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Innovation and Practice of Diversified Business Model of New Energy Power Generation Enterprises

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Abstract: With the growing global demand for clean energy, new energy power generation enterprises are facing new opportunities and challenges. This paper explores the diversified business model of new energy power generation enterprises. Firstly, the theoretical basis of the business model of new energy power generation enterprises is analyzed, including the characteristics and income sources of single and multiple industrial chain models. The advantages and applications of different business models are analyzed through the study of cases at home and abroad, such as the European aggregated generation side resource model, the United States focused on controllable load demand response model, and the domestic cases of Shanghai and Shenzhen virtual power plant projects and distributed photovoltaic power generation. Then it puts forward the diversified business model innovation strategy of new energy power generation enterprises, covering the innovation of comprehensive energy services, the development of power side energy storage business, and the expansion of key businesses and profit models. Finally, the research conclusions are summarized and the future research directions are prospected. In short, the exploration of diversified business models of new energy power generation enterprises is of great significance to promote the development of clean energy and improve the competitiveness of enterprises.

Keywords: Diversified business model, Integrated energy services, Energy storage at power side, Distributed photovoltaic power generation.

1. Introduction

With the continuous growth of global energy demand and the increasingly severe problems of environmental pollution and climate change, new energy power generation enterprises are facing many challenges. On the one hand, new energy power generation has randomness, intermittency and volatility, and it is difficult to maintain continuous, stable and balanced output, which greatly reduces its market competitiveness. For example, the most significant defect of new energy such as wind power and photovoltaic power is that they have these characteristics, and their occurrence time, duration, and intensity are difficult to accurately grasp, all of which are converted into operating costs. On the other hand, new energy power generation enterprises face greater pressure in terms of bearing system regulation costs, bearing deviation assessment costs, and meeting grid access requirements. At the same time, compared with traditional energy, the cost of new energy is still high, and the technology is still in the development stage, which requires continuous improvement and innovation. Energy storage technology still faces challenges in cost and efficiency, and the new energy market is highly competitive, requiring the search for new market opportunities and business models.

Against this backdrop, exploring diversified business models has become an inevitable choice for new energy power generation companies. By exploring diversified business models, new energy power generation enterprises can reduce costs, improve market competitiveness, and achieve sustainable development.

This article aims to conduct an in-depth analysis of the diversified business models of new energy power generation enterprises, and explore their feasibility and effectiveness in the current market environment. Through the research on different business models, we provide innovative suggestions for new energy power generation enterprises to help them stand out in the fierce market competition and achieve sustainable development. At the same time, this article also hopes to provide reference for policy makers to promote the healthy development of the new energy power generation industry.

2. Theoretical Basis of Business Model of New Energy Power Generation Enterprises

2.1. Single and Multiple Industrial Chain Models

The single-industry chain model and the multi-industry chain model in the new energy power generation industry have their own characteristics. Under the single industry chain model, enterprises complete the entire production chain from power generation to sales, such as a solar power station enterprise, which controls the entire process from the production of solar panels, the construction of power stations to the sale of electricity. The advantage of this model is that enterprises can fully control the entire industrial chain, ensuring product quality and service consistency. For example, the company can strictly control the quality of solar panels to ensure high conversion efficiency and long service life. At the same time, during the construction of the power station, it is able to carry out construction according to high standards to ensure the stability and safety of the power station. In the power sales process, it can directly communicate with users, understand their needs, and provide personalized services.

The multi-industry chain model involves enterprises in multiple sectors of the new energy power generation industry. Taking enterprises that engage in both wind power generation

and solar power generation as an example, when wind power generation encounters problems due to weather and other factors, solar power generation can play a complementary role and reduce the risks for the enterprise. For example, a new energy enterprise has both wind power plants and multiple solar power stations. At a certain period of time, when the wind power is weak and the wind power generation decreases, the solar power station can continue to generate electricity steadily to ensure the power supply and income of the enterprise. This diversified layout enables enterprises to better cope with market changes and risks.

2.1.1. Advantages of the single industry chain model

Taking a well-known solar power station construction enterprise as an example, the enterprise strictly controls product quality through independent research and development and production of solar panels. During the construction of the power station, advanced construction technology and equipment are used to ensure the stability and safety of the power station. At the same time, the enterprise has established a professional operation and maintenance team to conduct real-time monitoring and maintenance of the power station to ensure efficient operation of the power station. By fully controlling the industrial chain, the enterprise ensures the consistency of product quality and service, wins the trust and praise of customers, and occupies a dominant position in market competition.

2.1.2. Advantages of the diversified industrial chain model

For example, a large new energy enterprise is engaged in both wind power generation and solar power generation. Build wind farms in areas with abundant wind resources, and deploy solar power stations in areas with sufficient sunlight. When the wind resources in a certain area are unstable, solar power stations can continue to generate electricity to ensure the power output of enterprises. This diversified industrial chain model reduces the risks of enterprises and improves their ability to resist risks. For example, during a certain period, due to weather conditions, the power generation of wind farms dropped significantly, but the power generation of solar power plants remained stable, providing a continuous source of income for enterprises.

2.2. Analysis of Income Sources

The revenue sources of new energy power generation enterprises are not limited to electricity sales revenue, but also include carbon emissions trading, government subsidies, value-added services, and other methods.

2.2.1. Carbon emission trading income

Many power companies are reaping dividends by reducing carbon emissions. For example, Datang Power Generation's carbon emission trading revenue reached 302 million yuan in 2021, while Huaneng International's carbon emission trading revenue amounted to 269 million yuan in the current period. These enterprises have reduced carbon emissions through the use of advanced energy-saving and emission-reduction technologies, and have thus gained considerable benefits in the carbon emissions trading market. Taking a power plant as an example, the power plant has improved energy efficiency through technological innovation, reduced the use of coal, and thus reduced carbon emissions. In the carbon emission trading market, the power plant sold surplus carbon emission quotas to other enterprises, earning additional income.

2.2.2. Government subsidies and value-added service income

Government subsidies are crucial to the support of new energy power generation enterprises. The government reduces the investment costs of enterprises and improves their investment enthusiasm through financial subsidies, tax incentives, and other means. For example, the government provides subsidies to new energy power generation enterprises in the fields of straw energy utilization, biogas projects, biomass fuel boilers, and solar power generation. At the same time, new energy power generation enterprises can also obtain benefits by providing value-added services. Value-added services include services provided to users by technologies such as battery energy storage and smart grid. For example, the Pingguo Power Supply Bureau of Guangxi Baise in China Southern Power Grid has organized value-added services by providing customers with the entire chain of distributed photovoltaic projects, helping the development and growth of new energy enterprises in the jurisdiction. By providing value-added services, enterprises provide users with more stable and reliable power supply, while also improving their own revenue levels.

3. Case Analysis of Diversified Business Models of New Energy Power Generation Enterprises

3.1. Foreign Cases

3.1.1. Resource Model of European Polymerization Power Generation Side

European virtual power plants mainly aggregate power generation resources, and the virtual power plants in Germany have been fully commercialized. German virtual power plant operators can sell the electricity generated by medium-sized renewable energy power plants above 100kW in the wholesale market and optimize their electricity sales in the day-ahead market. In addition to renewable energy power plants, gas-fired cogeneration, battery energy storage, emergency generators, and demand response can all be used as virtual power plant resources. There are three main types of operators in Germany's virtual power plants: independent virtual power plant operators, large power companies, and new market participants.

Take Next Kraftwerke, one of the largest virtual power plant operators in Europe, as an example. Its business can be divided into three modes: energy aggregation for the power generation side, flexible energy storage supply for the grid side, and demand response for the demand side. For example, the company provides services to renewable energy power generation enterprises, helping them monitor power generation in real time, avoiding inaccurate power generation forecasts, saving the cost of power generation, and assisting them in optimizing the structure of power products and expanding profits, thereby earning ancillary benefits for aggregators. On the grid side, the company provides short-term flexible energy storage services and earns revenue by providing peak and frequency regulation services to TSOs. On the demand side, companies serve the grid side by controlling electricity consumption, earning ancillary fees, and allocating grid-side consumption to low-price periods on the spot market to reduce power procurement costs.

3.1.2. The controllable load demand response mode in the United States

The United States mainly uses controllable load demand response, distributed solar energy resources and active electricity markets. For example, Tesla's electricity retail plan aims to achieve self-sufficiency in household energy through its electric vehicle battery energy storage system and solar roof products, and to feed excess power back to the grid when necessary. The Sunverge energy platform integrates distributed solar power generation, battery energy storage, and intelligent energy management systems to provide users with personalized energy solutions, while participating in demand response and ancillary services in the electricity market. Virtual power plant projects in the United States are usually operated by energy service companies, technology companies, and power companies in cooperation, through advanced communication technology and data analysis, to achieve efficient management and optimal allocation of distributed energy resources.

3.2. Domestic Cases

3.2.1. Shanghai Virtual Power Plant Project

Shanghai took the lead in carrying out pilot projects for power demand response in 2014, and officially began operating the country's first provincial-level virtual power plant operation system in 2019. At present, Shanghai is committed to breaking down the communication and data barriers between platforms, exploring the "virtual power plant" model of "source follows load, load follows network, source and load interact", and carrying out new actions to deepen the application of the operation system. Shanghai mainly carries out the pilot project of virtual power plant by aggregating the air conditioning resources of commercial buildings. For example, the "virtual power plant" demonstration project for commercial buildings in Huangpu District was completed in 2017. Through pre-installed electronic terminals, it achieves minute-level remote flexible adjustable load demand response, raising the temperature of central air conditioning by 2 degrees Celsius to 3 degrees Celsius, which can reduce daily electricity consumption by nearly 20%, thereby reducing the burden on the power grid.

3.2.2. Shenzhen Virtual Power Plant Project

The Shenzhen Virtual Power Plant Management Center was established on August 26, 2022, becoming the first "virtual power plant" management center in China, marking a new stage of rapid development for Shenzhen's "virtual power plant". The center has connected 14 load aggregators such as distributed energy storage, data centers, charging stations, and subways, with a total access capacity of 870,000 kilowatts, which is close to the installed capacity of a large coal-fired power plant. The Shenzhen virtual power plant management platform aggregates and manages a large number of charging piles, air conditioning loads, and other resources in a unified manner, and organizes operators to carry out load regulation. This not only solves practical problems such as local equipment overload and peak load reduction in the power grid, but also creates economic benefits for users. For example, the operator Shenzhen Tecom New Energy Co., Ltd. scientifically reduced the power of its charging piles by 30% during peak hours, which helped reduce the load on the power grid while generating additional revenue and benefiting new energy vehicle owners. Shenzhen has also introduced a series of policies to support the development of virtual power plants, with plans to build a virtual power plant with a capacity of 1 million kilowatts by 2025.

3.3. Distributed Photovoltaic Power Generation Case

3.3.1. Household rooftop photovoltaic model

The installation of photovoltaic panels on residential roofs can provide clean, renewable electricity for households and reduce electricity costs. For example, some families have installed roof photovoltaic systems, which not only meet their own electricity needs, but also sell excess electricity to the grid and earn a certain amount of income. According to statistics, a roof photovoltaic system installed in an ordinary family can generate thousands of degrees of electricity per year, saving hundreds or even thousands of yuan in electricity bills. At the same time, household rooftop photovoltaics also reduce dependence on traditional energy sources, reduce carbon emissions, and contribute to environmental protection.

3.3.2. Enterprise roof photovoltaic mode

Enterprise rooftop photovoltaic systems install photovoltaic panels on the roofs of enterprise factories or warehouses to provide green power for enterprises, reduce energy costs, and respond to green energy development policies. For example, after installing a roof photovoltaic system, a manufacturing company can save a lot of electricity expenses every year. At the same time, enterprises can also participate in the carbon emissions trading market and sell excess carbon allowances to other enterprises to obtain additional benefits. In addition, the enterprise roof photovoltaic also improves the social image of the enterprise and enhances the competitiveness of the enterprise.

4. Innovation Strategies for Diversified Business Models of New Energy Power Generation Enterprises

4.1. Innovation in Comprehensive Energy Services

Develop "source-grid-load-storage integration" multi-energy supply services and value proposition.

4.1.1. Multi-energy supply service form

In commercial complexes, hospitals, hotels and other places, carry out the integrated construction of source, network, load and storage combining distributed energy supply and user-side energy storage. For example, in a large commercial complex, the use of natural gas distributed, photovoltaic + and other multi-energy supply forms can be used to build and operate energy supply networks such as electricity, heat, and gas. By installing roof photovoltaic power generation equipment, it can provide part of the power demand for commercial complexes; At the same time, a natural gas distributed energy system is equipped to provide stable power and heat energy during peak electricity consumption periods. In hospitals, according to their energy consumption characteristics, an energy supply system with natural gas combined cooling, heating and power as the core is built to meet the hospital's demand for various energy sources such as electricity, refrigeration, and heating. In hotels, the combination of solar water heating systems and energy storage equipment enables efficient use and stable supply of energy.

In the industrial park, we will carry out the construction of distributed renewable energy, incremental distribution network, and intelligent heat network integrated green park.

For example, an industrial park has built distributed photovoltaic power generation systems, wind power generation facilities, and biomass energy power generation projects to provide green power for enterprises in the park. At the same time, the power distribution is optimized through incremental distribution network to improve the system balance ability. The intelligent heating network system will allocate heat energy reasonably and improve energy utilization efficiency according to the energy demand of enterprises in the park.

In rural construction, the development model of "energy + ecology" is selected by utilizing distributed photovoltaics, garbage, straw, and livestock waste on-site. For example, in a rural area, a distributed photovoltaic power station is built to generate electricity using the abundant solar energy resources in the area. At the same time, garbage, straw and waste from the breeding industry will be treated, and biomass energy will be used for power generation and heating, achieving the circular utilization of resources. This model not only drives the construction of rural revitalization, but also provides clean and sustainable energy supply for the countryside.

4.1.2. Value proposition to meet the diversified energy demand

Meeting the diverse energy demand is one of the important goals of new energy power generation enterprises to carry out comprehensive energy services. The adjustment of energy structure has led to higher and newer requirements for energy services from users, and the traditional single electricity sales model is difficult to meet user needs. Power generation enterprises need to build an open, diversified, interactive and efficient modern energy supply system to achieve green, efficient, energy-saving and sustainable development of energy development and utilization.

Firstly, meeting the diverse energy needs of users can improve user satisfaction. For example, an industrial enterprise not only needs a large amount of power supply, but also has certain requirements for heat and cold energy. New energy power generation enterprises have built distributed photovoltaic power generation systems, natural gas combined cooling, heating and power supply systems, and energy storage equipment for the enterprise by providing "source-grid-load-storage integration" multi-energy supply services, which meet the enterprise's demand for various energy sources. This personalized energy solution improves the production efficiency of enterprises, reduces energy costs, and also enhances the trust and satisfaction of enterprises with new energy power generation enterprises.

Secondly, expanding the electricity sales service market is another important goal for new energy power generation enterprises to carry out comprehensive energy services. With the reform of the energy supply side and the new requirements of the electricity reform, the business model of the production and sales of electric energy has undergone profound changes. The marketing work of power generation enterprises has gradually shifted from being oriented towards the power grid to being oriented towards the market. Power generation enterprises should carry out comprehensive energy services by going deep into the user's internal world, exploring new business, new demand and energy-saving potential, providing differentiated "energy use + service" for users, continuously improving service quality, expanding the electricity sales market, and forming market competitive advantages.

For example, a new energy power generation enterprise provides users with intelligent power management services, through the installation of smart meters and energy management systems, real-time monitoring of users' electricity consumption, and providing users with optimization suggestions for electricity consumption. At the same time, the company also provides users with power equipment operation and maintenance services to ensure the safe and stable operation of users' power equipment. This integrated energy service model not only improves the efficiency of electricity consumption and reduces electricity costs for users, but also opens up the electricity sales market for enterprises and increases their revenue sources.

Promoting clean energy consumption is one of the important tasks for new energy power generation enterprises to carry out comprehensive energy services. The proposal of the "dual carbon" goal has accelerated the development of clean energy. Through integrated energy services, we can promote coordination and mutual assistance between different energy sectors and entities, enhance the flexibility of energy production, transmission, storage, consumption, and other aspects, effectively coordinate the development of different regions and industries, and effectively promote the widespread and safe consumption of clean energy.

For example, a new energy power generation enterprise in a certain region has built energy storage facilities to store excess electricity from photovoltaic and wind power generation during low-peak hours and release it during peak hours, achieving peak shaving of clean energy. At the same time, the company also optimizes energy distribution and improves the efficiency of clean energy utilization through intelligent energy management system. This integrated energy service model effectively promotes the consumption of clean energy and contributes to the realization of the "dual carbon" goal.

Establishing a win-win cooperation ecosystem is the long-term goal of new energy power generation enterprises to provide comprehensive energy services. According to the idea of "service + ecology", we aim to achieve "drainage + empowerment" for the integrated energy service ecosystem. Taking comprehensive energy efficiency, intelligent operation and maintenance, and demand-side management as entry points, we will promote the docking of supply and demand and the optimal allocation of resources across all links and elements, stimulate the growth of industrial clusters, drive the common development of upstream and downstream industries in the industrial chain, and build a new energy ecosystem of mutual benefit and win-win results.

For example, a new energy power generation enterprise has established cooperative relationships with energy equipment manufacturers, energy service providers, scientific research institutions, etc. to jointly create a comprehensive energy service ecosystem. Enterprises collaborate with energy equipment manufacturers to develop and promote energy-efficient equipment; Cooperate with energy service providers to provide users with a full range of energy services; Collaborate with scientific research institutions to conduct research on energy technology innovation. This win-win ecosystem not only brings more development opportunities for enterprises, but also promotes the sustainable development of the entire energy industry.

4.2. Development of Energy Storage Business on The Power Supply Side

Seize the opportunity of new power system and promote the construction of energy storage on the power side.

4.2.1. Energy storage construction of large-scale new energy grid-connected base

In large-scale new energy grid-connected bases in Northwest China and Inner Mongolia, it is of great significance to actively promote the construction of supporting energy storage. On the one hand, the construction of large-scale energy storage power station demonstration projects can achieve peak shifting and improve the compatibility of new energy with the grid and the accuracy of power generation forecasting. For example, in a large wind power base in the northwest, a large-scale battery energy storage power station has been built. During the peak period of wind power generation, excess power is stored; During peak hours of electricity consumption, the stored power is released to achieve peak shifting and online access. This approach not only improves the utilization efficiency of new energy, but also alleviates the pressure of peak regulation on the power grid.

On the other hand, the construction of energy storage can improve the stability and reliability of new energy power generation. Due to the randomness and volatility of new energy generation such as wind power and photovoltaic power, energy storage systems can provide power support when new energy generation is insufficient, ensuring the stable operation of the power grid. For example, in a photovoltaic base in Inner Mongolia, an energy storage power station was built. When the photovoltaic power generation suddenly drops, the energy storage power station can respond quickly and release the stored power to ensure the stability of power supply in the power grid.

4.2.2. Auxiliary service practice

Relying on the existing power plant demand, tracking the development of energy storage technology, and actively carrying out energy storage frequency regulation and peak regulation and auxiliary service practices. In terms of frequency modulation, the energy storage system can quickly respond to changes in grid frequency, adjust grid power through charging and discharging, and improve the frequency stability of the grid. For example, a thermal power plant combines with an energy storage system for joint frequency modulation. When the grid frequency fluctuates, the energy storage system can respond quickly and work in coordination with the thermal power unit to improve the frequency modulation effect.

In terms of peak regulation, the energy storage system can store electricity during the low-power period and release it during the peak period, alleviating the pressure of peak regulation on the power grid. For example, a hydropower plant uses excess hydropower generation during the low-demand period at night to charge the energy storage system; During the peak hours of electricity consumption in the daytime, the energy storage system discharges to provide power support for the power grid.

In addition, the energy storage system can also provide auxiliary services for the power grid, such as backup power supply and black start. In the event of a power grid failure, the energy storage system can quickly start up, providing power protection for important users and shortening the power outage time. For example, when a power grid failure occurs in a certain region, the energy storage power station serves as a backup power source to provide power support for important facilities such as hospitals and communications, ensuring the normal operation of society.

4.3. Expanding Key Business and Profit Model

Expand comprehensive energy services from energy supply and industrial chain extension.

4.3.1. Coordination of energy production and marketing and improvement of total factor efficiency

New energy power generation enterprises should combine with the actual energy demand of users to supply electricity, heat, cold, gas, water, hydrogen and other energy sources, achieve the coordination of energy production and marketing, optimize the dispatching, improve the efficiency of energy utilization, and maximize the consumption of renewable energy, so as to achieve the improvement of total factor productivity.

For example, in an industrial park, new energy power generation enterprises have built distributed photovoltaic power generation systems, wind power generation facilities, and biomass energy power generation projects to provide green power for enterprises in the park. At the same time, the enterprise has also built a natural gas distributed energy system to provide heat and cold energy for the enterprise. Through the intelligent energy management system, the optimal scheduling of electricity, heat and cold energy is achieved, and the energy utilization efficiency is improved. In terms of energy production and sales coordination, enterprises sign long-term energy supply contracts with enterprises in the park, and arrange energy production and supply reasonably according to their energy consumption needs. At the same time, enterprises also actively participate in power market transactions, selling excess power to other users to achieve a balance between energy production and consumption.

In terms of renewable energy consumption, enterprises can improve the utilization efficiency of renewable energy by building energy storage facilities to store excess power from photovoltaic and wind power generation during low-peak hours and release it during peak hours. In addition, enterprises also actively promote the technology of Internet plus to achieve the interconnection and optimal allocation of energy and further improve the total factor productivity.

4.3.2. Trading agency and energy value-added services

Transaction agency service is one of the important ways for new energy power generation enterprises to expand comprehensive energy services. The reform of the electricity sales side and the power trading mechanism promote the release of user demand, and users can choose more flexible ways of using electricity. Power generation companies can earn transaction agency income by building energy trading platforms to provide users with energy agency transaction services.

For example, a new energy power generation enterprise has built an energy trading platform to provide users with power agency trading services. Users can choose different power suppliers and electricity packages through the platform to reduce electricity costs. Enterprises obtain additional income by charging transaction agency fees. At the same time, the enterprise also provides users with power consumption data analysis and optimization suggestions through the platform to improve the power consumption efficiency of users.

Energy value-added services are an important means for new energy power generation enterprises to enhance their profit growth. Based on the dynamic development needs of the market, industry technology levels and other objective conditions, we will expand the value chain, be market-oriented and demand-centered, and focus on energy market

transactions. We will provide users with value-added services such as equipment operation and maintenance, energy hosting, energy-saving renovation, etc., enhance user stickiness, and increase profit growth points.

For example, a new energy power generation enterprise provides equipment operation and maintenance services for users, ensuring the safe and stable operation of equipment through regular inspection and maintenance of users' power equipment. The enterprise also provides energy hosting services for users, and develops personalized energy management plans for users based on their energy consumption needs, to achieve efficient use of energy. In addition, the company also provides users with energy-saving renovation services, reducing energy consumption and improving economic efficiency through the replacement of high-efficiency energy-saving equipment and technologies. These value-added services not only enhance user stickiness, but also bring more revenue sources to enterprises.

5. Conclusion

This article conducts an in-depth analysis of the diversified business models of new energy power generation enterprises. In terms of single and multiple industrial chain models, it is clear that the single industrial chain model can fully control quality and service, while the multiple industrial chain model can reduce risks and improve risk resistance. In the analysis of revenue sources, carbon emissions trading, government subsidies, and value-added services provide multiple profit channels for new energy power generation companies. Through the analysis of diversified business model cases at home and abroad, such as the virtual power plant model in Europe and the United States, as well as the virtual power plant projects and distributed photovoltaic power generation cases in Shanghai and Shenzhen, practical references are provided for new energy power generation enterprises. In terms of innovation strategies, comprehensive energy service innovation, power-side energy storage business development, and expansion of key business and profit models provide specific paths for new energy power generation companies to achieve diversified development.

References

[1] Abegaz, B.. (2005). The diversified business group as an innovative organizational model for large state-enterprise reform in china and vietnam. Working Papers, 5(5/6), 379-400(22).

[2] Xu, N., & Xu, Y. (2016). Research on the key success factors of reverse innovation of the latecomer engineering and technical services enterprises. Journal of Science & Technology Policy Management, 7(1), 58-76.

[3] Liang, L. (2021). Design of the internet plus drug circulation business model based on value chain. Journal of Healthcare Engineering.

[4] Jian-Li, H., & Bang-Tao, W. U. An empirical study on profit model affecting business performance of scenic spots listed enterprises in china. Journal of Southwest University for Nationalities (Natural Science Edition).

[5] Lv, W., Geng, M., Zhang, T., Shan, M., & Xie, M. (2020). Research on the market mechanism of energy storage participating in Electric Auxiliary Services. 2020 12th IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC). IEEE.

[6] Yang, X., Niu, D., Chen, M., Wang, K., Wang, Q., & Xu, X. (2020). An operation benefit analysis and decision model of thermal power enterprises in china against the background of large-scale new energy consumption. Sustainability, 12.