Energy Proceedings
Vol 54, 2025
ISSN 2004-2965

Research on New Energy Storage Policy and Future Development in China Based on the Case Study of Shenzhen

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ABSTRACT

Under the background of "carbon neutral", the new energy storage represented by electrochemical energy storage is developing rapidly. Shenzhen, as an electrochemical advantageous industrial city of China, has a strong industrial foundation and technical independence. This paper takes Shenzhen as an example, through technical analysis, policy analysis and patent analysis, the status quo and challenges and opportunities of Shenzhen energy storage systems are deeply analyzed to provide a reference for the future development of new energy storage system in China.

Keywords: new energy; new energy storage system; electrochemical energy storage; energy storage technology

1. INTRODUCTION

With the deepening of global energy transformation, energy storage technology has gradually become an important part of modern energy system. In 2023, the total installed capacity of the world's pumped storage capacity dropped to 67%; About 47.1GW/103.5GWh of new energy storage capacity will be added, up 130% year on year; The installed capacity of new energy storage systems in China was 23.2GW/51.13GWh, a year-on-year increase of 224%. By May 2024, China's cumulative installed capacity of new energy storage has reached 38GWh, ranking first in the world.

In the context of carbon neutrality, new energy storage support policies at home and abroad have been further enhanced. The United States Clean Energy Demonstration Office (OCED) plans to release the funding opportunity announcement of "energy storage pilot demonstration project" in July 2024. The European Union in 2021-2022 through the "Fit for 55" plan and REPowerEU plan, it is clear that by 2030 the proportion of renewable energy generation increased to 45%. Australia AEMO's integrated system plan proposed a nine-fold increase in utility-scale variable renewable energy capacity by 2050. Japan's Tokyo Metropolitan government released support for the installation of photovoltaic power generation equipment and batteries in 2024. International experience has also inspired China's energy storage policy and market mechanism. In the process of promoting the development of new energy storage, China not only pays attention to technology research and development and market mechanism construction, but also emphasizes solving the problem of energy poverty and promoting the optimization of regional energy structure. Due to the differences in resource endowment, economic development level and energy demand in different regions, its energy storage policies also show diversity. Domestic with the emergence of a focus on the national and provincial level energy storage policy research.

The related studies [1-11] mostly focus on the comparison and analysis of energy storage development and top-level design at the national and provincial levels, and highlight the relative lack of energy storage research in cities based on characteristics. In order to make up for this shortage, this paper, based on Shenzhen, a typical electrochemical energy storage advanced city, explores the challenges and opportunities of Guangdong Province and China in the electrochemical and energy storage industry, and provides references and suggestions for provinces in China's future layout of energy storage industry and policy formulation according to local characteristics.

This is a paper for the 16th International Conference on Applied Energy (ICAE2024), Sep. 1-5, 2024, Niigata, Japan.

2. CURRENT SITUATION OF ENERGY STORAGE INDUSTRY

2.1 Status of global energy storage industry

The theme of global carbon neutrality supports long-term energy storage demand, and new energy storage has broad prospects. It is expected that by 2030, the total global energy storage market will reach 1,164 GWH, with a market size of over one trillion yuan. According to the incomplete statistics of the Global Energy Storage Data Project (www.esresearch.com.cn) of Zhongguancun Energy Storage Industry Technology Alliance (CNESA), by the end of 2023, the cumulative installed capacity of the world's energy storage projects has been 289.2GW, with an annual growth rate of 21.9%. The cumulative installed capacity of new energy storage projects has reached 91.3GW, nearly double that of the same period in 2022.

From the perspective of technology route, the global total installed capacity of pumped storage dropped by 12.3pct to 67%, below 70% for the first time. In contrast, the new energy storage technology route has diversified characteristics. Electrochemical energy storage, molten salt heat storage, compressed air energy storage and flywheel energy storage are the top four types of new energy storage technologies in the world. Among them, lithium-ion batteries continue to grow rapidly, with an annual growth rate of more than 100%, occupying an absolute dominant position in new energy storage. With the development of technology and the maturity of the market, the cost of lithium battery energy storage has room for continuous decline.

2.2 Development history and status quo of China's energy storage industry

The development history of China's energy storage industry is shown in Figure 1, which can be roughly divided into four stages.

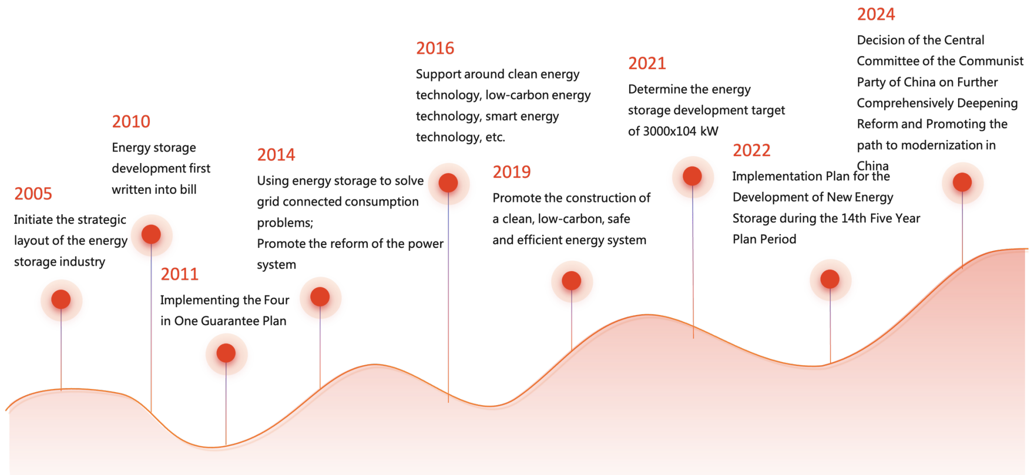

Fig. 1 Energy storge technology History in China

Before 2016: Initial development stage

Development characteristics: mainly used for power system "peak cutting and valley filling", pumped storage accounted for the largest proportion, good economy.

Market performance: As of the end of 2015, China's cumulative installed capacity of energy storage 23.5GW, of which 23.4GW of pumped storage capacity.

2016-2020: Accelerated development phase

Development characteristics: electrochemical energy storage is gradually increasing, mainly used for new energy consumption and power grid peak load, but there are still limitations such as high cost and short life.

Market performance: By the end of 2020, China's cumulative installed capacity of pumped storage capacity is 32GW, and the cumulative installed capacity of electrochemical energy storage is 3.3GW.

2021-2030: high-speed upgrading stage

Development characteristics: grid-connected consumption of new energy on the power generation side, peak frequency regulation on the power grid side, and peak-valley spread arbitrage on the power consumption side jointly stimulate the energy storage demand, the cost of electrochemical energy storage decreases, the cycle life increases, and the economy becomes apparent.

Market performance: By the end of 2023, new energy storage has been put into operation more than 30GWh, and is expected to achieve comprehensive market-oriented development during the "15th Five-Year Plan" period.

2031-2060: mature development stage

Development characteristics: wind power becomes the main power generation energy, energy storage becomes the main power supply in the low period of new energy, and provides power guarantee for the peak load of the power system.

Market trend: energy storage battery technology is maturing, sodium-ion batteries, flow batteries, compressed air, gravity energy storage, flywheel energy storage and other new technology routes are gradually maturing, the commercialization of the power market has become higher, and the economic benefits have become better.

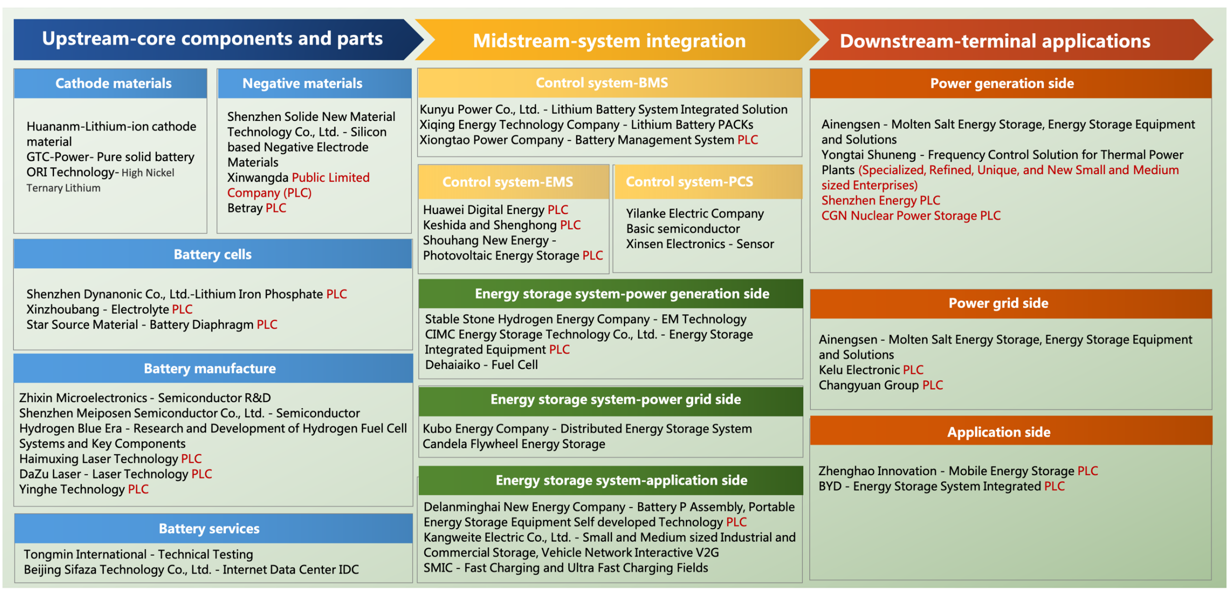

Fig. 2 Distribution Map of New Energy Storage Industry in Shenzhen

3. RESEARCH ON THE CURRENT STATUS AND LIMITATIONS OF ENERGY STORAGE DEVELOPMENT IN SHENZHEN

By the end of 2022, electrochemical energy storage constituted 19.3% of the global energy storage market. It is expected that the global installed capacity of electrochemical energy storage will increase from 69.0GWh in 2022 to 652.4GWh in 2027. Electrochemical energy storage is poised to become the most widely adopted and rapidly developing energy storage technology. China, as the second-largest market, accounts for 26.9% of the global newly installed capacity. In 2023, the output value of the electrochemical energy storage industry in Shenzhen will increase by 16.1%, exceeding 300 billion yuan. The installed capacity of power battery enterprises is nearly 80 GWh, accounting for about 27% of the national market. Shenzhen has taken a leading position in the electrochemical energy storage industry in China, and its industrial advantages are beginning to emerge globally. The research on the energy storage industry and policies in Shenzhen will provide strong reference value for the future technological layout and policy customization of electrochemistry and the entire energy storage industry nationwide.

3.1 Current situation of energy storage industry in Shenzhen

The electrochemical energy storage industry chain is segmented into upstream materials, midstream core component manufacturing, and downstream applications. The upstream mainly refers to battery raw materials which including positive electrode materials, negative electrode materials, electrolytes, separators, and structural components. The midstream mainly involves the system integration and manufacturing. For a complete energy storage system, it generally includes four major components: battery pack, battery management system (BMS), energy management system (EMS), and energy storage converter (PCS). The downstream mainly provides operation and maintenance services for different application scenarios.

Among them, Shenzhen has comprehensively laid out key links such as electrochemical energy storage battery materials, precision structural components, current collectors, BMS, EMS, PCS, etc. Key enterprises and market status are shown in Figure 2.

3.2 Analysis of energy storage patents in Shenzhen

With 49,000 patent applications in the electrochemical energy storage industry, Shenzhen ranks first among Chinese cities, leading significantly in total volume. Among them, there are 22000 invention patent applications and 27400 utility model patents.

From the perspective of industrial structure positioning, Shenzhen's patent application volume in the fields of lithium-ion batteries and battery management system technology is at the leading level in the country, and its patent application volume in the field of energy storage inverter technology ranks second among domestic cities. Therefore, based on the analysis of Shenzhen's technological development status and trends in the above fields, it can provide reference for the future development direction of energy storage in the country.

Table 2: Patent Applications for First Level Electrochemical Energy Storage Technology in Various Cities

Techno-logy	Shenzhen		Beijing	Shanghai	Suzhou
	Patents application amount	Nation-wide ranking	Patents application amount	Patents application amount	Patents application amount
lithium-ion battery	15662	1	8066	6657	6586
sodium-ion battery	523	3	631	636	120
Flow battery	167	7	656	348	14
Lead acid battery	549	5	511	432	140
BMS	4040	1	3987	2732	769
EMS	363	5	1280	696	45
PCS	415	2	444	238	40

From the perspective of national and technological development analysis, Shenzhen has 191 invention patents for the layout of lithium iron phosphate cathode materials, ranking first among all cities in China. The composite growth rate of lithium iron phosphate cathode materials in Shenzhen over the past five years is 11.9%, indicating Shenzhen's absolute advantage in the field of lithium-ion phosphate batteries and its optimistic outlook on the market prospects of lithium iron phosphate batteries. Shenzhen has 267 invention patents for the layout of ternary positive electrode materials, ranking second among all cities in China, only behind Beijing.

Shenzhen has a relatively low number of invention patent applications for lithium cobalt oxide cathode materials, with only 67 applications, ranking third among all cities in China. The composite growth rate of lithium cobalt oxide cathode materials and lithium manganese oxide cathode materials in Shenzhen in the past five years is negative, indicating that Shenzhen's research and development enthusiasm in these two technological branches is not high.

Shenzhen ranks first among domestic cities in terms of the number of invention patent applications for lithium-ion battery negative electrode materials. Especially Shenzhen has the highest number of invention patent applications for carbon based negative electrode materials, silicon-based, and tin based technology branches among domestic cities. It is worth noting that the composite growth rate of metal lithium negative electrodes in Shenzhen in the past five years is 27.2%, indicating that research of lithium metal negative electrodes in Shenzhen is a hotspot in recent years.

Shenzhen ranks first among domestic cities in terms of the number of invention patents in the lithium-ion battery cell, battery module, and battery pack technology branches. In recent years, research heat in the battery cell and battery pack technology branches has been relatively high, while the heat in the battery module technology branch is relatively low.

3.3 Shenzhen Energy Storage Policy

As one of the earliest cities in China to develop the new energy industry, Shenzhen has launched a series of policies from fiscal stagnation, policy incentives, project construction to investment promotion. “Notice from the Shenzhen Development and Reform Commission on Organizing and Implementing the First Batch of Support Plans for Shenzhen's Green and Low Carbon Industries” was first launched in 2019 to provide key support for Key support for industries like efficient energy storage and renewable energy. During the next few years the government gradually clarified the significance of developing electrochemical energy storage and brought up “Several Measures to Support the Accelerated Development of Electrochemical Energy Storage Industry in Shenzhen” in 2023. Shenzhen Hydrogen Energy Industry Innovation and Development Action Plan (2024-2025) implies Shenzhen’s further movement towards the comprehensive layout of energy storage industry.

3.4 Inspiration for the Development of Shenzhen's Energy Storage Industry

The industrial sector requires completion, and several technologies remain underdeveloped. Currently, Shenzhen has a leading advantage in energy storage lithium batteries, but its layout in the fields of positive electrode materials, negative electrode materials, electrolytes, raw materials for all vanadium flow batteries, and battery manufacturing is limited.

The enthusiasm on the application side requires enhancement. From the perspective of application scenarios, power supply, power grid, and user side are widely used, but the overall willingness of industrial and commercial energy storage is not high. In the future Shenzhen still need to do a good job in policy promotion from the application end.

The guarantee of essential factors needs to be strengthened. Energy storage manufacturing has space requirements for factory buildings, and customized factory buildings have deficiencies in industrial space.

Hidden risks of losing small and medium-sized potential enterprises. The innovation atmosphere in Shenzhen also brings strong competition. The policy support after investment attraction in Shenzhen is insufficient compared with other places like Yangtze River Delta region.

4. SUGGESTIONS FOR THE FUTURE DEVELOPMENT OF NEW ENERGY STORAGE SYSTEMS NATIONWIDE

4.1 The future development direction of new energy storage technologies

At present, there are some segmented structural opportunities for the development of the new energy storage industry. The power electronic components field represented by PCS, BMS, and EMS in the upstream is still a potential track; New material technologies such as new battery materials, photovoltaic materials, and third-generation semiconductors are in the import stage and have growth potential; New battery technologies represented by sodium-ion batteries, flow batteries, solid-state batteries, etc. are gradually emerging; The bidding for large-scale storage has continued to grow year-on-year and is thriving.

4.2 Strengthen top-level design and policy guidance

Focusing on key factors such as safety, reliability, comprehensive efficiency, lifespan, and cost, strengthening top-level planning and design, researching and formulating national level development strategies for the new energy storage industry, preparing special development plans, clarifying industry development goals, breakthrough directions, and key tasks.

4.3 Building an effective system for technological innovation and technological reserves

Integrate technological innovation resources, strengthen the innovation of new energy storage basic technologies, focus on the overall goal of low cost, long life, high safety, and high efficiency salt water resources into the key direction of technological innovation, promote the high-quality development of lithium and other raw material industries.

4.4 Establish safety and quality standards and testing certification system as soon as possible

Establish a standard system that is in line with international standards, covering various application links such as new energy storage planning and design, equipment and testing construction and acceptance, grid connection and testing, operation and maintenance, hierarchical utilization and recycling, and improve the admission and evaluation standards for new energy storage projects.

5. CONCLUSION

Taking Shenzhen as an example, this article conducts an in-depth analysis of the current situation, challenges, and opportunities of energy storage in Shenzhen through technical analysis, policy analysis, and patent analysis. The research indicates significant structural opportunities within various segments of the new energy storage industry. This article also puts forward policy recommendations on strengthening top-level design and policy guidance like building an effective system for scientific and technological innovation and reserves, establishing safety and quality standards and certification systems as soon as possible, and expanding overseas markets.

ACKNOWLEDGEMENT

This article is the result of the key research base of humanities and social sciences in Shenzhen. This study was supported by the Special fund support for basic scientific research business expenses of central universities (project support number: HITHSS.202224), Guangdong Provincial Philosophy and Social Science Planning Project (GD23XGL088), Shenzhen Science and Technology Plan Project: KCXST20221021111405012, and Shenzhen Colleges and Universities Stable Support Planning Project (GXWD20231129110222001). We would like to thank the anonymous reviewers for their invaluable comments and suggestions.

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