant cuts in the use of fossil fuels in the coming decades. The role of China's renewable energy development in driving the global energy transition is examined.

Kawulur, H.R. (2024) analyzes the development of China's carbon emissions trading market and its implications for global climate governance. These studies provide a multidimensional perspective for understanding China's energy market.

However, most of the existing studies focus on a specific aspect and lack a systematic analysis of the Chinese energy market. In addition, with the rapid changes in China's energy market, many studies can no longer fully reflect current market conditions. Therefore, there is a need for a comprehensive, up-to-date data-based analysis of the Chinese energy market to fill this research gap.

Methodology

This study employs a combination of literature review and data analysis. First, it examines the current research landscape and theoretical framework of China's energy market by systematically reviewing relevant literature from both domestic and international sources. Second, we collect and analyze the latest data released by authoritative institutions, such as China's National Bureau of Statistics and the National Energy Administration. This data includes statistics on energy consumption, production, imports, and exports.

The analysis focuses on descriptive statistics and trend analysis methods. By comparing data across different years, we evaluate the trends in China's energy consumption structure, production structure, and import-export patterns. Additionally, we interpret the policy driving factors and the market dynamics behind the data by examining relevant policy documents and industry reports.

History and current status of China's energy market

The development of China's energy market can be traced back to the early years of New China. During the period of planned economy, the energy industry was mainly monopolized by state-owned enterprises, with coal occupying a dominant position. After the reform and opening up, China's energy market gradually introduced market mechanisms, and the energy structure began to diversify, with the development of energy forms such as oil, natural gas and hydropower. Entering the 21st century, with the rapid economic growth, China's energy demand has risen sharply, and the energy security problem has become increasingly prominent, which has promoted the further reform and opening of China's energy market.

Over the past four decades, China's remarkable economic growth has lifted hundreds of millions of people out of poverty and made it a leader in many industries. At the same time,

however, China has become the world's largest carbon emitter, accounting for one-third of global carbon dioxide (CO₂) emissions. China supplies more than half of the world's steel and cement, yet these two industries alone emit more CO₂ than the European Union.

China plans to peak CO₂ emissions by 2030 and become carbon neutral by 2060. The energy system is the source of nearly 90 per cent of China's greenhouse gas emissions, making energy policy central to China's carbon-neutral transition.

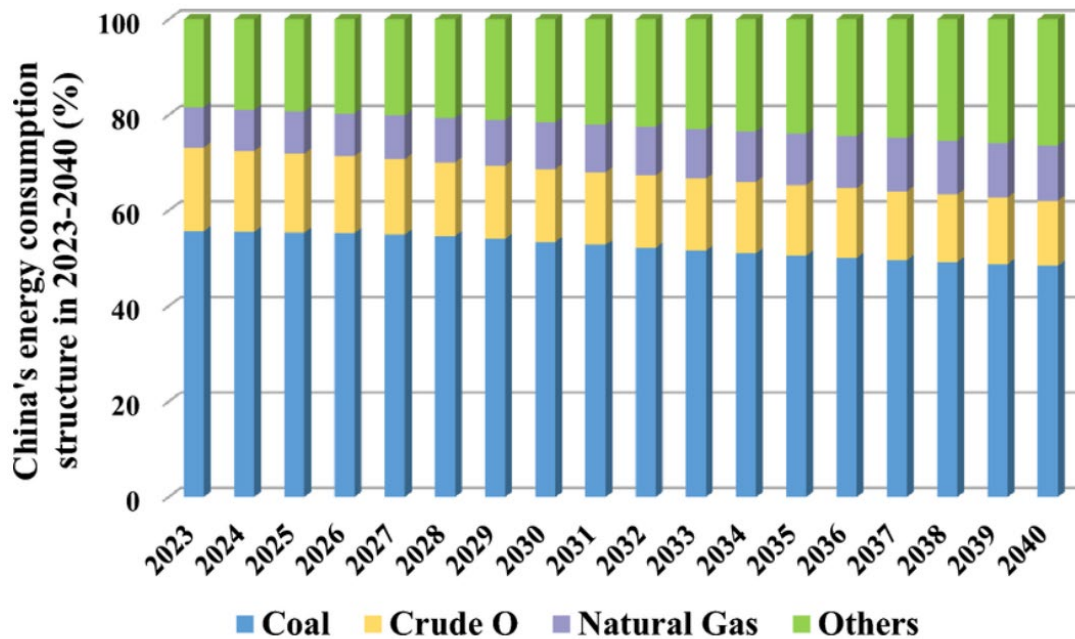


Figure 1. Energy consumption structure in China, 2023-2040.

Source: <https://www.researchgate.net>.

Currently, China's energy market is characterized by a diversified structure. Coal is still the most important source of energy, but its proportion is decreasing year by year; oil and natural gas consumption continues to grow, with a high degree of external dependence; the power market is developing rapidly, with installed capacity and power generation ranking first in the world. Renewable energy is developing rapidly, and the installed capacity of wind power and photovoltaic power generation ranks first in the world.

China's energy market is undergoing profound changes, presenting new development characteristics. In terms of the structure of energy consumption, the proportion of coal consumption continues to decline, from 69.2% in 2010 to 56.8% in 2020. At the same time, the proportion of clean energy consumption is steadily rising, with the proportion of natural gas consumption increasing from 4.0% to 8.4% and the proportion of non-fossil energy consumption increasing from 8.6% to 15.9%. Such changes reflect the effectiveness of China's energy consumption structure optimization and its determination to promote energy transformation.

In terms of energy production and supply, China continues to maintain a diversified development trend. In 2020, China's output of raw coal will reach 3.9 billion tons, crude oil production will reach 195 million tons, and natural gas production will reach 192.5 billion cubic meters. Renewable energy is developing rapidly, with installed capacity of wind power and photovoltaic power reaching 280 million kilowatts and 250 million kilowatts respectively, both ranking first in the world. In terms of energy imports, China's dependence on foreign countries for

crude oil and natural gas has reached 73% and 43% respectively, and energy security issues remain prominent.

The energy price formation mechanism has been gradually marketized. Coal prices have basically been marketized, the price formation mechanism of refined oil products has been improved, and natural gas price reform has been steadily promoted. The scale of electricity market-oriented trading has been expanding, and the market-oriented trading of electricity in 2020 will reach 3.1 trillion kilowatt-hours, accounting for more than 40% of the total electricity consumption of the whole society. These changes indicate that China's energy market is moving in the direction of greater marketization and modernization.

Market reform and liberalization

China's energy market reform continues to advance, aiming to establish a modern energy market system that is unified, open, competitive and orderly. The reform of the oil and gas industry focuses on the liberalization of the upstream exploration and development market, the independent operation of pipeline networks and the liberalization of downstream market access. Reform of the electric power system is based on the principle of “regulating the middle and liberalizing both ends”, and has promoted the reform of transmission and distribution tariffs, the independent operation of power trading institutions, and the opening up of the market for the sale of electricity. The renewable energy market mechanism has been continuously improved, and policies such as green power certificate trading and renewable energy quota system have been gradually implemented.

Reform of the energy price formation mechanism is an important element of market reform. Coal prices have basically been marketized, the price formation mechanism of refined oil products has been improved, natural gas price reform has been steadily promoted, and the scale of market-based trading of electricity has been expanded. However, energy price reform still faces challenges such as how to balance market-oriented reform with social affordability and how to reflect environmental costs.

Technological innovation and international cooperation

Technological innovation is a key driver of China's energy market transformation. China has made significant progress in areas such as clean coal technology, unconventional oil and gas development, renewable energy generation, smart grids and energy storage. The government has supported energy technology innovation by setting up major science and technology special projects and building national laboratories. Enterprises are investing more and more in R&D, and cooperation between industry, universities and research institutes is becoming increasingly close. However, the problems of insufficient independent innovation capacity in core technologies and inefficient transformation of scientific and technological achievements still exist.

International energy cooperation is an important part of China's energy strategy. China actively participates in global energy governance, promotes ‘Belt and Road’ energy cooperation, and strengthens bilateral cooperation with major energy producing and consuming countries. The ‘going out’ strategy of energy enterprises has achieved remarkable results, and the scale of overseas energy investment and mergers and acquisitions has been expanding. However, international energy cooperation also faces challenges such as geopolitical risks and investment protectionism.

Legal framework for China's energy market

The legal framework of China's energy market is fundamental to ensuring the healthy development of the energy sector. This framework consists of multiple levels of laws and regulations, including the Constitution, the Basic Law on Energy, individual energy laws, administrative regulations, departmental rules and local regulations. The Constitution provides the fundamental basis for national ownership and management of energy resources. Basic energy laws, such as the (draft) Energy Law of the People's Republic of China, establish the basic principles and policy directions for energy development.

At the level of individual laws, China has enacted specialized laws, such as the Electricity Law, the Coal Law, and the Law on the Protection of Oil and Gas Pipelines, to regulate the development and management of specific energy sectors. These laws specify market access, business norms, safety standards and environmental protection requirements for each energy sector. In addition, China has issued a series of administrative regulations and departmental rules, such as the Regulations on Electricity Supervision and the Provisions on the Administration of Renewable Energy Power Generation, which have refined the specific requirements for the implementation of the laws.

China's energy policy system is centred on the Energy Law and covers a wide range of areas, including coal, oil, natural gas, electricity and renewable energy. In recent years, the Chinese Government has issued a series of policy documents, such as the Strategic Action Plan for Energy Development (2014-2020) and the Thirteenth Five-Year Plan for the Development of Renewable Energy, which clearly define the strategic objectives of energy restructuring, energy conservation and emission reduction, and energy security. With regard to carbon emission policies, China actively participates in global climate governance, commits itself to achieving carbon peak and carbon neutrality targets, and promotes the construction of a national carbon emission trading market.

The main objectives and principles of China's energy policy include: guaranteeing energy security, improving energy efficiency, promoting the optimisation of the energy structure, promoting innovation in energy science and technology, and strengthening environmental protection. These objectives and principles are reflected in various laws and regulations and implemented through specific policy measures. For example, in order to promote the development of renewable energy, China has formulated policies such as a renewable energy power quota system and feed-in tariff subsidies.

Regulators of national energy markets

The energy regulatory system continues to improve, with a multi-level regulatory structure comprising the National Energy Administration, local energy authorities and industry associations. Regulatory priorities include energy prices, market access, production safety and environmental protection. However, energy regulation still faces challenges such as insufficient sectoral coordination and the need to improve regulatory capacity.

The regulatory system of China's energy market consists of several government departments and agencies, forming a multi-level and multi-sectoral regulatory landscape. The National Energy Administration (NEA) is the main energy industry regulator, responsible for formulating and implementing energy development strategies, planning and policies, and supervising and managing energy industry operations. The National Development and Reform Commission (NDRC) plays an important role in energy pricing and investment approval. In addition, the Ministry of Natural Resources (MNR), the Ministry of Ecology and Environment

(MOE) and other ministries are also involved in energy regulation within their respective areas of responsibility.

The main responsibilities of the regulators include setting industry standards and norms, supervising market operation, maintaining market order, ensuring the safety of energy supply, and promoting energy efficiency improvement and environmental protection. In recent years, China's energy regulatory system has undergone a number of reforms aimed at improving regulatory efficiency and adapting to the new requirements of energy market development. For example, the reform of the electricity system has promoted a regulatory model of “regulating the middle and liberalizing the ends”, which strengthens the regulation of the power grid while liberalizing competition in power generation and sales.

However, China's energy regulatory system still faces a number of challenges. First, regulatory functions are dispersed across multiple sectors, making coordination difficult. Second, with the rapid development of the energy market and the application of new technologies, regulatory capacity needs to be continuously upgraded. Furthermore, how to balance the roles of government regulation and market mechanisms is still an issue that needs to be explored. In the future, China's energy regulatory system needs to be further reformed and improved to better meet the needs of energy transformation and market development.

Transport and distribution systems in the Chinese energy market

China's energy transport and distribution system is an important infrastructure that supports the operation of the energy market. In terms of coal transport, China has formed a transport network that is mainly railway-based, supplemented by waterways and roads. Major coal transport corridors include railway trunk lines such as the Daqin Line and the Shuo Huang Line, as well as waterway corridors such as the Yangtze River and the Pearl River. In recent years, with the westward shift of the centre of gravity of coal production, the construction of coal export capacity in the western region has become a priority.

The transport of oil and natural gas relies mainly on pipeline networks. China has built a pipeline system for crude oil and refined oil products spanning east to west and north to south, as well as a natural gas pipeline network covering the whole country. The construction of major pipeline projects such as the West-East Natural Gas Pipeline and the China-Russia Eastern Route has greatly increased natural gas transmission capacity. Meanwhile, the construction of liquefied natural gas (LNG) receiving terminals has also provided important support for natural gas import and distribution.

The power transmission and distribution system is another important component of energy transport and distribution. China has built the world's largest ultra-high-voltage transmission network, realising long-distance and large-capacity power transmission. The interconnection of regional power grids is being strengthened, improving the ability to optimise the allocation of power resources. The construction of distribution grids is also being accelerated to adapt to the development of distributed energy resources and changes in user demand.

Renewable Energy Market in China

China's renewable energy market has developed rapidly in recent years and has become a global leader in renewable energy. Driven by policy support and technological advances, China has made remarkable achievements in the fields of wind energy, solar energy, hydropower and biomass energy. In terms of wind energy, China has become the world's largest wind power market, with

continuous growth in installed capacity. Offshore wind power is developing rapidly, becoming a new growth point. The scale of solar photovoltaic industry continues to expand, with remarkable technological progress and a continuous decline in power generation costs.

The development of hydro energy is advancing steadily, and large hydropower projects such as Baihetan Hydropower Station have been put into operation one after another. Biomass energy is being utilised in various forms, including power generation, heating and gas production, and plays an important role in rural energy transformation. Emerging renewable energy fields such as geothermal energy and ocean energy are also being actively explored and demonstrated for application.

The rapid development of the renewable energy market has benefited from policy support on various fronts. China has set renewable energy development targets and implemented policies such as the renewable energy power quota system and feed-in tariff subsidies. At the same time, it has continued to improve the renewable energy consumption mechanism and promote power market reform, creating a favourable environment for the development of renewable energy.

China's renewable energy market faces several challenges. Firstly, the volatility and intermittency of renewable energy generation place increased demands on the stable operation of power systems. Secondly, there is a significant gap in renewable energy subsidy funding, necessitating the exploration of a sustainable support mechanism. Additionally, the innovation capacity of renewable energy technology needs improvement, and key core technologies require further development.

Looking ahead, China's renewable energy market is expected to continue its rapid growth. With advancements in technology and reductions in costs, the competitiveness of renewable energy will further increase. Distributed energy systems, energy storage technology, and the development of smart grids will facilitate the large-scale implementation of renewable energy. Moreover, the synergistic integration of renewable energy with traditional energy sources and the establishment of a complementary multi-energy system will be crucial for transforming the overall energy system.

Trends and Challenges in China's Energy Market

As we look to the future, China's energy market is expected to experience the following development trends:

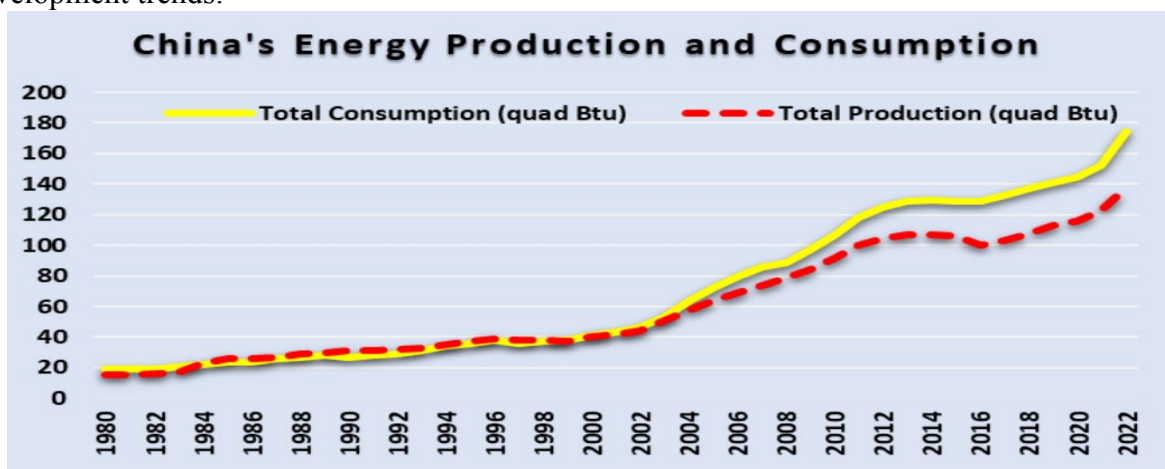


Figure 2. Trends in China's energy consumption versus production, 1980-2022, expressed in quadrillion British thermal units (quad Btu)

Source: <https://www.eia.gov/international/data/country/chn>.

First, while the growth rate of total energy consumption will slow down, the energy structure will continue to improve. It is anticipated that by 2030, non-fossil energy consumption will account for approximately 25 percent of the total. Secondly, renewable energy sources will see significant development, with the capacity for wind and photovoltaic power generation expected to double. Lastly, innovation in energy science and technology will accelerate, leading to breakthroughs in emerging technologies such as energy storage and hydrogen energy. toward the future.

However, China's energy market also faces many challenges. Risks to energy security remain, especially the high level of external dependence on oil and gas. Environmental pressures continue to increase, and peak carbon emissions and carbon neutrality targets have put forward higher requirements for energy transformation. Energy market reform has entered a deep water zone, and how to balance market efficiency and public interest has become a challenge. In addition, regional energy development imbalances and energy poverty also require attention.

To address these challenges, China must enhance its energy policy framework. This involves: accelerating the development of a clean, low-carbon, safe, and efficient energy system; deepening market-oriented reforms in the energy sector and refining the energy pricing mechanism; increasing investments in energy science and technology innovation while promoting a technological revolution in energy; and strengthening international cooperation to improve energy security. Additionally, it is crucial to consider the social implications of energy transformation, ensuring that energy policies are fair and inclusive.

Conclusion

This paper comprehensively analyses the current situation and development trends of China's energy market. The study shows that China's energy market is in transition, with traditional energy sources still dominating but renewable energy sources developing rapidly. The continuous improvement of the legal framework and regulatory system provides a guarantee for the healthy development of the energy market. The construction of energy transport and distribution systems has laid the foundation for the optimal allocation of energy resources.

Challenges facing China's energy market include: the pressure of energy structure transformation, energy security risks still exist, environmental protection is an arduous task, and energy technology innovation capacity needs to be upgraded.

At the same time, China's energy market is also facing great opportunities:

- Large space for optimising the energy consumption structure,
- Huge potential for the development of renewable energy,
- Broad prospects for energy technology innovation and industrial upgrading, and vast space for international cooperation.

To cope with these challenges, China needs to adopt the following strategies:

- Accelerate the energy production and consumption revolution, build a clean, low-carbon, safe and efficient energy system;
- Deepen reforms in the energy sector, improve the energy price formation mechanism and the market system;
- Increase the investment in energy science and technology innovation, and break through the bottlenecks of the key core technologies;
- Strengthen the international cooperation in energy, and enhance the right to speak in the global energy governance;

-Improve the energy laws and regulations system, and Improve energy governance capacity.

Only through the joint efforts of the government, enterprises and society can China achieve sustainable development of the energy market and provide strong support for high-quality economic development and the construction of ecological civilisation. In the future, China's energy market will continue to develop in the direction of cleanliness, low-carbonisation and intelligence. In the process of realising the 'dual-carbon' goal, China's energy market will usher in new opportunities for development, and at the same time will make an important contribution to the global energy transition and sustainable development.

References

- International Energy Agency (IEA), The sustainability revolution. Retrieved from https://iea.blob.core.windows.net/assets/WEO_2017_Special_Report_China.pdf, 153-175
- Kilian, L. (2008). The Economic Effects of Energy Price Shocks. *Journal of Economic Literature*, 46 (4), pp. 871-909.
- Wang X X, Wang A J, Zhong W Q, et al. Challenges of International Turmoil Situation to China's Energy Resource Security and Coping Strategies, Retrieved from http://www.bulletin.cas.cn/BCAS_CH/doi/10.16418/j.issn.1000-3045.
- Climate-Change- and-Sustainability-Services/2011---ESR---Main-Page.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company. How Japanese companies create the dynamics of innovation*. Oxford: Oxford University Press.
- Suo, Ruixia & Wang, Qi & Tan, Yuanyuan & Han, Qitong. (2024). An innovative MGM-BPNN-ARIMA model for China's energy consumption structure forecasting from the perspective of compositional data. *Scientific Reports*. 14. 10.1038/s41598-024-58966-z.
- Eurostat. (2017). Statistici privind prețul energiei electrice. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_price_statistics/ro&oldid=365977.
- Kawulur, H.R., Saraswati, E., Ghofar, A., Prastiwi, A. (2024). On the book *International Journal of Energy Economics and Policy: a textual analysis. Carbon Strategy, Political Connection and Carbon Performance: Evidence from Polluting Industries Capital*, 7(1), 93-110.
- Dalby, P.A.O., Gillerhaugen, G.R., Hagspiel, V., Leth-Olsen, T., Thijssen, J.J.J. Green investment under policy uncertainty and Bayesian learning. (2018) *Energy*, 161, pp. 1262-1281.
- Central People's Government of the People's Republic of China, 2021b. Pumped storage long-term development plan (2021-2035). (accessed 9 Sep 2021).
- Central People's Government of the People's Republic of China, 2021c. 2021 State council government work report. (accessed 12 Mar 2021).
- Central People's Government of the People's Republic of China, 2021d. The carbon peak action plan before 2030. (accessed 24 Oct 2021).
- Díaz and Soares, 2020, H. Díaz, C.G. Soares Review of the current status, technology and future trends of offshore wind farms. *Ocean Eng.*, 209 (2020), Article 107381
- Chen, G. (2020), pp. 5493-5506. P., Dong, Y., Liang, Z.F. Analysis and reflection on high-quality development of new energy with chinese characteristics in energy transition. *Proceedings of the CSEE*, 40 (17):
- China Energy Portal, 2022 Accelerating the construction of dynamic modelling and testing platforms for variable-speed pumped storage units tailored for new power systems. (accessed 25 Nov 2022).