Proceedings of the 4th International Conference on Functional Materials and Civil Engineering
DOI: 10.54254/2755-2721/2026.35393

Energy Storage-Supported New Energy Smart Grid Architecture and Typical Application Analysis

Xue Zhai

School of Ecology and Environment, Central South University of Forestry and Technology, Changsha, China
zx1904583845@gmail.com

Abstract. With the large consumption of traditional energy, global climate change and environmental problems are gradually emerging, and the dual-carbon goal continues to advance. The category of energy use has gradually changed from traditional energy to new energy. Smart grid is the carrier of energy transformation, and also provides different models for the operation of new energy. Energy storage technology provides stability for new energy and improves power regulation capacity through its unique energy space-time transfer nature. This paper systematically describes the classification of energy storage technology and the architecture of new energy smart grids containing energy storage technology, analyze two typical cases: the case of photovoltaic power generation intelligent microgrid with energy storage system, and the case of wind power generation combined with energy storage technology smart grid, discusses the comprehensive application of different types of new energy, and looks forward to the future application of artificial intelligence to provide reference for the integration of various new energy into intelligent power grids in the future.

Keywords: Energy storage, Smart grid, New energy, Power generation

1. Introduction

The global demand and use of energy is increasing. The consumption of traditional energy is too large, and its pollution to the environment is gradually emerging. Climate change is also affected by it. Against this background, new energy has become the core of energy transformation and is gradually facing the world [1]. High efficiency and environmental preservation are features of the smart grid system. It can make sensible use of new energy and progressively achieve energy transformation while enhancing power system stability, which is crucial for the nation's sustainable growth.

According to the notion of global sustainable development, additional energy is progressively added to the smart grid system through the integration of energy storage technologies. China's photovoltaic power generation will account for 30.8% of China's total installed power supply capacity in 2025 [2]. Hydropower stations have also been established in China's Three Gorges, Gezhouba, Baihetan and other places [3]. North China, northwest China and coastal areas have

DOI: 10.54254/2755-2721/2026.35393

become important areas for wind power projects [4]. Some developed countries have come to the forefront of the world in the innovation and application of new energy smart grids.

Although some progress has been made in the application of new energy in smart grids, from the overall practice, there are many cases of a single new energy power generation mode, and the engineering application cases of multiple new energy collaborative integration are still relatively limited, especially the model of cooperation between typical energy sources such as wind energy and solar energy The research and actual system verification still need to be further improved. For example, can wind photovoltaic power generation n and power generatio be combined? The access of artificial intelligence, but how to achieve efficient coupling under the unified scheduling framework and optimize the operation in cooperation with the energy storage system, there is still a lack of mature application models with wide promotion value.

2. Types of energy storage technologies

Energy storage technology primarily handles energy conversion in the smart grid, which may produce electricity and power in a flexible manner, and understand that the energy supply may be controlled to satisfy customer demands. The most basic principle of mechanical energy storage is to convert electrical energy into mechanical energy for storage, where mechanical energy can be kinetic energy or potential energy. There are now four main types of energy storage technologies that may be utilized with smart grids: mechanical 、 electromagnetic, 、 electrochemical, 、 and hydrogen energy Storage.

2.1. Mechanical energy storage

An energy storage technique that stores energy as mechanical energy (also known as kinetic or potential energy) is referred to as mechanical energy storage. Its basic concept is to utilize the motor to convert electrical energy into mechanical energy storage when there is excess energy, and to convert the mechanical energy stored in the device back into electrical energy when needed. Large-scale or high-frequency peak adjustment situations are often appropriate for this type of energy storage technology, which typically has a lengthy lifespan. Examples of mechanical energy storage include compressed air energy storage, flywheel energy storage, and pumped hydro storage. The first mechanical energy storage system was pumped energy storage. Next were compressed air and flywheel energy storage.

2.1.1. Pumped hydro storage

A pumped hydro storage system is an energy storage technology that realizes the mutual conversion of electrical energy and gravitational potential energy by storing and producing electricity using two reservoirs at different elevations [5]. During the low period of electricity consumption, the power station uses the excess electricity in the power grid to run the pumping pump, transferring electrical energy to gravitational potential energy while pumping water to the reservoir, and accomplishing the goal of power storage. The power plant uses a turbine to transfer water from the higher reservoir back to the lower reservoir during the power system's peak continuous operating time. It then transforms the gravitational potential energy into electrical energy and provides it to the power grid, and achieves the purpose of power generation. The specific principle is shown in Figure 1.

Pumped hydro storage system is a relatively mature, long-life and mechanical energy storage technology with high circulation capacity [6]. However, its application scenarios have limitations

DOI: 10.54254/2755-2721/2026.35393

and need to consider the terrain and water resources, so its cost is slightly higher than that of other energy storage technologies.

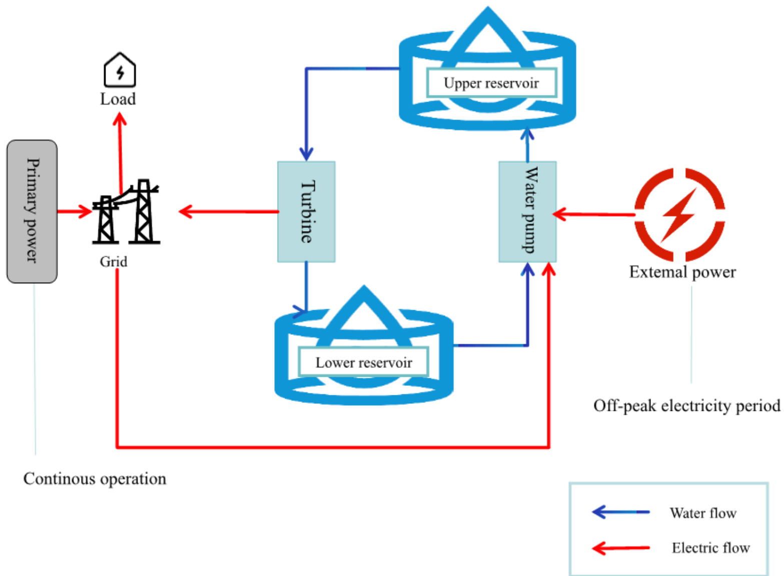

Figure 1. Principle of pumped storage technology
picture credit: original

2.1.2. Compressed air energy storage

Figure 2 illustrates the two primary processes involved in compressed air energy storage: energy storage and power generation. During times of low electricity demand, compressors are powered by excess electricity to compress and cool air. Subterranean salt caverns or artificial storage caverns are used to store the compressed air. This technology stores electrical energy in compressed air. During periods of high demand, high-pressure air is released and expanded to power a turbine, which then powers a generator to produce energy [7]. Compressed Air Energy Storage systems are characterized by large scale, long service life, and relatively low cost, making them uitable for large power plants. However, they have slower response times, strong dependence on geological conditions, and relatively low overall system efficiency.

DOI: 10.54254/2755-2721/2026.35393

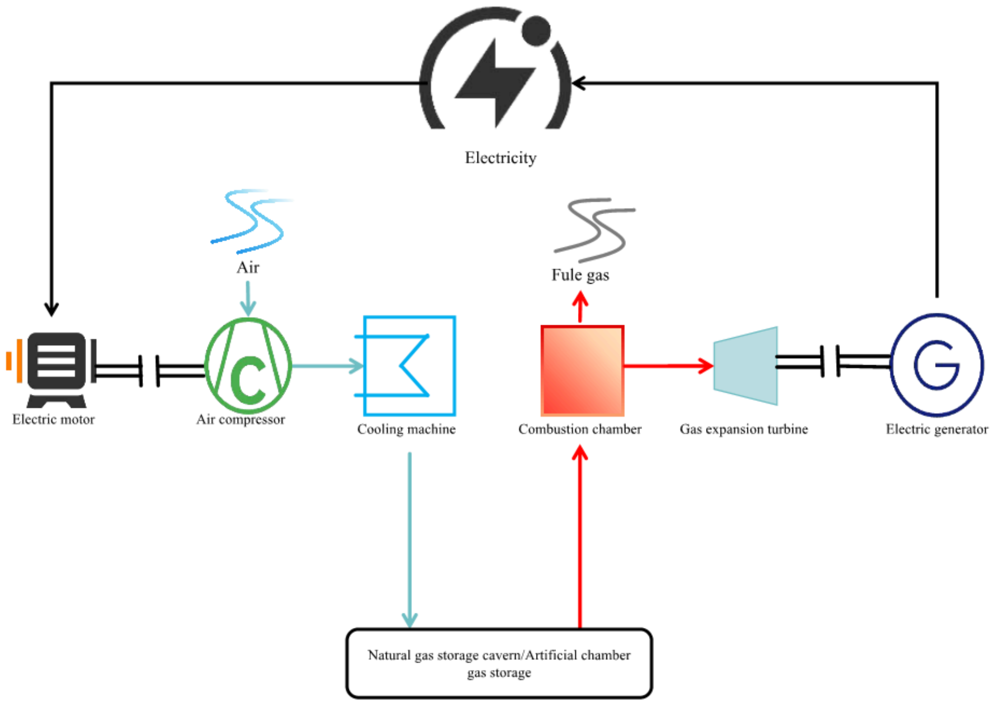

Figure 2. Principle of compressed air energy storage technology
picture credit: original

2.1.3. Flywheel energy storage

As shown in Figure 3, during the charging process of a Flywheel Energy Storage System, external electrical energy is fed into the control system, which issues commands to drive the motor. The motor accelerates the flywheel to a specified rotational speed, during which electrical energy is converted into kinetic energy and stored in the rotating flywheel. During discharge operation, when a power generation signal is received while the flywheel is rotating at a constant speed, the system begins generating electricity. The high-speed rotating flywheel drives the generator, and the produced electricity is then regulated through voltage stabilization, rectification, and frequency control before being delivered to the output.

Flywheel Energy Storage Systems are characterized by extremely fast response speed, high power density, long service life, and low maintenance cost, and they do not produce environmental pollution during operation. However, they also have notable limitations, such as being unsuitable for long-duration energy storage, potential safety risks including explosion under runaway conditions, and unavoidable losses associated with permanent magnets in the motor. At present, flywheel energy storage systems are commonly used in wind power plants [8].

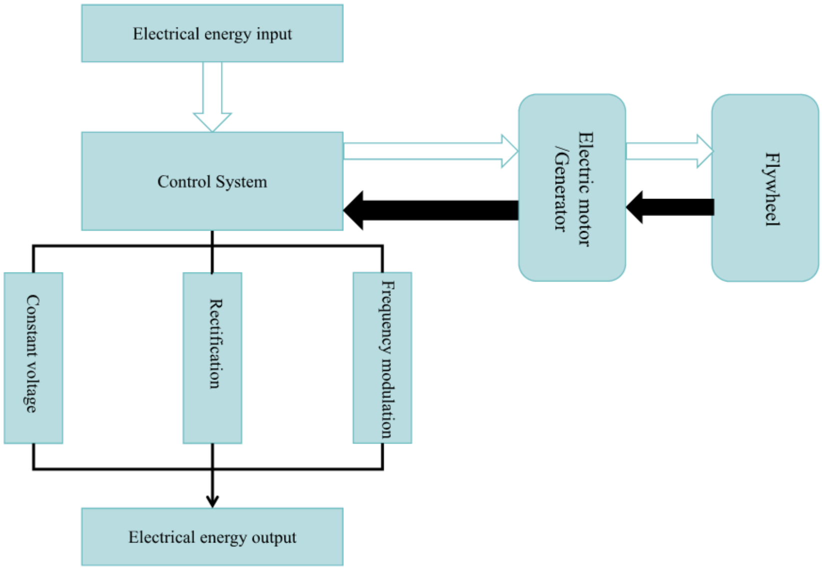

Figure 3. Principle of flywheel energy storage technology
picture credit: original

2.2. Electromagnetic energy storage

Electromagnetic energy storage refers to an energy storage technology that directly stores energy through a magnetic field or electric field. Its energy storage process does not involve chemical reaction or mechanical conversion. Electromagnetic energy storage has an extremely fast response and is very suitable for specific precision scenarios. Its infinite cycle life is suitable for improving the quality of electricity and stabilizing voltage fluctuations. Electromagnetic energy storage mainly includes two energy storage methods: superconducting magnetic energy storage and supercapacitor energy storage.

2.2.1. Superconducting magnetic energy storage

Superconducting magnetic energy storage is to use the low-temperature resistance of superconducting materials to realize the 0 loss cycle of current, and to charge and discharge when needed. Superconducting magnetic energy storage shows ultra-high energy storage efficiency, extremely fast discharge time and low rated power, high power density, and a life can usually exceed 20 years, but its cost is relatively high. Short storage time can only achieve short cycle cycles. The existence of cooling system makes this technology not a completely environmentally friendly technology, and for a long time Exposure to high magnetic fields is also harmful to human physical and mental health. Therefore, when applying this technology, not only economic feasibility but also environmental and human health issues should be considered. At present, this technology is mainly used in photovoltaic power generation, thermal power generation and wind power generation [9].

DOI: 10.54254/2755-2721/2026.35393

2.2.2. Supercapacitor

The actual theory of supercapacitors is the electrochemical double layer theory. Supercapacitors theoretically require two electrodes like traditional electrostatic capacitors, but unlike traditional electrostatic capacitors, supercapacitors use electrolyte solutions to replace one of the electrodes. The heterogeneous ions in the surrounding electrolyte solution are drawn to the supercapacitor's charge during the charging stage and stick to the electrode's surface to create a double electric layer capacitor. Supercapacitors are superior than batteries in terms of power density, longevity, and temperature tolerance [10].

2.3. Electrochemical energy storage

From the current perspective, electrochemical storage technology—owing to its reusability, flexible adaptability to diverse operational scenarios, notably high energy density, and general ease of use—has gradually become the most prevalent and fastest-expanding form of power accumulation available today. This technology can be principally divided into four categories: lithium-ion, sodium-ion, liquid-flow, and lead-acid batteries. Among these, the lead-acid type, as is commonly acknowledged, stands as the most technically mature storage solution, while its cost remains relatively modest. Lithium-ion systems, on the other hand, benefiting from their superior energy density, prolonged cycle longevity, and rapid responsiveness, are extensively adopted across grid-level, user-side, and renewable-energy generation fields. Liquid-flow batteries, thanks to their intrinsic safety and exceptionally extended cycle life, exhibit clear advantages in long-duration storage applications. Over the last few years, sodium-ion batteries have witnessed a remarkable enhancement in technological readiness, and their cost competitiveness is notably striking. In the domain of large-scale storage, it is anticipated that sodium-ion technology will forge a relationship that is both competitive and complementary with its lithium-ion counterparts.

2.3.1. Lithium-ion battery

One of the most advanced electrochemical energy storage systems available today is the lithium-ion battery, which is essentially made up of positive and negative poles in addition to diaphragms with electrolytes [11]. The reversible shuttling of lithium ions back and forth between the positive and negative electrodes forms the core operational foundation for Lithium-ion batteries. During the charging phase, these ions exit from the positive material and journey across the electrolyte to the negative terminal, whilst electrons are simultaneously conveyed from the positive to the negative through the outside circuitry. The discharging procedure, on the other hand, is simply the reverse of that. As for their physical attributes, Li-ion batteries are noted for being lightweight, offering high voltage, and enduring cold conditions fairly well. In a distributed energy setting, such battery systems can retain the electrical output derived from renewable generation, and they are mostly adopted in smart grid applications, aiming to fill nitrate peaks (or mitigate load fluctuations).

2.3.2. Sodium-ion battery

Lithium-ion and sodium-ion batteries, it should be noted, operate in a fairly close manner, for they both utilize an insertion/extraction mechanism. In the case of sodium-ion devices, the operational sequence consists of sodium ions shuttling between the cathode and anode to accomplish charge and discharge cycles. A prominent benefit of sodium-ion technology is the ample availability of sodium

DOI: 10.54254/2755-2721/2026.35393

elements on earth, which helps to curtail its manufacturing expenses. The lithium-ion variety, although analogous in working principle, proves more amenable to industrial production. Additionally, sodium-ion cells exhibit favorable low-temperature performance and a high degree of safety. Such combined advantages, consequently, render sodium-ion batteries more advantageous for deployment in large-scale storage contexts, for instance, wind power and photovoltaic storage installations [12].

2.3.3. Redox flow battery

An innovative electrochemical energy storage device called a Redox Flow Battery stores energy in an electrolyte solution. Essentially, two distinct redox electrolytes housed in separate tanks are pumped into a reactor where they undergo redox reactions at electrodes. Its fundamental structure comprises electrolytes, electrode stacks, storage tanks, and circulation pumps. During charging, it stores chemical energy; during discharging, it releases electrons. Key advantages include the ability to simply increase electrolyte volume when capacity expansion is required, complete decoupling of capacity from power output, exceptionally long cycle life, high safety, and suitability for energy storage applications in smart grids as well as wind and solar energy systems [13].

2.3.4. Lead-acid battery

The basic structure of lead-acid battery includes electrolyte (sulfuric acid solution) storage tank, positive pole (lead oxide), negative pole (sponge lead), partition and fluid collector. During the discharge process, the total reaction equation is such as equation (1), and the negative and positive reaction equations are such as equation (2) and equation (3) [14].

$$Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O \tag{1}$$

$$Pb \rightarrow PbSO_4 + 2e^- \tag{2}$$

$$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O \tag{3}$$

Lead-acid batteries have low production costs, strong power transmission ability and high recoverability rate, which is suitable for uninterruptible power supply systems and power grid peak adjustment scenarios.

2.4. Hydrogen energy storage

Hydrogen energy storage refers to the two-way conversion process based on electricity-hydrogen-electricity: the process of converting electrical energy into hydrogen energy is usually achieved through electrolysis of water, while the conversion of hydrogen energy into electrical energy mainly relies on fuel cells or through hydrogen combustion to drive the power generation system.. In the case of excess electricity, electricity promotes the electrolysis of water to produce hydrogen and store it. At the peak of electricity consumption, hydrogen is generated into the power grid through

DOI: 10.54254/2755-2721/2026.35393

fuel cells or hydrogen combustion. Hydrogen energy storage has the absolute advantage of 0 emissions, which is very environmentally friendly, and its long energy storage cycle and high energy density are often applied to wind and light power generation systems. However, its round-trip efficiency is low, the cost is high, and there are safety problems such as hydrogen leakage, so it has limitations in application [15].

3. Energy storage-integrated new energy smart grid architecture

Three layers make up the globally recognized smart grid architecture: the perception layer, the network layer, and the application layer. However, the new energy smart grid architecture with energy storage introduced in this article is five layers, which mainly includes the power generation layer, the energy storage layer, the power transmission and distribution layer, the communication and control layer, and the user application layer. Some intelligent microgrids will ignore the transmission and distribution layer, so that they only have the other four-layer structures.

The power generation layer mainly uses new energy to generate electricity, such as photovoltaic power generation, wind power generation, etc. Its main function is to provide the basic electricity of the whole smart grid system, so that the system can start and support the new energy grid connection.

The energy storage layer refers to the application of energy storage technology to store electricity when the whole system has excess electricity, and to release electricity during high electricity consumption. It is necessary to choose the best energy storage technology according to the applicable scenario. The role of the energy storage layer is to realize the time transfer of energy, reduce peaks and fill valleys, improve the stability of smart grids, and control the fluctuations of new energy power generation.

The power transmission and distribution layer is the central hub for power transmission, mainly including intelligent distribution grids, high-voltage transmission grids and two-way power flow systems. The power transmission and distribution king network connects new energy power generation and users, and supports distributed energy access.

The communication and control layer mainly includes six parts: data acquisition, data transmission, data analysis and forecasting, control scheme generation, execution control scheme and feedback. Data collection can be realized through smart meter, PMU(Phasor Measurement Unit), etc., mainly to collect current, voltage, frequency, energy storage data, etc. The collected data can be transmitted through optical fiber, PLC, 4G/5G. After the data is transmitted to the control center, data analysis and prediction begin, mainly analyzing and predicting new energy power generation data, load, energy storage data, etc. After the data analysis and prediction results are generated, the system will calculate the energy storage power, charging/discharge situation according to the data, and finally generate the plan to be implemented. After the completion of the above process, the control system will issue execution instructions to finally realize the operation of the intelligent power grid system. After a period of system operation, the data is collected again for feedback to form a closed loop.

The user application layer is the last layer of the new energy smart grid, which mainly focuses on the use of users, such as electric vehicles, smart home networks, etc.

DOI: 10.54254/2755-2721/2026.35393

4. Case study

4.1. A smart grid project case for photovoltaic power generation

Cyprus, an island nation in the eastern Mediterranean, will launch a user-centric smart microgrid charging station in 2025（now running） as part of its isolated grid system. The charging station adopts a rooftop photovoltaic design, its photovoltaic array specification is 60.32kWP, and it is equipped with a battery energy storage system with a battery specification of 100KW/97kWh. It is equipped with a customized cloud-based energy management platform enabling real-time data monitoring and analysis, achieving a self-sufficiency rate of 28.97% and a self-consumption rate of 98.69%. This system belongs to the intelligent microgrid layer architecture model proposed in this paper. Photovoltaic power generation technology is adopted in the power generation layer, and the battery energy storage system is applied in the energy storage layer. The communication and control layer adopts independent customized design, and the user application layer is directly used by users [16].

4.2. Case studies of smart grid projects for wind power generation

The CDV Wind Farm in northeastern Brazil has become a key region for wind power development due to its abundant wind resources. Located in João Câmara, Rio Grande do Norte state, this wind farm project comprises 24 wind turbines each with a capacity of 2.1 MW, totaling an installed capacity of 50.4 MW. The facility is equipped with a battery energy storage system featuring lithium iron phosphate batteries as the cathode material, with a rated power output of 1 MW and a storage capacity of 1.2 MWh. The energy management system monitors real-time data and formulates operational strategies based on feedback. This storage system connects to a 34.5 kV distribution bus via bidirectional converters, ultimately feeding electricity into Brazil's national interconnected grid. For residential use, the wind power generation in João Camara virtually meets the city's entire electricity demand [17].

This study corresponds to the five-layer architecture proposed in this paper, which are reflected in the power generation layer, energy storage layer, power transmission and distribution layer, communication and control layer, and user application layer. Through the analysis of the study, it is evident that following the battery energy storage system is configured and put into operation, the fluctuation of the power when the wind farm is connected to the power grid on the minute scale is significantly weakened, thus effectively reducing the impact on the stability of the power grid. At the same time, in the intelligent power grid architecture, the multi-function integration of the energy storage system is the core way to improve the overall economy of the project, and further reflects the important advantages of energy storage technology in the application of wind power intelligent power grid.

5. Prospects for integrated energy grids and smart grid integration

With the continuous development of intelligent power grid systems towards digitalization, intelligence and greening, the global energy structure has also changed significantly. The traditional power generation system, which was once dominated by non-renewable fossil energy, has exposed its shortcomings, including high energy consumption, large resource consumption, low efficiency, difficult system maintenance, and serious pollution. In recent years, new energy sources such as wind energy and solar energy have been developed and utilized, and have begun to be gradually

DOI: 10.54254/2755-2721/2026.35393

applied to intelligent power grid systems, alleviating the pressure on fossil energy resources and protecting the environment. However, new energy power generation is uncertain and random. The use of a certain new energy alone cannot meet the requirements of continuous and reliable power supply, and may lead to problems such as frequent switching, battery overload and increased impact on the main network. In response to these problems, we can think about integrating different types of energy sources together and then applying them, such as the smart grid system for landscape storage and the intelligent power grid for wind-light-storage integration. These systems help to improve the overall output stability and enhance the system regulation ability.

At the same time, with the acceleration of global energy transformation, the penetration rate of new energy in the market is gradually increasing, which also brings more serious challenges to the safe and stable operation of the power system. With its large-scale data processing, complex pattern recognition and optimization-based decision-making capabilities, artificial intelligence technology provides an important technical path for improving new energy consumption and supporting the development of new power systems with multiple energy integration. However, in practical engineering applications, these technologies still face many challenges, including limited model generalization capabilities, incomplete data governance frameworks, limited computing resources, and a shortage of highly skilled interdisciplinary talents. These factors limit its large-scale deployment and further promotion to a certain extent, so we need to optimize the system and form breakthrough solutions.

6. Conclusion

In conclusion, the large-scale integration of new energy has emerged as a key trend in the development of contemporary power systems due to the ongoing advancement of low-carbon and clean energy systems. However, due to the significant randomness and variability of wind energy and photovoltaic power, their integration inevitably leads to increased scheduling complexity, increased system stability restrictions, and increased demands for the electricity grid's operational capacity. These negative consequences are progressively lessening due to ongoing advancements in energy storage technology, power electronics, and sophisticated management techniques, and it is anticipated that the percentage of new energy in the power system will keep increasing. In order to increase the flexibility and dependability of the system as a whole, future research and engineering practice should focus more on the development of multi-energy collaborative operation systems, reinforce the crucial role of energy storage systems in energy balance and power regulation, and further optimize the complementary mechanisms between new energy sources like solar and wind energy. In addition, the introduction of artificial intelligence technology is reshaping the development path of smart grids. Through machine learning and data-driven methods, the efficiency of system decision-making is significantly improved in the fields of load forecasting, power forecasting and real-time scheduling optimization, thus promoting the transformation of the power system from traditional experience-driven operation to intelligent and adaptive operation mode. However, for practical engineering applications, it is still necessary to carefully solve challenges such as model reliability, data governance quality and computing resource limitations to ensure long-term stable deployment in the power system. In general, with the help of the progress of energy storage technology, multi-energy coordination and optimization and the deep integration of artificial intelligence, the future smart grid is expected to achieve higher safety, economic efficiency and sustainability, laying a solid foundation for the development of new energy systems.

References

[1] Stancu, A., Popescu, C., Panait, M., Rădulescu, I. G., Brezoi, A. G., & Voica, M. C. (2025). Pathways to carbon neutrality: Innovations in climate action and sustainable energy. *Sustainability, 17*(24), 11240. https://doi.org/10.3390/su172411240

[2] Chen, X. J., Ai, L., & Si, J. L. (2026). Status and prospect of China's photovoltaic power development in 2025. *Electric Power, 52*(5), 1-6.

[3] Sun, Y. T., Wei, X. Z., & Chen, T. P. (2022). Technical development of hydropower equipment in China. *China Heavy Equipment*, (4), 7-10+17. https://doi.org/10.14145/j.cnki.51-1702/th.2022.04.004

[4] Su, X. Y., Guo, X. D., Xie, X. Y., Li, H., & Ma, Z. (2026). Analysis of spatiotemporal pattern evolution and emission reduction benefits of China's wind power development. *Acta Scientiae Circumstantiae, 46*(2), 504-519. https://doi.org/10.13671/j.hjkxxb.2025.0405

[5] Rekioua, D. (2023). Energy storage systems for photovoltaic and wind systems: A review. *Energies, 16*(9), 3893. https://doi.org/10.3390/en16093893

[6] Rojas-Flores, S. J., Liza, R., Nazario-Naveda, R., Díaz, F., Delfin-Narciso, D., & Cardenas, M. G. (2026). Sustainability and circular economy perspectives on the integration of hybrid energy systems with mechanical storage: An analysis of its trajectory and progress. *Processes, 14*(4), 623. https://doi.org/10.3390/pr14040623

[7] Burian, O., & Dančová, P. (2023). Compressed air energy storage (CAES) and liquid air energy storage (LAES) technologies—A comparison review of technology possibilities. *Processes, 11*(11), 3061. https://doi.org/10.3390/pr11113061

[8] Xu, K., Guo, Y., Lei, G., & Zhu, J. (2023). A review of flywheel energy storage system technologies. *Energies, 16*(18), 6462. https://doi.org/10.3390/en16186462

[9] Huang, Y. Y., Ru, Y., Shen, Y. L., & Zeng, Z. R. (2021). Characteristics and applications of superconducting magnetic energy storage. *Journal of Physics: Conference Series, 2108*, 012038. https://doi.org/10.1088/1742-6596/2108/1/012038

[10] Sharma, S., & Chand, P. (2023). Supercapacitor and electrochemical techniques: A brief review. *Results in Chemistry, 5*, 100885. https://doi.org/10.1016/j.rechem.2023.100885

[11] Detka, K., & Górecki, K. (2023). Selected technologies of electrochemical energy storage—a review. *Energies, 16*(13), 5034. https://doi.org/10.3390/en16135034

[12] Wu, Y., Shuang, W., Wang, Y., Chen, F., Tang, S., Wu, X. L., Bai, Z., Yang, L., & Zhang, J. (2024). Recent progress in sodium-ion batteries: Advanced materials, reaction mechanisms and energy applications. *Electrochemical Energy Reviews, 7*(1), 17. https://doi.org/10.1007/s41918-024-00215-y

[13] Sun, J., Guo, Z., Pan, L., Fan, X., Wei, L., & Zhao, T. (2023). Redox flow batteries and their stack-scale flow fields. *Carbon Neutrality, 2*(1), 30. https://doi.org/10.1007/s43979-023-00072-6

[14] Vangapally, N., Penki, T. R., Elias, Y., Muduli, S., Maddukuri, S., Luski, S., Aurbach, D., & Martha, S. K. (2023). Lead-acid batteries and lead–carbon hybrid systems: A review. *Journal of Power Sources, 579*, 233312. https://doi.org/10.1016/j.jpowsour.2023.233312

[15] Ge, L., Zhang, B., Huang, W., Li, Y., Hou, L., Xiao, J., Mao, Z., & Li, X. (2024). A review of hydrogen generation, storage, and applications in power system. *Journal of Energy Storage, 75*, 109307. https://doi.org/10.1016/j.est.2023.109307

[16] Livera, A., Herodotou, P., Marangis, D., Makrides, G., & Georghiou, G. E. (2026). Case study of a photovoltaic (PV)-powered, battery-integrated system in Cyprus. *Energies, 19*(10), 2402. https://doi.org/10.3390/en19102402

[17] Pontes, L., Costa, T., Souza, A., Dantas, N., Vasconcelos, A., Rissi, G., Dias, R., Mohamed, M. A., Siano, P., & Marinho, M. (2023). Operational data analysis of a battery energy storage system to support wind energy generation. *Energies, 16*(3), 1468. https://doi.org/10.3390/en16031468