Confidential

Independent Market Research on Global and China Energy Storage, Telecom and Data Center Energy Storage Industry

For

双登集团 SHUANGDENG GROUP

August, 2025

Signature _____

Date August 18, 2025

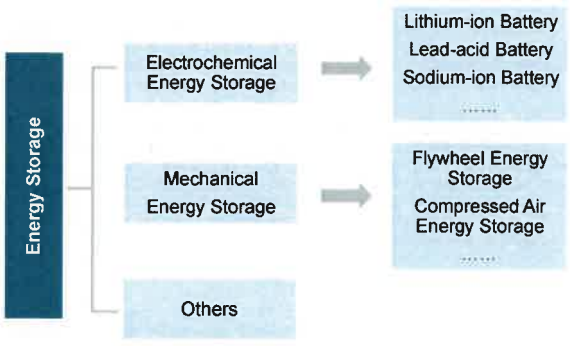
Agenda

Overview of Global and China Energy Storage Market

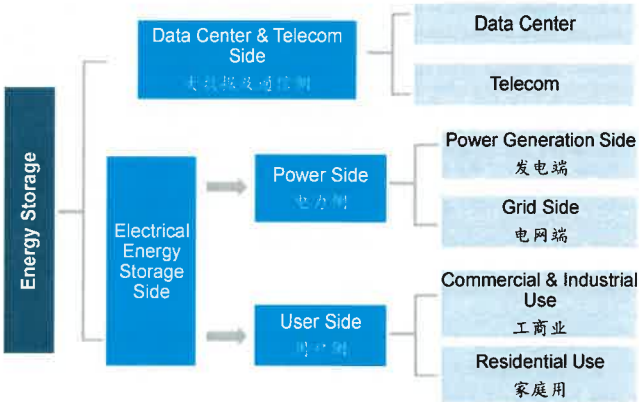
Definition and Classification of Energy Storage

- Energy storage refers to the storage of electric energy, encompassing technologies and measures that use chemical or physical methods to store electricity and release it when needed.
- Energy storage technologies mainly encompass electrochemical and mechanical energy storage technologies. Electrochemical energy storage technologies can be further categorized into lithium-ion battery, lead-acid battery, sodium-ion battery, and other types. Mechanical energy storage technologies can be further divided into flywheel energy storage and compressed air energy storage. Energy storage technologies have broad applications in telecom and data center side, as well as in the electrical side, which is further divided into the power side and user side.
- In 2024, the market size of the global energy storage market by added installed capacity reached approximately 268.3 GWh. Electrochemical energy storage technologies such as lithium-ion batteries, lead-acid batteries, and sodium-ion batteries, dominate the market by occupying over 99% of the energy storage market share by added installed capacity.
- Different characteristics align lithium-ion and lead-acid batteries with distinct downstream market segments in the energy storage market. While lead-acid batteries remain a safe, reliable and cost-effective choice for traditional applications, the performance characteristics of lithium-ion batteries are driving their adoption in more diversified scenarios.
- Differing requirements of core customers in telecom base stations and data centers drive the distinct usage and applications of lithium-ion and lead-acid batteries, as each technology aligns with specific performance characteristics suited to their needs. Lead-acid batteries, with high safety level and mature recycling value chain, dominate traditional applications like emergency backup power. Meanwhile, lithium-ion batteries, with their advantages in energy density, life cycle, and adaptability, are increasingly being adopted for high energy consuming base stations and evolving data center energy needs, especially for sustainable electricity supply.

Classification of Energy Storage by Technology



Classification of Energy Storage by Application

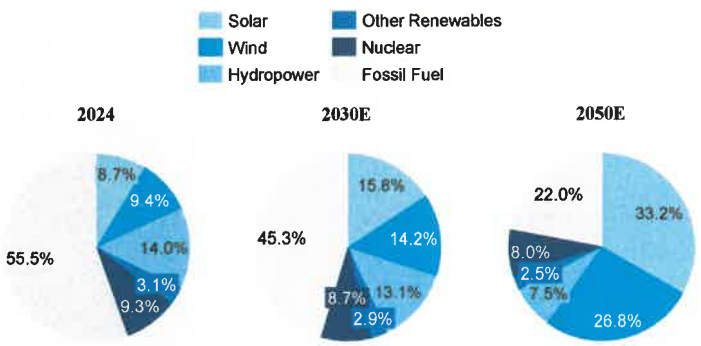


Source: China Energy Storage Alliance(CNESA), Frost & Sullivan

Overview of Global and China Energy Storage Market

Proportion of Renewable Energy Generation

Proportion of Renewable Energy among the Global Power Generation Structure, 2024, 2030E & 2050E



- Under the global coalition for carbon neutrality, reducing greenhouse gas emissions and promoting the development of renewable energy has become an international consensus. At the same time, geopolitical tensions and fluctuations in fossil fuel prices have also prompted countries to seek more stable and sustainable energy supplies. With continuous technological advancements, the cost of renewable energy has been steadily decreasing in recent years, further driving market demand for renewable energy. In 2024, the proportion of renewable energy power generation surpassed 35% of the global total power generation for the first time. Looking ahead, with the accelerating of energy structure transformation to solar and wind energy and continuous development of renewable energy technologies, it is projected that the market share of renewable energy power generation among the global power generation structure will reach over 45% by 2030 and approximately 70% by 2050, respectively.

Source: International Energy Agency (IEA), Frost & Sullivan

Overview of Global and China Energy Storage Market

Comparison between Lead-acid Battery and Lithium-ion Battery

Lead-acid Battery

- Low cost
- Good reliability
- High surge currents
- Highly recyclable
- Good temperature tolerance
- Relatively low energy density

VS

Lithium-ion Battery

- High energy density
- Fast charging
- Low self-discharge rate
- Safety concern
- Relatively high cost
- Sensitive to environmental conditions

Major Applications of Lead-acid Battery

- **Automotive starting battery:** Lead-acid batteries are widely used in the automotive field as starting batteries, providing sufficient power to start the engine. In this application scenario, lead-acid batteries have relatively low costs, as well as good reliability and durability, making them one of the mainstream choices in the automotive industry.
- **Telecom base station energy storage:** Telecom base stations require a stable power supply to ensure the continuous operation of communication networks. Lead-acid batteries are widely used in backup power systems for telecom base stations to store energy to cope with power outages or emergencies. In this scenario, lead-acid batteries can provide reliable backup power, ensuring that communication networks remain uninterrupted.
- **Data center energy storage:** Data centers are collections of large-scale servers and network equipment that require a stable power supply to ensure the continuity of data processing and storage. Lead-acid batteries are utilized as backup power sources in data centers to address grid failures or emergencies. They are often combined with other energy storage technologies such as diesel generators to form comprehensive backup power systems, safeguarding the operation of data centers against power fluctuations.

Applications of Lithium-ion Battery

- **Mobile device:** Lithium-ion batteries are widely used in mobile devices such as smartphones, tablets, and laptops. Due to their high energy density and lightweight characteristics, lithium-ion batteries can provide long battery life, making them the preferred battery type for these mobile devices.
- **Electric vehicle:** As the demand for clean energy and reducing carbon emissions increases, lithium-ion batteries are becoming increasingly common as the power source for electric vehicles. They can provide sufficient power and range, while also having relatively short charging times, meeting the needs of the electric vehicle market.
- **Energy storage of the power system:** Lithium-ion battery energy storage systems play a crucial role in various scenarios, including the power grid, commercial and industrial applications, and residential settings. For energy storage of power grid, lithium-ion batteries are widely used to store surplus electricity from renewable sources and release power during peak demand periods to balance grid loads. In commercial and industrial sectors, lithium-ion battery are utilized to smooth load peaks and valleys, and reduce energy costs.

Irreplaceability of Lead-acid Battery

Lead-acid batteries are widely used in automotive starting battery, base station and data center energy storage due to its relatively lower cost, good safely and good temperature tolerance under varying environmental conditions.

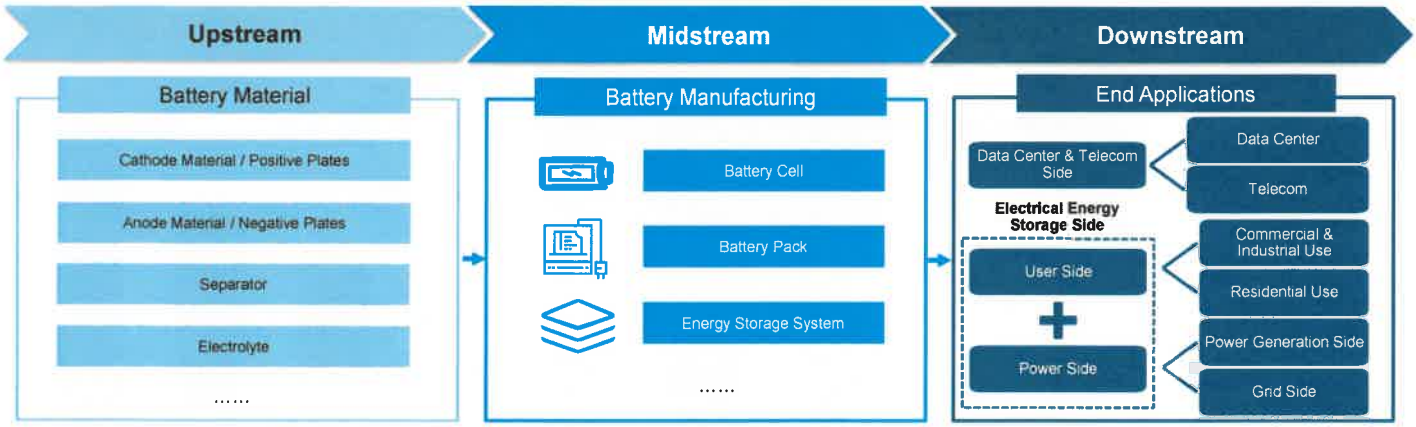
Irreplaceability of Lithium-ion Battery

Lithium-ion batteries are widely used in consumer electronic devices, new energy vehicles, and energy storage systems due to their high energy density, faster charging speeds and low self-discharge rate.

Source: Frost & Sullivan

Overview of Global and China Energy Storage Market

Value Chain Analysis



- The upstream of the energy storage industry primarily focuses on lithium-ion and lead-acid battery raw materials, including cathode material/positive plates, anode material/negative plates, separator, electrolyte, and other key elements. These materials significantly influence the overall quality and performance of batteries.
- The midstream of the energy storage industry mainly involves battery cells, battery packs, and energy storage systems. Battery manufacturing is a multi-step process that includes electrode manufacturing, cell assembly, and training, aging and testing. Battery cells are assembled through notching, stacking and pouch assembly. Battery packs are assembled from these cells, incorporating additional components for safety and performance. Energy storage systems involve developing backend systems to precisely control and monitor batteries, ultimately integrating these systems with battery packs into final products.
- The downstream segment covers end applications, including the data center, telecom, and electrical energy storage. For data centers and telecom applications, these new information infrastructures are characterized by high power consumption and stable power supply, thus boosting energy storage demand. Among the electrical energy storage side, commercial, industrial, and residential use can effectively achieve power supply and demand balance and reduce the load pressure from the power side.

Source: Frost & Sullivan

Overview of Global and China Energy Storage Market

Development History of Global and China Energy Storage Industry

- Pumped storage technology is already mature, with related projects having been launched a long time ago. In 2012, China's electrochemical energy storage and power conversion system industry started mainly with demonstration projects. With the successful exploration of demonstration projects, the maturity of energy storage technology, the reduction of energy storage system cost, and the supportive subsidies for energy storage projects, the market of electrochemical energy storage and power conversion system is gradually maturing.

Global

Early Stage	Developing Stage	Expansion Stage
Early Stage, 1800-2012 • The first battery—called Volta's cell—was developed in 1800. • The first pumped-storage hydroelectricity was built in 1882 in Switzerland. • The U.S. first large-scale energy storage was the Rocky River Pumped Storage plant in 1929, on the Housatonic River in Connecticut.	**Developing Stage, 2013-2017** • In 2015, Europe initiated the Paris Agreement to reduce global greenhouse gas emissions. • At the end of 2016, the Australian Energy Storage Project has installed more than 1.5 million rooftop solar systems, with an installed capacity of more than 5.7 GW.	**Expansion Stage, 2018-Present** • In 2019, the EU took the lead in addressing climate change by adopting a carbon neutral 2050 plan. At a EU summit in 2020, leaders of the 27 member states agreed a target to cut greenhouse gas emissions by 55% by 2030 compared with 1990 levels. • In 2020, the UK cancelled the capacity limit of energy storage projects, allowing the deployment of energy storage projects above 50MW and 350MW in England and Wales respectively, officially opening the prelude of large-scale energy storage project construction. • In 2020, The U.S. has achieved a breakthrough in the scale of new operations in the utility-scale market, doubling that of 2019. • In 2021, the US and China overtake South Korea as the two largest energy storage markets.

China

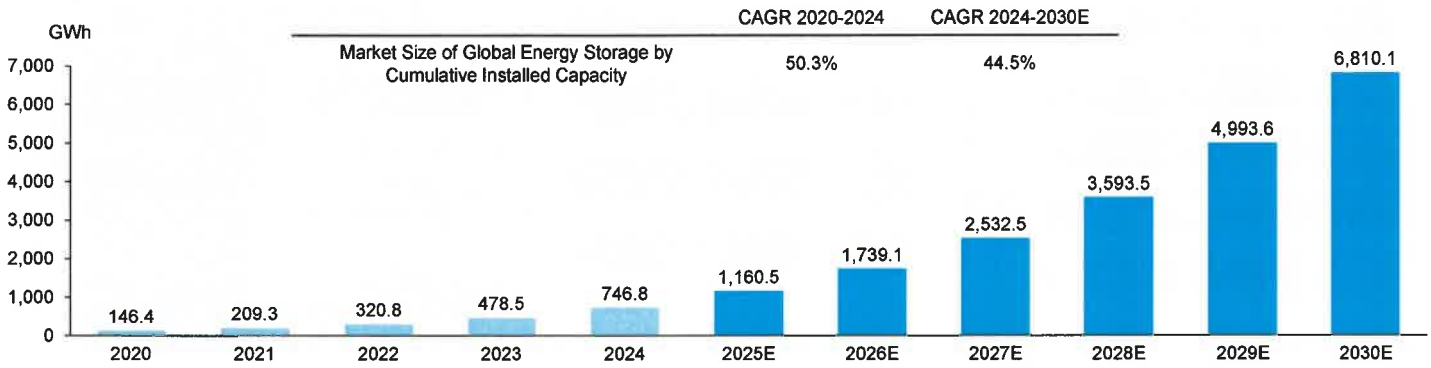
Early Stage	Developing Stage	Expansion Stage
Early Stage, 1960-2012 • China's first pumped-storage hydroelectricity - Gangnan was built in 1968 . • In 2011, China's first electrochemical energy storage industrialization project "Zhangbei Scenery Storage Integration"（张北风光储一体化） was completed. • In 2011, Energy storage was included in the '12th Five-Year Plan' outline." • In 2012, demand for power conversion system in China initially appeared.	**Developing Stage, 2013-2017** • In 2014, "Strategic energy action plan (2014-2020)" was published, highlighting the utilization of energy storage as a solution to enhance the grid-connected consumption of renewable energy sources. • In 2017, " Guiding opinions on promoting energy storage technology and industry development " is the first guiding policy in China for the large-scale development of energy storage technology and its applications.	**Expansion Stage, 2018-Present** • With the decrease of energy storage system cost and LCOE, the economy of energy storage system has improved, and the scale of energy storage system has begun to take off. • In 2021, The National Development and Reform Commission issued the Notice on Further Improving the TOU Pricing Mechanism (关于进一步改善分时电价机制的通知), which further increase the price difference between peak and valley electricity prices and improved the economic benefits of energy storage system.

Source: Frost & Sullivan

Overview of Global and China Energy Storage Market

Market Size of Global Energy Storage Industry by Cumulative Installed Capacity

Market Size of Global Energy Storage Industry by Cumulative Installed Capacity, 2020-2030E



- Energy storage can be combined with new energy power generation such as photovoltaics and wind power to alleviate the problem of poor stability of renewable energy. At the same time, energy storage can provide auxiliary services such as peak regulation, frequency regulation, AGC, and black start to ensure the security of the power grid. In addition, energy storage can play the role of peak shaving and valley filling, saving electricity costs for residential, industrial and commercial users. As the importance of energy storage is gradually recognized by the market, more and more companies have begun to enter the industry. From 2020 to 2024, the market size of global energy storage by cumulative installed capacity increased from 146.4 GWh to 746.8 GWh, representing a rapid CAGR of 50.3%.
- Looking forward, with the large-scale promotion of renewable energy such as solar energy and wind power, the energy storage industry will usher huge developing potential. It is expected that the the market size of global energy storage by cumulative installed capacity will continue to keep a fast growth, increasing from 746.8 GWh in 2024 to 6,810.1 GWh in 2030 at a CAGR of approximately 44.5%.

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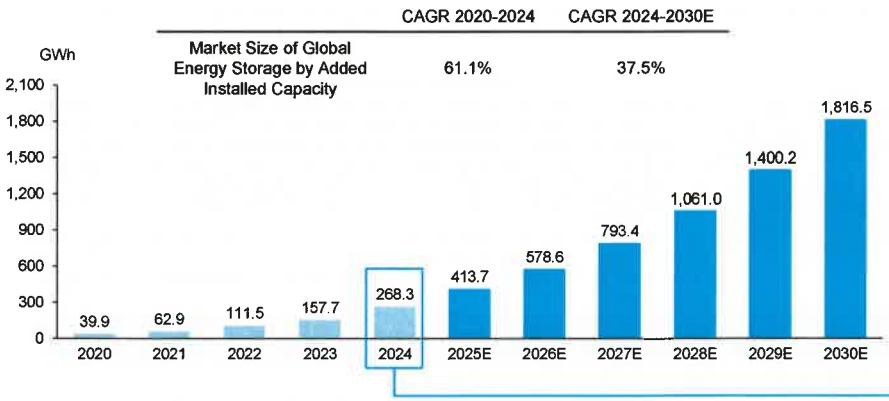
Source: China Energy Storage Alliance (CNESA), Frost & Sullivan

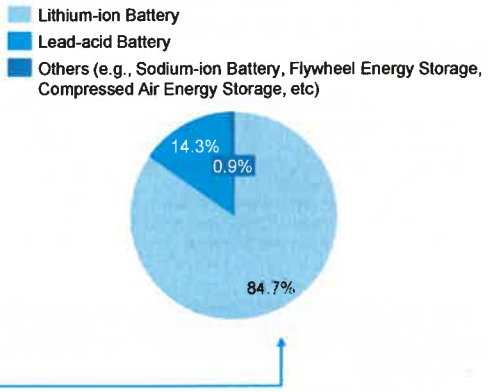
Overview of Global and China Energy Storage Market

Market Size of Global Energy Storage by Added Installed Capacity

Market Size of Global Energy Storage by Added Installed Capacity, 2020-2030E



Breakdown of Energy Storage Technologies by Added Installed Capacity, 2024



- The market size of global energy storage by added installed capacity increased from 39.9 GWh in 2020 to 268.3 GWh in 2024 at a CAGR of 61.1%. Energy storage plays a key role in many countries' energy strategy by meeting the demands for stability, cost-effectiveness, and environmental sustainability. It strengthens energy self-sufficiency, flexibility, and security, while also contributing to lower electricity costs. As such, driven by the supportive government policies, cost reduction of energy storage batteries, increasing adoption of renewable energy, as well as increasing awareness of energy storage, it is forecasted that the market size of global energy storage by added installed capacity will increase from 268.3 GWh in 2024 to 1,816.5 GWh in 2030, representing a CAGR of 37.5%.
- Supported by the massive downstream demand, mature industrial chain layout and favorable policies, China has solidified its position as the global leader in energy storage installation, boasting an impressive added installed capacity of 161.0 GWh in 2024 which constituted approximately 60.0% of the total added installed capacity worldwide in the same year. Looking ahead to 2030, China is projected to maintain its dominance, accounting for approximately 64.0% of the total added installed capacity of energy storage globally.
- In the realm of energy storage technologies, lithium-ion batteries and lead-acid batteries emerge as the predominant types, collectively representing 99.0% of the total added installed energy storage capacity worldwide in 2024. Of these, lithium-ion batteries notably dominate the landscape, constituting a significant 84.7%, while lead-acid batteries maintain a notable presence, accounting for 14.3%. This dual dominance underscores the pivotal role these technologies play in meeting the burgeoning demand for energy storage solutions across various applications globally.

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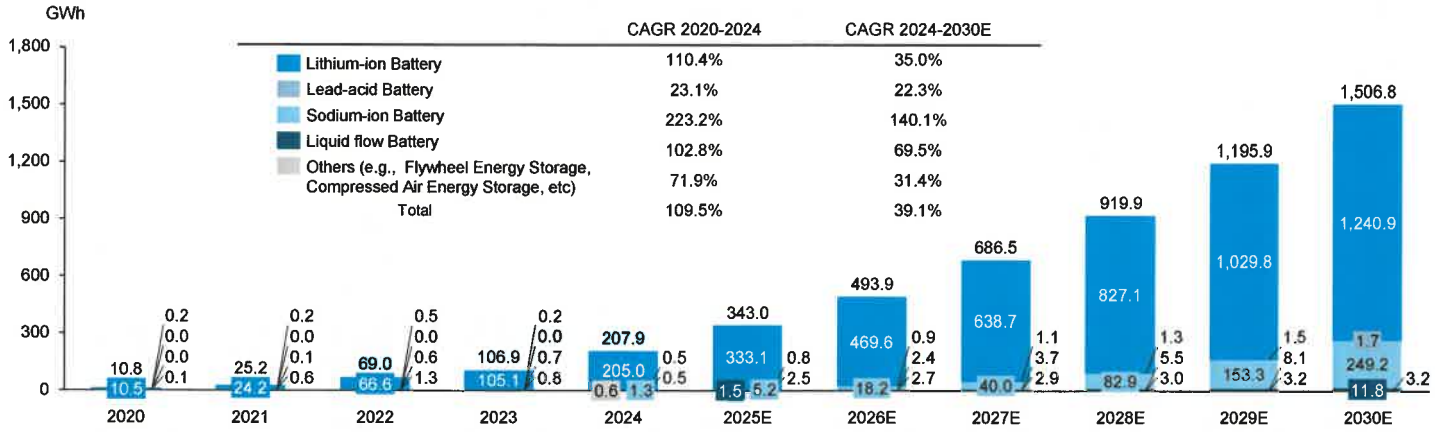
Source: China Energy Storage Alliance (CNESA), Frost & Sullivan

Overview of Global and China Energy Storage Market

Market Size of Global Electrical Energy Storage Side by Added Installed Capacity

Market Size of Global Electrical Energy Storage Side by Added Installed Capacity, Breakdown of Energy Storage Technologies, 2020-2030E



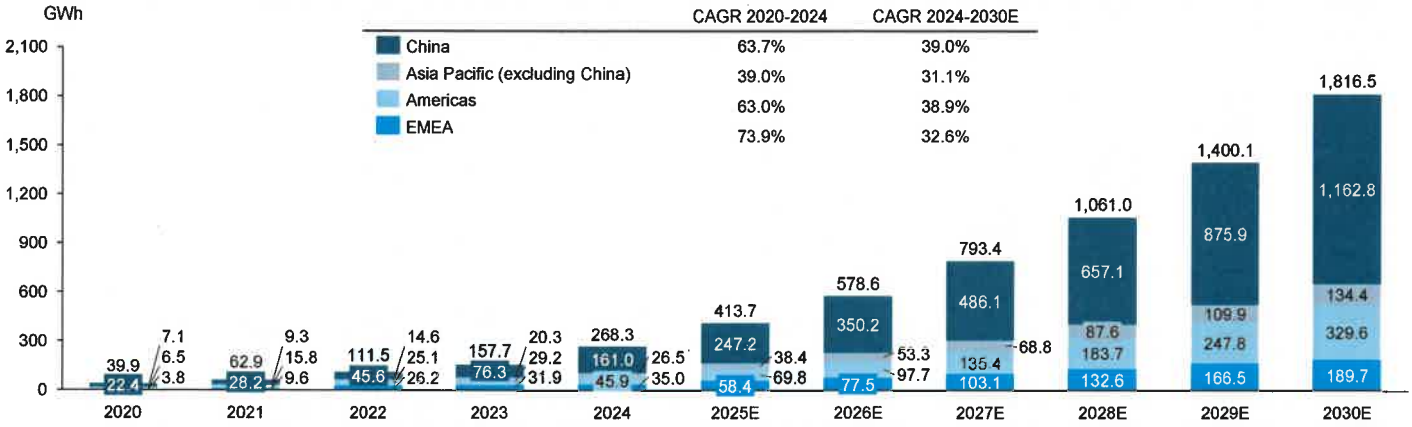
- In line with the development trend of accumulated installed capacity of global energy storage industry, the market size of global electrical energy storage by added installed capacity increased from 10.8 GWh in 2020 to 207.9 GWh in 2024 at a CAGR of 109.5%. It is forecast that the market size of global electrical energy storage by added installed capacity will increase from 207.9 GWh in 2024 to 1,506.8 GWh in 2030, representing a CAGR of 39.1%. In the realm of energy storage technologies, lithium-ion batteries and lead-acid batteries emerge as the predominant types, collectively representing 98.8% of the total added installed power and user side energy storage capacity worldwide in 2024. This dual dominance underscores the pivotal role these technologies play in meeting the burgeoning demand for energy storage solutions across various applications globally.

FROST & SULLIVAN 沙利文 *Source: International Energy Agency (IEA), China Energy Storage Alliance (CNESA), Frost & Sullivan*

Overview of Global and China Energy Storage Market

Market Size of Global Energy Storage by Added Installed Capacity

Market Size of Global Energy Storage in Major Countries and Regions Worldwide by Added Installed Capacity, 2020-2030E



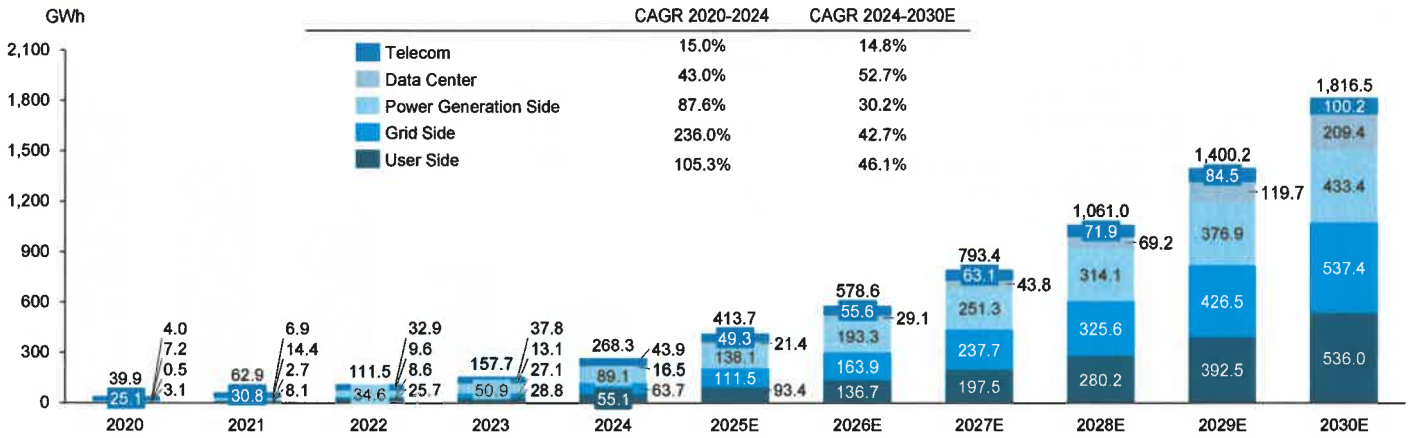
- In 2024, China maintained its dominance in downstream applications of energy storage such as the solar energy, wind energy industry, etc. Support by the massive downstream demand. China solidified its position as the global leader in energy storage installation, boasting an impressive added installed capacity of 161.0 GWh, which constituted approximately 60.0% of the total added installed capacity worldwide. Following closely behind were the Americas and EMEA regions, with installations of 45.9 GWh (17.1%) and 35.0 GWh (13.0%) respectively. Looking ahead to 2030, China is projected to maintain its dominance, expected to account for approximately 64.0% of the total added installed capacity of energy storage globally. The Americas and EMEA regions are anticipated to follow suit, with shares of 18.1% and 10.4% respectively.

FROST & SULLIVAN 沙利文 *Source: China Energy Storage Alliance (CNESA), International Renewable Energy Agency (IRENA), Global Wind Energy Council (GWEC), Frost & Sullivan*

Overview of Global and China Energy Storage Market

Market Size of Global Energy Storage by Added Installed Capacity

Market Size of Global Energy Storage by Added Installed Capacity by Application, 2020-2030E



- The development of energy storage is witnessing a dynamic landscape across various scenarios. In the telecom and data center sectors, there's a growing emphasis on deploying energy storage solutions to ensure reliable power supply and enhance energy efficiency. On the power generation side, energy storage is increasingly integrated with renewable energy sources to address intermittency issues and optimize grid stability. Moreover, on the grid side, energy storage systems are being deployed to improve grid flexibility, manage peak demand, and enhance overall grid resilience. At the user side, energy storage solutions are becoming increasingly popular for residential, commercial and industrial applications, enabling energy independence, load shifting, and cost savings. Overall, the trend across all scenarios indicates a shift towards greater adoption of energy storage technologies to support the transition towards a more sustainable, reliable, and efficient energy system in the world.

FROST & SULLIVAN 沙利文

Source: China Energy Storage Alliance (CNESA), Frost & Sullivan

Overview of Global and China Energy Storage Market

Supply-demand Dynamics of Energy Storage Battery

For IO Use

- The upstream industries of lithium-ion and lead-acid energy storage battery providers involve with the supply of main raw material including lithium carbonate and lead ingots, respectively. Lithium carbonate production is primarily driven by downstream demand, and most companies adopt a make-to-order model. With the surging demand for downstream new energy vehicles and energy storage systems, China's lithium carbonate production volume witnessed an significant increase from 171 thousand tons in 2020 to 379 thousand tons in 2022, primarily driven by robust downstream demand. At the beginning, the growth rate of production capacity is lower than demand, and the supply shortage led to an increase in the price from RMB48.0 thousand per ton in 2020 to over RMB482.4 thousand per ton in 2022. In 2023, China's lithium carbonate production volume further increased to 518 thousand tons, while price decreased to RMB272.3 thousand per ton following with the balance between supply and demand. Furthermore, the growth momentum continued in 2024, with lithium carbonate production volume amounted to 696 thousand tons in 2024. The production of lead ingots is primarily influenced by national policies, the release of smelting capacity, and downstream demand. With the establishment of a nationwide lead resource recycling system and a recycling lead system, China's lead ingot production volume has shown a steady year-on-year growth trend. In 2023, China's lead ingot production volume reached approximately 6.6 million tons, compared with 5.6 million tons in 2020, representing a CAGR of 5.6% from 2020 to 2023. The price remained relatively stable within the range from RMB14.0 thousand per ton to RMB17.5 thousand per ton. In 2024, global capacity contraction of mining and smelting led to the increase of lead ingot price to RMB17.6 thousand per ton in the second quarter, and the mitigation of this condition gradually decreased the average price to RMB16.8 thousand per ton in the fourth quarter.
- The downstream market demand for lithium-ion and lead-acid energy storage batteries in the energy storage industry is primarily driven by the energy transition to a low-carbon energy system, the growth in the number of telecom base stations and data center racks. During the energy transition, energy storage technologies play a crucial role in minimizing energy waste caused by fluctuations in renewable energy supply. In 2024, the proportion of renewable energy power generation surpassed 35% of the global total power generation for the first time. Looking ahead, with the accelerating of energy structure transformation to solar and wind energy and continuous development of renewable energy technologies, it is projected that the market share of renewable energy power generation among the global power generation structure will reach over 45% by 2030. Thus, fueled by the sustained growth in market demand of transition to low-carbon energy system, it is forecast that the market size of global electrical energy storage by added installed capacity will increase from 207.9 GWh in 2024 to 1,506.8 GWh in 2030, representing a CAGR of 39.1%.
- In the telecom industry, since the inception of 5G telecom base stations, they have rapidly become the mainstream in global telecom base station market, depending on its faster speeds, lower latency, increased capacity as well as enhanced connectivity. Thus in 2024, the cumulative volume of global 5G telecom base stations has reached 6.5 million units, presenting a CAGR of 56.5% from approximately 1.1 million units in 2020. Till 2030, the cumulative volume of global 5G telecom base stations is expected to reach 22.4 million units, presenting a CAGR of 22.8% from 2024. As the number of newly built telecom base stations increases and the demand for replacement of existing telecom base stations rises, the added installed capacity of global telecom energy storage is expected to reach 100.2 GWh in 2030, representing a CAGR of 14.8% from 43.9 GWh in 2024.
- The surge in demand for data center energy storage batteries is propelled by the proliferation of artificial intelligence (AI) and big data analytics, driven by the increasing complexity and scale of AI algorithms. Consequently, the global number of data center racks surged from 12.5 million units in 2020 to 33.9 million units in 2024, exhibiting a CAGR of 28.3%. With the rapid advancement of AI technology and increase in computational capacity from data center racks, it is anticipated that the global number of data center racks will reach 181.3 million units by 2030, growing at a CAGR of 32.3% from 2024. To ensure reliable power supply and enhance energy efficiency through sustainable energy supply, added installed capacity of global data center energy storage is expected to further increase to 209.4 GWh by 2030 from 16.5 GWh in 2024, representing a CAGR of 52.7% from 2024 to 2030.

FROST & SULLIVAN 沙利文

Source: Frost & Sullivan

Overview of Global and China Energy Storage Market

Policy Analysis (1/2)

In 21st Century, many countries have introduced policies to promote the vigorous development of industries, through efforts such as direct financial support of demonstration projects, comprehensive market transformations and mandates for energy storage projects. Below introduces related policies in different regions:

Country	Policy	Issuing Agency	Release Date	Content
Vietnam	Power Development Plan 8	Prime Minister of Vietnam	2023.5	PDP8 also aims to develop storage with a capacity of 2,400 MW and battery storage of 300MW by 2030 to manage the electricity loads.
Germany	Annual Tax Act 2022	Germany Cabinet	2022.9	Germany cabinet cancel the EEG surcharge and exempt the value-added tax and income tax on electricity generation revenue associated with residential energy storage systems.
U.S	Inflation Reduction Act	The White House	2022.8	US government will invest $400 billion into the clean energy industry, and for the first time, standalone energy storage will be included in the Investment Tax Credit (ITC) scope.
Brazil	Vale Project	The Government of Brazil, Vale, Siemens and MircroPower Comerc	2020.9	Propose to build a 5MW/10MWh lithium-ion battery system at a large port facility in Rio de Janeir, which becomes the largest battery energy storage system in Brail. The construction for peak cutting will save costs for Vale.
The U.K.	Secondary Legislation	The UK Cabinet	2020.7	Remove capacity restrictions on battery storage projects, allowing projects of 50MW and 350MW in England and Wales respectively.
Uzbekistan	Power Supply Plans by 2030	The Department of Energy	2020.5	Propose that projects with power generation capacity of more than 300MW will be equipped with energy storage systems to regulate grid load.
Austria	Tax Rebate Scheme	The Austrian Government and OeMAG energy agency	2020.3	Launch a €36 million rebate program for small solar-plus-storage installations. Two-thirds of the pot will subsidize rooftop PV with €12 million for energy storage.

Source: Frost & Sullivan

Overview of Global and China Energy Storage Market

Policy Analysis (2/2)

In recent years, Chinese government has issued intensive energy-storage related policies to improve existing policies on new energy storage, pricing mechanism, and new energy consumption since 2020, paving the way of the large-scale development of energy storage.

Policy	Issuing Agency	Release Date	Content
Notice on Promoting the Use of New Energy Storage Grid-connected and Scheduling Applications 《国家能源局关于促进新型储能并网和调度运用的通知》	National Energy Administration	2024.4	Align with new energy storage's functional roles and market demands, streamline the interconnection management of new energy storage, enhance its dispatch mechanisms, and ensure efficient utilization, thereby robustly supporting the development of advanced power systems.
Guideline on Energy Work in 2024 《2024年能源工作指导意见》	National Energy Administration	2024.3	Promote the development of new types of energy storage technologies and strengthen the policy measures to facilitate the interconnection and dispatch operation of new energy storage.
Notice on Promoting the Participation of New Energy Storage technologies in the Electricity Market and Dispatches 《关于进一步推动新型储能参与电力市场和调度运用的通知》	National Development and Reform Commission,	2022.6	Enhance the capacity of independent energy storage facilities to participate in the electricity market, promoting cooperation for peak shaving, and optimizing dispatch mechanisms with a mature pricing system.
Implementation Plan of New Energy Storage Development in the 14th Five-year Plan 《“十四五”新型储能发展实施方案》	National Development and Reform Commission, Energy Administration	2022.3	Plan to enter the stage of large-scale development from the initial stage of commercialization in new energy storage industry. The performance of electrochemical energy storage technology will be further improved, and the systematic cost will be reduced by more than 30% by 2025.
Guidelines on Accelerating the Development of New Energy Storage 《关于加快推动新型储能发展的指导意见》	National Development and Reform Commission, Energy Administration	2021.7	Clarify the development goal of installed scale of 30GW in 2025, and plan to realize the comprehensive market-oriented development of new energy storage by 2030.
Circular Economy Development Plan in the 14th Five-year Plan 《“十四五”循环经济发展规划》	National Development and Reform Commission	2021.7	Promote the application of integrated systems of heat and power generation, distributed energy and photovoltaic energy storage.
Notice on the Action Plan for Deepening Price Mechanism Reform during the 14th Five-Year Plan Period 《关于“十四五”时期深化价格机制改革行动方案的通知》	National Development and Reform Commission	2021. 5	Improve pricing mechanisms for wind power, photovoltaic power and pumped storage, and establish a new pricing mechanism for energy storage.

Source: Frost & Sullivan

Agenda

Overview of Global and China Telecom and Data Center Energy Storage Market

Development History of Data Center and AI Technologies

Development of Data Center

2000s

Early Concepts

Data Center started gaining traction in early 2000s. It referred to datasets that were too large and complex for traditional data processing applications to handle efficiently. Some companies began grappling with massive amounts of data generated by users' interactions with the internet.

2000s-early 2010s

Technological Foundations

Technologies like Apache Hadoop emerged as solutions for processing and storing large datasets across distributed computing clusters. Hadoop's distributed file system(HDFS) and MapReduce programming model allowed for scalable and fault-tolerant processing of Data Center.

2010s

Rise of NoSQL Databases

Traditional relational databases struggled to handle the volume, velocity, and variety of data centers. NoSQL databases such as MongoDB, Cassandra, and Couchbase emerged as alternatives, offering flexible data models and horizontal scalability suitable for data center applications.

2010s-Present

AI Integration

Big data and AI have become deeply intertwined. Organizations leverage data center platforms to collect, store, and process data for training AI models. These models, in turn, help derive insights, make predictions, and automate decision-making processes across various domains.

Development of AI

1956-1974

Early Concepts

AI was firstly introduced in the Dartmouth meeting in 1956. The core at that time was to train the computer to be capable of reasoning. Computer started to be able to solve some algebra problems, geometrical problems, etc.

1975-1987

Simple Applications

Some AI programs started to be able to solve certain problems provided by humans. DENDRAL was considered the first expert system since it automated the decision-making process and problem-solving behavior of organic chemists.

1988-2011

Extended Research

Some basic obstacles in computer's performance has been overcame. An IBM computer called IBM Deep Blue beat world chess champion after a six-game match in 1997. The idea of Deep Learning was proposed in 2006.

2012-2022

Expeditated Application

Capitals started to pay close attention on tech-driven startups as technologies such as cloud computing, big data, AI became mature and were ready to be commercialized in various applications.

2023-Present

Energy Sustainability

The emergence of ChatGPT and other NLP models makes AI applications widespread, and the demand for electrical power continues to grow, prompting concerns about energy efficiency and sustainability.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Market Overview of Global and China Telecom and Data Center Energy Storage Industry

- The telecom and data center industries are highly interrelated in terms of technological foundation, application scenarios, and market demand, mutually supporting each other to drive the development of the modern information society. The telecom industry is responsible for data transmission and exchange, ensuring that information is transmitted quickly and reliably, while data center processes and analyzes these large volumes of data. Both telecom and data center require extensive infrastructure, high bandwidth, and low-latency network support, and rely on technological innovation and security protection. With the increase in smart devices and internet users, market demand drives the development of these two industries, which together support intelligent decision-making, optimize network performance, and improve service quality. The development of telecom and data center energy storage industry is crucial for various purposes, including (i) ensuring the stable operation of data centers and telecom networks, preventing data loss and communication interruptions; (ii) enhancing energy efficiency and reducing energy waste; (iii) lowering operating costs by storing electricity during off-peak hours and using it during peak times; supporting the application of renewable energy by providing stable power supply, thus contributing to green development; responding to emergencies and unexpected situations to ensure business continuity and reliability; and (iv) promoting the development of smart grids, enabling flexible power scheduling and management to provide more reliable power guarantees for the telecom and data center industries.
- The faster and stabler communication networks as well as data services brings significant convenience and comfort to daily life, while it also increases computational and electricity burden, leading to substantial electricity consumption and energy costs. By 2024, China's total installed capacity of data center standard racks exceeded 10 million units, accounting for 32.2% of total number of global data center, and China's computational capacity has ranked second globally. With the continuous development of data center industry, its total electricity consumption percentage in national one will continue to rise. In 2024, approximately 4.0% of global electricity consumption was used for data centers, and this figure may rise to over 10% by 2030, putting computational power consumption on par with energy-intensive industries such as manufacturing.
- In terms of telecom base station, the number of 5G base stations constructed has far exceeded that of 4G, putting great pressure on energy consumption as its energy consumption is 2 to 3 times that of 4G. Upgrading energy saving technologies and strengthening energy management has also become an increasingly urgent task in telecom side.
- **Under such circumstance, the application of energy storage technology in telecom and data center sectors is gradually shifting from emergent backup power to sustainable energy power supply, thus effectively improving energy utilization efficiency and promoting the industrial transformation towards a low-carbon economy model.** Additionally, by integrating intelligent means such as AI and Battery Management System (BMS) technology, energy storage facilitates customers reduce their dependance on grid and create excessive revenue from it. Through grid efficiency increase, emergent backup power and other functions, energy storage systems realize a value enhancement in energy management, proving customers with more stable, reliable and economical energy solutions, thus are poised for remarkable growth in the future.

Market Size of Global and China's Big Data Industry (in RMB Billion)

Market Size of Global and China's AI Industry (in RMB Billion)

Global Energy Consumption Comparison between 4G and 5G Telecom Base Stations, 2024

Telecom Base Station Type	Number Constructed Multiple	Energy Consumption per Station Multiple	Total Energy Consumption Multiple
4G Telecom Base Station	1x	1x	1x
5G Telecom Base Station	2-3x	2-3x	4-9x

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Source: CNESA, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Importance of Telecom and Data Center Energy Storage to New Infrastructure Construction

- **New infrastructure refers to the construction of infrastructure that promotes both economic and social development through the utilization of next-generation information technologies such as AI, big data, and other intelligent technologies.** Telecom and data center energy storage, as synergy of both next-generation information technology and energy management, plays a crucial role in the construction of new infrastructure in driving innovation and efficiency in development and laying foundation for building increasingly intelligent, resilient, and sustainable cities and communities.

Increasing Demand for Intelligent Infrastructure

The construction of new infrastructure, spanning smart transportation, smart cities, and smart factories, necessitates heightened stability and reliability in telecom networks. Big data analytics within the energy system are able to optimize performance by leveraging vast data streams to inform precise infrastructure design and resource allocation. Meanwhile, the energy storage systems ensure network resilience, providing vital backup power to sustain operations during electricity outages or fluctuations. This convergence of big data analytics and energy storage is pivotal in driving the success and sustainability of intelligent infrastructure, enabling innovation, efficiency, and progress while ensuring seamless connectivity and functionality in critical systems.

Growing Need for Mobile Network Construction

As a critical component of new infrastructure, the development of 5G/6G networks will drive the growth of the telecom energy storage market. 5G networks, with their higher data transmission rates, lower latency, and increased device connectivity, will lead to a surge in power demand for Telecom base stations. The high construction density due to shorter transmission distances of 5G will also result in higher demand for batteries. In addition, the evolution of 6G networks will pose new requirements for telecom and data center energy storage, including addressing high energy consumption, ensuring network reliability and stability, meeting demands for rapid charging and prolonged power supply, and adhering to energy conservation and environmental protection standards. To meet the continuous operation requirements of Telecom systems during electricity outages or emergencies, energy storage devices need to operate stably in various environmental conditions, and prioritize energy efficiency and environmental sustainability to reduce energy waste and environmental impact.

Effective Empowerment on Intelligent Energy Systems

In the construction of new infrastructure, the integration of intelligent energy systems, including smart grids and distributed energy systems, is paramount. These systems leverage advanced technologies such as big data analytics and telecom energy storage to optimize energy management, enhance grid stability, and facilitate the integration of renewable energy sources. Among this, big data analytics within the energy system enables real-time monitoring and analysis of energy consumption patterns, allowing for predictive maintenance, demand response, and efficient resource allocation. Besides proving backup power during outages and fluctuations, telecom energy storage systems enable peak shaving and load balancing, reducing strain on the grid and enhancing overall energy efficiency. These technologies combinedly contribute to the development of robust and sustainable smart energy infrastructure, laying the foundation for a more resilient and efficient energy ecosystem.

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Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Definition and Function of Telecom and Data Center Energy Storage

Definition

- **Telecom and data center energy storage primarily include energy storage systems and solutions applied on both telecom base station side and data center side.** The requirements for electricity in telecom and data center energy storage comprises of safety and stability, fast response, high energy density, cost-effectiveness as well as long cycle life. Safety and stability are fundamental to ensuring normal operation of telecom systems and data centers, while fast response capability addresses sudden electricity demands or any emergencies. Further, energy density is essential for storing large amounts of energy in a limited volume, in order to meet long-term stable electricity supply needs of telecom base stations and data centers while minimizing gas emissions. Long cycle life ensures system durability and reliability, thus reducing maintenance and replacement costs, and increasing high cost-effectiveness of the energy storage solutions. In those ways, **telecom and data center energy storage provide stable and reliable electricity support for telecom base stations and data centers, promoting continuous development and innovation in the field of information and communication.**
- In the future, **the integration of big data and AI technologies will enable energy storage systems in the realms of data centers and telecom to achieve advanced levels of operational intelligence and comprehensive management**, which leads to increasingly sophisticated energy storage solutions capable of dynamic optimization, predictive maintenance, and real-time monitoring, enhancing efficiency and reliability across diverse applications.

Energy Storage as Emergency Backup Power Sources

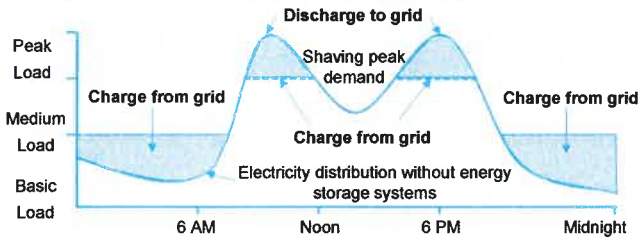
- Energy storage systems serve as emergency backup power sources, ensuring **continuous operation of downstream application systems, especially data centers,** during unstable power supply situations or sudden outages, thereby **safeguarding the stability and reliability**.

Unexpected Emergency Scenario in Power Outages

Without Energy Storage Systems	With Energy Storage Systems
A disruption in the transmission network occurs, leading to the interruption of transmission in most areas and widespread network failure, as well as **severe telecom breakdowns.**	Backup power sources provide electricity supply to **maintain the normal operation of critical equipment or systems** when the primary power source fails. Additionally, they can be used to **monitor and regulate the power grid**, adjusting the quality parameters of energy and addressing issues such as transient overvoltage.

Energy Storage as Sustainable Electricity Supply

- Through peak shaving and valley filling, energy storage systems can store electricity during low-price periods and release it during high-price periods, thereby **providing redundant power storage and reducing energy procurement costs, improving electricity utilization efficiency.**



Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Classification of Telecom and Data Center Energy Storage Battery

- In terms of technical routes, lead-acid batteries and lithium-ion batteries are two of the most widely used batteries in telecom and data center energy storage domain, each presenting distinct advantages and drawbacks in terms of energy density, cycle life, safety, and cost. Lead-acid batteries generally have lower energy density and cycle life, yet they excel in cost-effectiveness and safety. In contrast, lithium-ion batteries boast higher energy density and longer cycle life than lead-acid batteries, but they come at a higher cost and exhibit lower safety levels.
- Leveraging its advantages in safety, cost-effectiveness, and years of mature technological expertise, lead-acid storage batteries have emerged as the mainstream choice for specific applications such as energy storage at telecom base stations and data centers that prioritize safety. In recent years, lithium-ion batteries have gained significant traction in residential and grid-scale energy storage due to their high energy density and long cycle life. As the demand for energy storage solutions accelerates in the future, the shipment volume of lithium-ion storage batteries is expected to rise rapidly. With continuous advancements in lithium-ion battery technology, improvements in safety and cost-effectiveness are anticipated, thereby increasing their penetration in energy storage applications at communication base stations and data centers. **As various battery technologies continue to evolve, the energy storage industry in telecom and data center sectors will witness the parallel development of multiple battery technologies, providing diversification of battery options and further improving energy storage performance.**

Classification by Technical Routes

Energy Storage Battery Type	Lead-acid Battery	Lithium-ion Battery
Voltage	2V	3.3V-3.7V
Energy Density	30-60Wh/kg	>100Wh/kg
Cycle Life	300 times	>1,000 times
Self-discharge Rate	4%-5%	<5%
Memory Effect	No	No
Safety	High	Relatively High
Cost	Relatively Low	Relatively High
Major Application Scenarios	Energy Storage, Transportation, Military Use, etc.	Energy Storage, Transportation, Electronics, Electric Tool, etc.
Technical Stage	Mature Stage	Development Stage

Classification by Application Scenarios

Energy Storage Battery Type	Data Center Energy Storage Battery	Telecom Energy Storage Battery
Function of Application Scenario	Provide mass data storage, processing and interaction services	Provide wireless coverage, facilitating wireless signal transmission between wired communication networks and wireless terminals
Function of Energy Storage Battery	Improve power quality, control frequency and provide emergency power backup to ensure smooth and efficient operation	Provide electricity to critical equipment during power outages to ensure stable operation
Core Consideration on Battery	Safety and cost	Energy density, battery volume and battery weight especially under 5G base station
Major Type of Battery	Lead-acid battery	Lead-acid battery and lithium-ion battery

Source: CNESA, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Development Background Analysis of Telecom Energy Storage

- **Telecom energy storage refers to the use of energy storage systems to provide backup power or supplementary energy to ensure the continuous operation of telecom base stations.** The energy storage solutions, especially energy storage batteries, are crucial for maintain communication networks during power outages or fluctuations, ensuring uninterrupted connectivity and reliable communication services.
- With the rapid proliferation and iterative advancement of technologies such as mobile communication, the Internet of Things (IoT), big data, AI, 5G, as well as 6G, user demand for telecom networks continues to grow. To ensure the reliability, stability, and continuity of Telecom networks, the demand for stable and reliable power supply for base stations has also increased. In recent years, some regions have faced issues with unstable power supply including power outages and voltage fluctuations, impacting the normal operation of telecom base stations. Consequently, Telecom energy storage is widely used **as emergency backup power sources to provide stable power support and ensure the continuous operation of communication networks.**
- Recently, many countries and regions have introduced policies and subsidy measures to encourage the development of renewable energy and energy storage technologies. Since 2021, China has issued multiple policies to encourage the cascade utilization in telecom base stations and accelerate the construction of new infrastructure, in order to promote the development of the telecom energy storage industry. **These policy initiatives also have created a favorable policy environment and market growth prospect for the telecom energy storage market.**

Comparison between 4G and 5G Telecom Base Stations

Base Station Types	4G	5G
Frequency Band	Relatively low	Relatively high
Covering Range	1-3km	100-300m
Laying Density	1x	~3-4x relative to 4G
Equipment Cost	~RMB 100,000	~RMB 200,000-250,000
Core Consideration on Battery	Cost	Battery Volume, flexibility and energy density
Major Type of Battery	Lead-acid battery	Lithium-ion battery

Comparison between 5G and 6G Telecom Base Stations

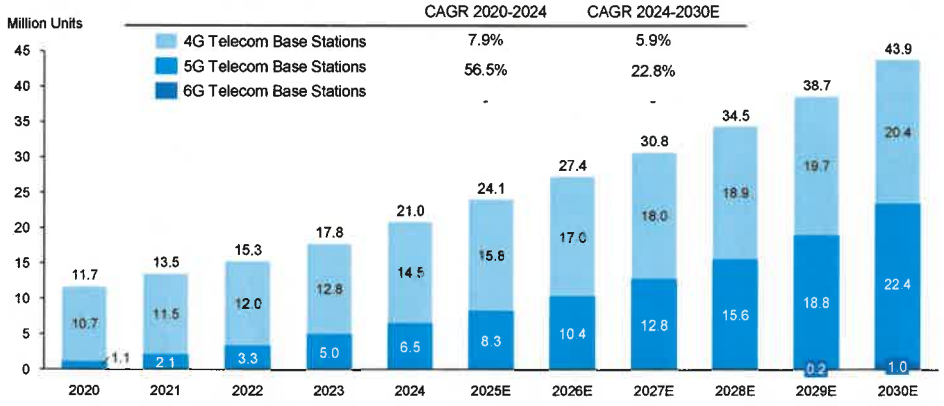
Base Station Types	6G	5G
Peak Data Rate	>100 Gb/s	10-20 Gb/s
Traffic Density	>100 Tb/s/km^2	>10 Tb/s/km^2
Connection Density	>10 million/km^2	1 million/km^2
Delay	<1ms	ms level
Spectrum Efficiency	>3x relative to 5G	3-5x relative to 4G
Energy Efficiency	>10x relative to 5G	1,000x relative to 4G

Source: CNESA, Frost & Sullivan

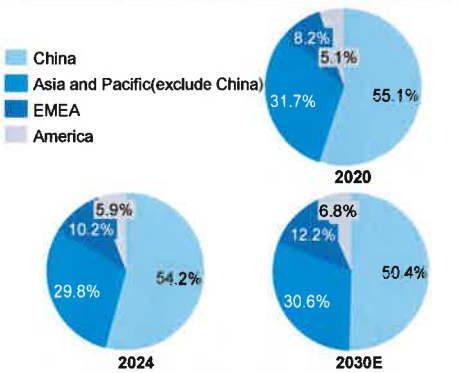
Overview of Global and China Telecom and Data Center Energy Storage Market

Global Telecom Cumulative Volume of Base Station Overview

Cumulative Volume of Telecom Base Stations (Global), 2020-2030E



Geographic Breakdown of Telecom Base Stations by Cumulative Volume, 2020, 2024 and 2030E



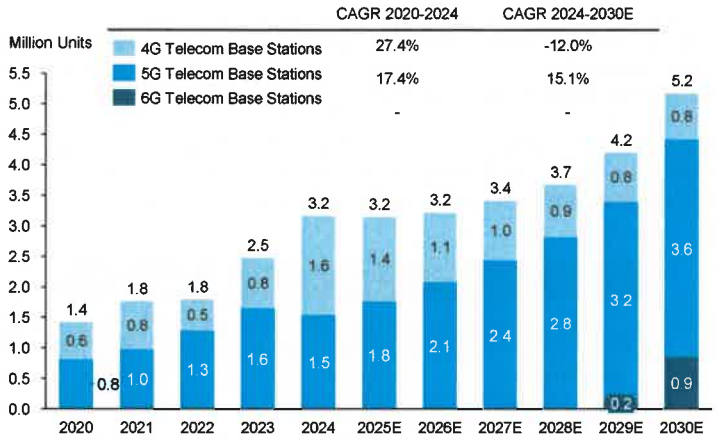
- Global 5G base station construction is steadily progressing, with vast future development potential and continuous positive market prospects. The Chinese market serves as a crucial pillar for global 5G market growth. Since the inception of 5G telecom base stations, they have rapidly become the mainstream in global telecom base station market, with construction speed far exceeding that of 4G telecom base stations, depending on its faster speeds, lower latency, increased capacity as well as enhanced connectivity. Thus in 2024, the cumulative volume of global 5G telecom base stations has reached 6.5 million units, presenting a CAGR of 56.5% from 2020. Additionally, with the accelerated technological deployment and the achievement of significant milestones in 6G key technology research, the construction pace of 6G telecom base stations is accelerating, and it is expected that the future cumulative volume will reach 1.0 million units in 2030, taking up approximately 2.3% of total telecom base station market. As for geographic breakdown, in 2024, China, Asia and Pacific (exclude China), EMEA and America accounted for 54.2%, 29.8%, 10.2% and 5.9% of global telecom base stations, and these figures are expected to reach 50.4%, 30.6%, 12.2% and 6.8% in 2030, respectively.

Source: MIIT, Frost & Sullivan

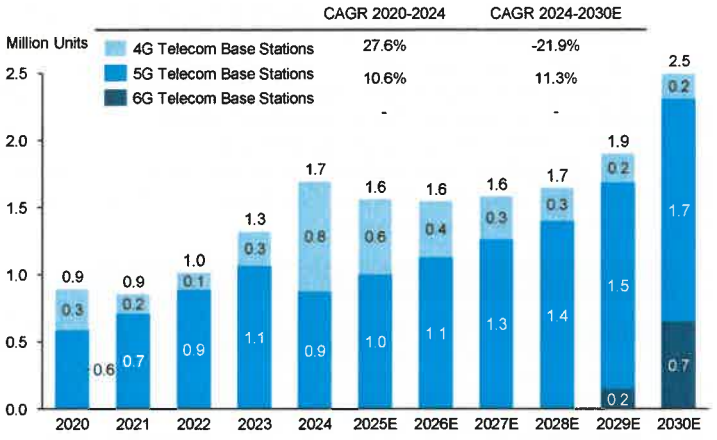
Overview of Global and China Telecom and Data Center Energy Storage Market

Global and China Added Volume of Telecom Base Station Overview

Added Volume of Telecom Base Stations (Global), 2020-2030E



Added Volume of Telecom Base Stations (China), 2020-2030E



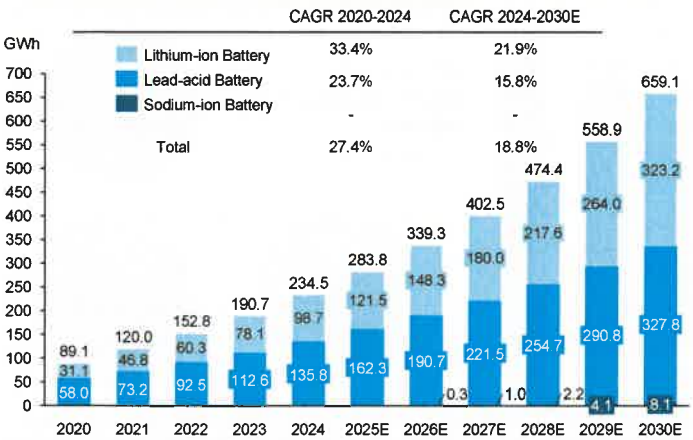
- 5G telecom base station construction is steadily progressing, with vast future development potential and continuous positive market prospects. The Chinese market serves as a crucial pillar for global 5G market growth. Since the inception of 5G telecom base stations, they have rapidly become the mainstream in global telecom market, with construction speed far exceeding that of 4G telecom base stations, depending on its faster speeds, lower latency, increased capacity as well as enhanced connectivity. Thus in 2024, the added volume of both global and China 5G telecom base stations has reached 1.5 and 0.9 million units, presenting a CAGR of 17.4% and 10.6% from 2020, respectively. Additionally, with the accelerated technological deployment and the achievement of significant milestones in 6G key technology research, the construction pace of 6G telecom base stations is accelerating, and it is expected that the future added volume in both global and China market will reach 0.9 and 0.7 million units in 2030.

Source: MIIT, Frost & Sullivan

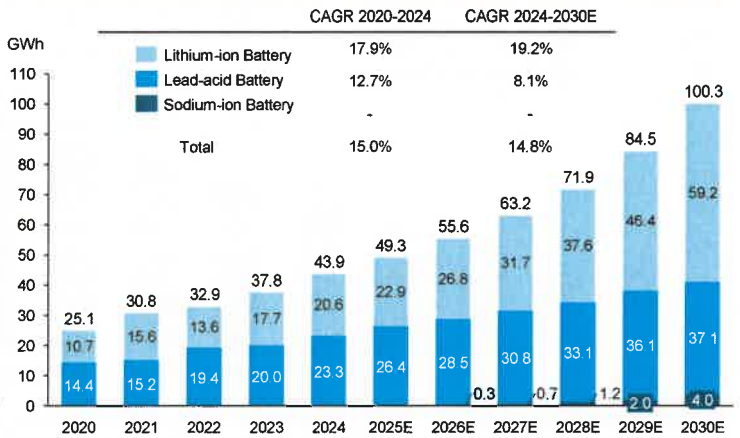
Overview of Global and China Telecom and Data Center Energy Storage Market

Global Telecom Energy Storage Overview by Technical Routes

Cumulative Installed Capacity of Telecom Energy Storage (Global), 2020-2030E



Added Installed Capacity of Telecom Energy Storage (Global), 2020-2030E



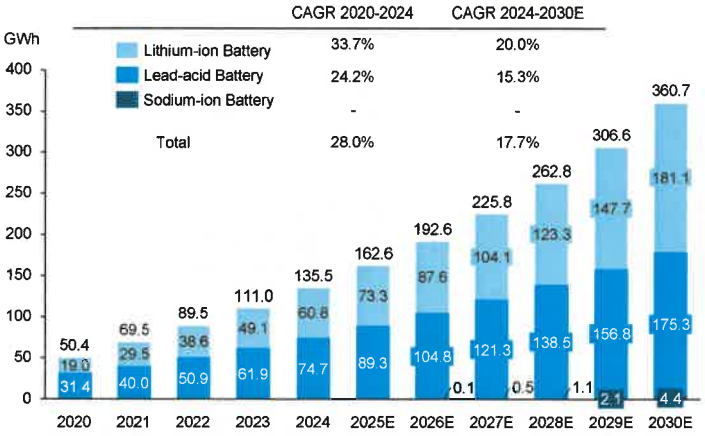
- In terms of technical routes, historically lead-acid batteries dominate the market for global telecom energy storage with relatively lower initial cost and well-fit for applications requiring short-duration, high-power bursts, such as backup power sources for telecom base stations. Recently, with the fast construction of 5G telecom base stations and significant technological breakthrough in 6G telecom base stations, the proportion of lithium iron batteries is increasing steadily to meet the needs of base station with higher speed and larger capacity. In the future, sodium-ion batteries are relatively advantageous due to their low cost, abundant raw materials, high energy conversion efficiency, long life cycle, high energy density rate and high safety, thus sodium-ion battery will also come into commercialization stage and take up 1.2% and 2.9% of global telecom energy storage in term of both cumulative and added installed capacity in 2030. In 2024, the cumulative installed capacity of global telecom energy storage with lithium-ion and lead-acid batteries has reach 98.7 GWh and 135.8 GWh, respectively, and these figures will become 323.2 GWh and 327.8 GWh in 2030.

Source: CNESA, Interviews with Industry Experts, Frost & Sullivan

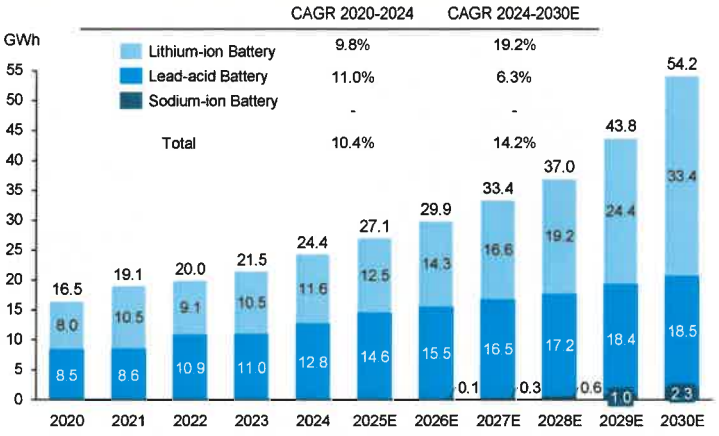
Overview of Global and China Telecom and Data Center Energy Storage Market

China Telecom Energy Storage Overview by Technical Routes

Cumulative Installed Capacity of Telecom Energy Storage (China), 2020-2030E



Added Installed Capacity of Telecom Energy Storage (China), 2020-2030E



- Driven by large telecom infrastructure and rapid technological advancements, China is a significant player in telecom energy storage. As the largest producer and consumer of lead-acid batteries, China continues to improve their performance and environmental impact with technological advancements. In lithium-ion batteries, China leads the global market, driven by major manufacturers in comprehensive control over supply chain from raw materials to applications. Also, China is heavily investing in sodium-ion batteries, with institutions and companies pushing for advancements to offer a cost-effective, safer alternative to lithium-ion batteries, which is expected to account for 1.2% and 4.2% of China telecom energy storage in term of both cumulative and added installed capacity in 2030. In 2024, the cumulative installed capacity of China telecom energy storage with lithium-ion batteries and lead-acid has reach 60.8 GWh and 74.7 GWh, respectively, and these figures will become 181.1 GWh and 175.3 GWh in 2030.

Source: CNESA, Interviews with Industry Experts, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Market Size of Global and China Telecom Energy Storage

For IO Use

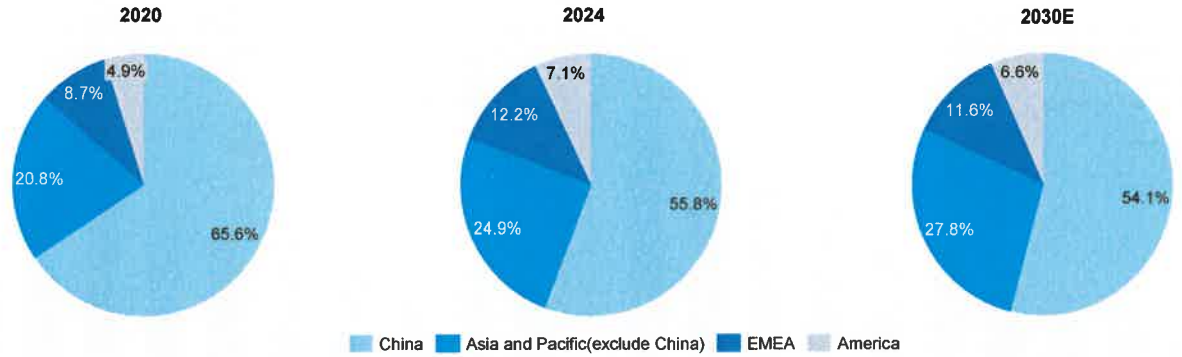
- Telecom energy storage refers to the use of energy storage systems to provide backup power or supplementary energy to ensure the continuous operation of telecom base stations. Energy storage solutions, especially energy storage systems, are crucial for maintaining communication networks during power outages or fluctuations, ensuring uninterrupted connectivity and reliable communication services. With the rapid proliferation and iterative advancement of technologies such as mobile communication, the Internet of Things (IoT), big data, AI, and 5G, user demand for telecom networks continues to grow. In 2024, the cumulative volume of global 5G telecom base stations has reached 6.5 million units, presenting a CAGR of 56.5% from 2020. China solely accounted for 65.1% of global 5G telecom base stations in 2024. In line with the expansion of telecom base stations, power demand also increases dramatically. In recent years, some countries and regions have faced issues with unstable power supply, including power outages and voltage fluctuations, impacting the normal operation of telecom base stations. To ensure the reliability, stability, and continuity of telecom networks, the demand for stable and reliable power supplies for base stations has also increased.
- The added installed capacity of global telecom energy storage increased from 25.1 GWh in 2020 to 43.9 GWh in 2024, representing a CAGR of 15.0%. By 2030, the added installed capacity of global telecom energy storage is expected to reach 100.3 GWh, representing a CAGR of 14.8% from 2024. China is a significant market in telecom energy storage industry, driven by its extensive telecom infrastructure and rapid technological advancements. In 2024, China alone accounted for 55.8% of the global increase in added installed telecom energy storage capacity.
- The added installed capacity of China telecom energy storage increased from 16.5 GWh in 2020 to 24.4 GWh in 2024, representing a CAGR of 10.4%. By 2030, the added installed capacity of China telecom energy storage is expected to reach 54.2 GWh, representing a CAGR of 14.2% from 2024.
- In populous Asia Pacific nations like India and Indonesia, telecom energy storage is indispensable given the impending rapid deployment of telecom base stations and the inadequacy of existing power grids. Thus, the added installed capacity of telecom energy storage in Asia Pacific excluding China is expected to increase from 10.9 GWh in 2024 to 27.9 GWh in 2030, representing a CAGR of 16.9%.
- In the EMEA market, the development of 5G and overall telecom industry in Europe is mature and gradually advancing, while other EMEA regions are still in the early stages of 5G commercialization, possessing significant development potential. Thus, the added installed capacity of telecom energy storage in EMEA is expected to increase from 5.4 GWh in 2024 to 11.6 GWh in 2030, representing a CAGR of 13.7%.
- In terms of technical routes, lead-acid batteries have previously taken a larger share of the market for global telecom energy storage with relatively good reliability and temperature tolerance. Recently, with the fast construction of 5G telecom base stations, the proportion of lithium-ion batteries is increasing steadily to meet the needs of 5G base station construction with higher speed and larger capacity. Lithium-ion batteries generally have higher energy density, faster charging speeds, and lower self-discharge rate. Looking ahead, lead-acid batteries, with strengths in wide temperature range adaptability, good reliability, high safety level, and mature technology, are projected to grow alongside with lithium-ion batteries in the telecom energy storage industry. The established recycling system of lead-acid batteries supports its shift towards low-carbon development. By 2030, it is forecasted that lithium-ion batteries will account for 59.1% of the global telecom energy storage market by added installed capacity, while lead-acid batteries will maintain with market share of 37.0% in global market.
- Thus, in the telecom energy storage market, lithium-ion batteries are increasingly implemented in base stations requiring high discharge rate and high energy consuming application scenarios. Lead-acid batteries still maintain its position in telecom energy storage market especially in some central area depending on their safety, reliability and maturity. In 2024, the market shares of lithium-ion batteries and lead-acid batteries in China's telecom energy storage market by added installed capacity reached 47.5% and 52.5%, respectively. By 2030, the market shares of lithium-ion batteries and lead-acid batteries by added installed capacity in China are expected to reach 61.7% and 34.1%, respectively.

Source: CNESA, Interviews with Industry Experts, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Global Telecom Energy Storage Overview by Major Countries and Regions

Geographic Breakdown of Telecom Energy Storage by Added Installed Capacity, 2020, 2024 and 2030E



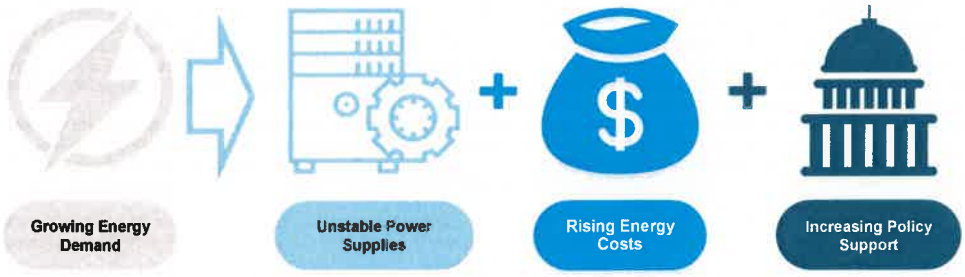
- As for geographic breakdown in global telecom energy storage market, China holds a dominant position, stemming from its extensive manufacturing capabilities, substantial investments in battery technology, and control over critical supply chains. Also, in the Asia and Pacific region excluding China, countries such as South Korea and India are experiencing robust growth due to increasing demand for reliable telecom infrastructure. As for EMEA which includes Europe, Middle East and Africa, it showcases a diverse market characterized by varying levels of technological adoption and regulatory environments. Europe leads in sustainability initiatives, driving a shift towards advanced energy storage solutions. While the Middle East and Africa although continues to rely more on relatively traditional technologies, there is a growing interest in increasingly advanced and sustainable options with developing infrastructures. In addition, the Americas, particularly North America present a dynamic market with a strong emphasis on technological innovation and sustainability. Therefore, in 2024, China, Asia and Pacific (exclude China), EMEA and America accounted for 55.8%, 24.9%, 12.2% and 7.1% of global Telecom energy storage industry in term of added installed capacity, and these figures are expected to reach 54.1%, 27.8%, 11.6% and 6.6% in 2030, respectively.

Source: MIIT, CNESA, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Development Background of Global and China Data Center Energy Storage Systems

Importance of Data Center Energy Storage

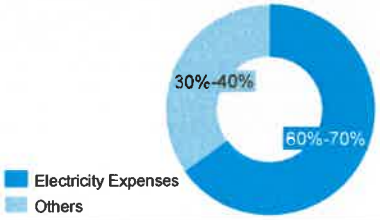


- ***Unstable Power Supplies:*** Data centers rely heavily on consistent and reliable power supplies as they host essential network and computing infrastructure. Any disruption in power supply can lead to service interruptions and data loss, which can have severe implications for businesses and users. Thus, energy storage systems in data centers primarily serve as backup power sources, ensuring operational continuity during power outages.
- ***Rising Energy Costs :*** Energy costs typically account for 60%-70% of the operating costs in data centers. Despite efforts to optimize energy efficiency, the financial burden remains substantial. Energy storage technology plays a crucial role in "peak shaving" and "valley filling" – storing energy during off-peak times when it is cheaper and using it during peak demand to reduce costs. This not only helps in managing expenses but also in stabilizing grid demand.
- ***Increasing Policy Support :*** Various national and regional policies and subsidies encouraging the development of renewable energy and energy storage technologies provide a favorable environment for the growth of the data center energy storage market. Recent initiatives by government bodies to support the high-quality development of computational infrastructure and promote the interaction of energy production, network, and consumption through intelligent systems highlight the policy-driven push towards adopting energy storage solutions.

Cost of Data Center Energy Storage

Energy storage technology is emerging as a crucial strategy for reducing the substantial electricity costs of data centers through a method known as "peak shaving" and "valley filling." Data centers are known for their high energy consumption, with electricity expenses accounting for 60% to 70% of their total operating costs. This method involves storing energy during periods of low demand (valleys) when electricity rates are lower, and then using this stored energy during periods of high demand (peaks) to avoid the higher charges typically associated with these times. By implementing energy storage systems, data centers can not only manage their energy expenditures more efficiently but also contribute to stabilizing the overall demand on the electrical grid, resulting in economic and operational efficiencies.

Operating Cost of Data Centers



Source: MIIT, Frost & Sullivan

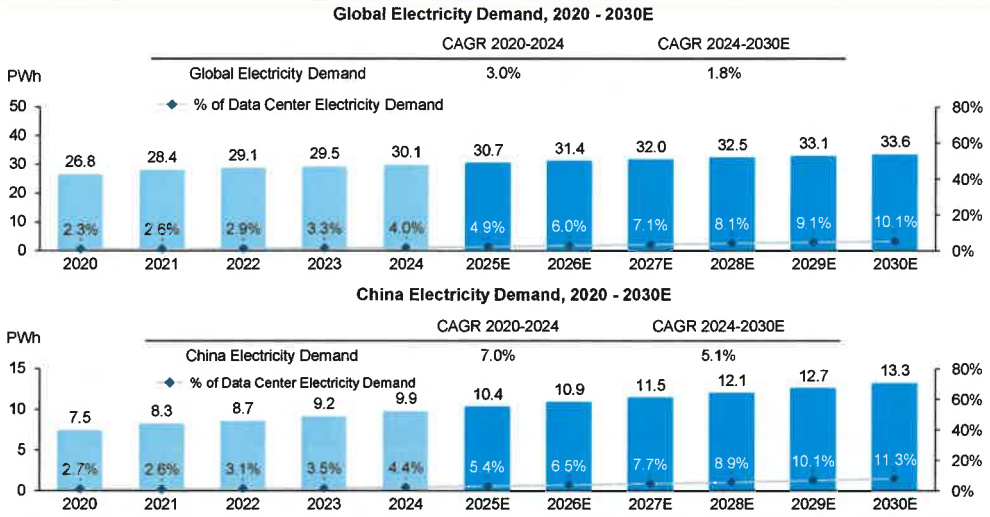
Overview of Global and China Telecom and Data Center Energy Storage Market

Development Background of Global and China Data Center Energy Storage

Background of Data Center Energy Storage

- The background of data center energy storage is significantly shaped by the increasing energy demands of data centers, fueled by the rise of artificial intelligence (AI) and big data analytics. The escalating complexity and scale of AI algorithms necessitate immense computational resources, leading to heightened energy consumption across both traditional and modern computing platforms like cloud and edge computing.
- *This surge in energy needs poses challenges to existing energy supply systems, necessitating the adoption of energy storage technologies.* These technologies are vital for ensuring the stability of power supply and enhancing energy efficiency within data centers.
- As the focus within the data center sector shifts towards addressing these energy challenges alongside computational demands, energy storage becomes a crucial element. It supports data center operations and contributes to broader environmental and economic goals by improving energy efficiency and facilitating integration with renewable energy sources. The growth of the data center energy storage sector is thus essential for the sustainable development of data center infrastructure.

Importance of Data Center Energy Storage



- The increase in computational capacity from data center racks has exerted significant pressure on the energy requirements for data centers. The proportion of data center electricity demand in the global electricity demand is expected to increase from 4.0% in 2024 to 10.1% in 2030. Such a surge in energy needs poses challenges to existing energy supply systems, necessitating the adoption of energy storage technologies. These technologies are vital for ensuring the stability of the power supply and enhancing energy efficiency within data centers.

Source: MIIT, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Key Characteristics of the Development Of the Data Center Energy Storage Market

1 Urgent Need to Optimize Space Utilization

- The development of the data center energy storage market is characterized by the critical need to optimize space utilization within data centers. Data centers typically allocate 3% to 10% of their total building area to battery rooms, with larger data centers requiring more space for batteries. However, many ongoing projects face the challenge of limited machine room areas, and data centers aim to maximize the number of server cabinets while minimizing the footprint of technical facilities. This space constraint has made the substantial area occupied by current battery systems a significant pain point for large data centers. To address these issues, there has been a shift towards increasing power density, enhanced product performance and improving space efficiency. Lithium-ion batteries, as a potential solution to this problem, are becoming increasingly popular, as they can significantly reduce the space occupied. Additionally, these batteries have a better self-discharge rate, making them crucial during unexpected power outages. As a result, minimizing the space battery packs take up in the data center can greatly reduce the rental or land cost, making this pursuit a key solution in the evolution of energy storage for data center applications.

2 Increased Demand for High-temperature-resistance Batteries

- The development of the data center energy storage market is significantly influenced by the limitations and advancements in battery technology, particularly in response to high-temperature environments. Traditional batteries, especially lithium-ion batteries, are relatively low-efficient in the high-temperature environment due to the thermal instability of the electrolyte and the poor chemical stability of electrode materials, leading to increased side reactions. In contrast, high-temperature-resistant batteries offer substantial energy-saving benefits, presenting a vast market potential for replacing conventional batteries in data centers. For example, if data centers across China were to adopt these high-temperature batteries, the reduction in cooling costs, calculated at an industrial electricity rate of RMB0.5 per KWh, could save approximately RMB 5 to 10 billion. This transition would not only enhance the operational efficiency and stability of data centers but also contribute to significant economic savings.

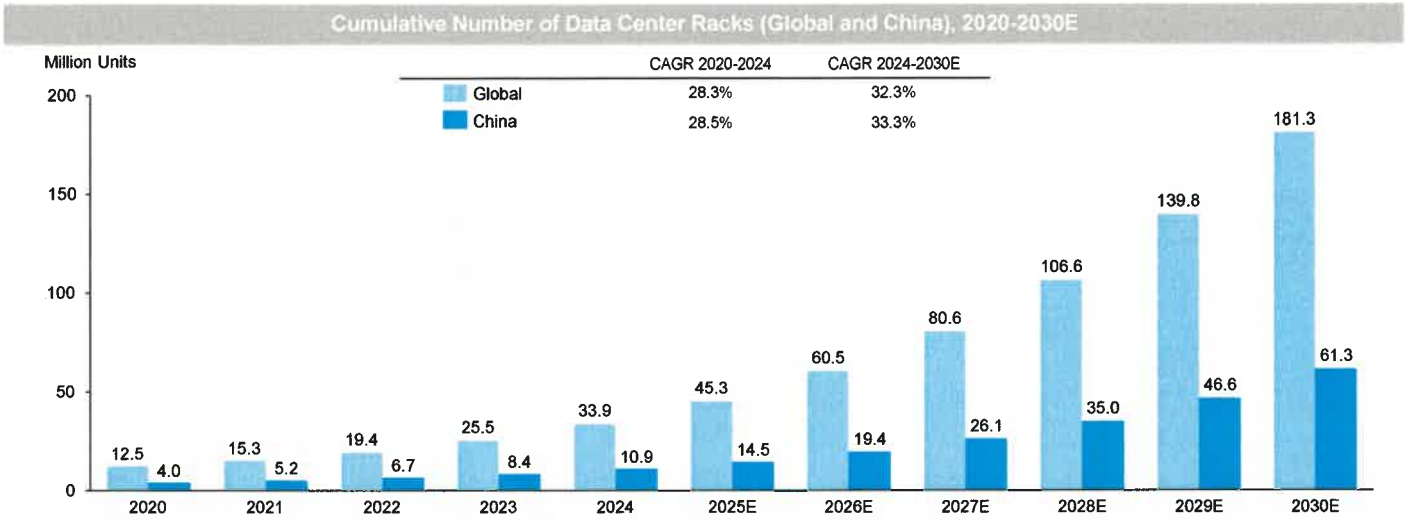
3 Growing Demand for Customization

- The development of the data center energy storage market is increasingly driven by the urgent need for custom solutions in power density, cooling, and connectivity, especially for hyperscale data centers engaging with high-performance computing (HPC) installations and AI applications. Energy storage of data centers must be capable of customization to meet diverse demands for computing power, network, and storage, requiring flexible power, rack configurations, infrastructure, and security requirements. The need for tailored solutions is underscored by the fact that many energy storage system of data centers are not plug-and-play and must accommodate unique physical architectures. For example, customized battery management system (BMS) is designed to ensure the safety of battery, manage cooling effectively, and ensure stable connectivity, even in constrained environments. To form an efficient and reliable data center energy storage system solution, monitoring different load circuits in the data center is crucial to ensure the high integration, and to meet the customer's customized, integrated, and efficient requirements. Thus, data center operators are increasingly seeking customized energy storage solutions that can handle specific power and connectivity needs while providing robust environmental monitoring and remote management capabilities to best fit the data center.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Cumulative Number of Global Data Center Racks

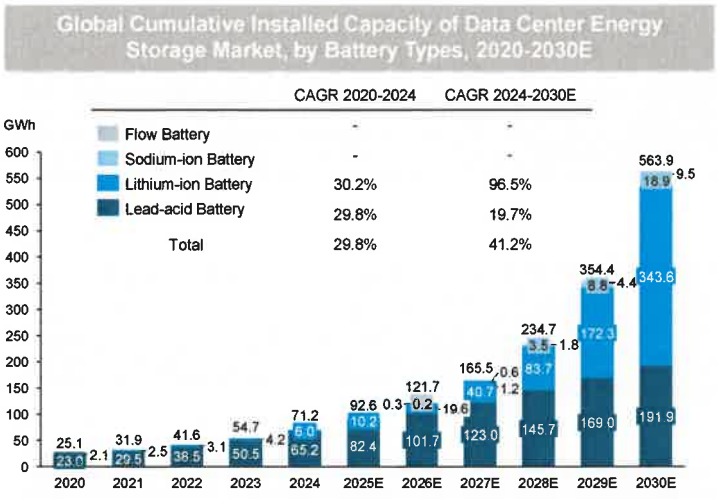


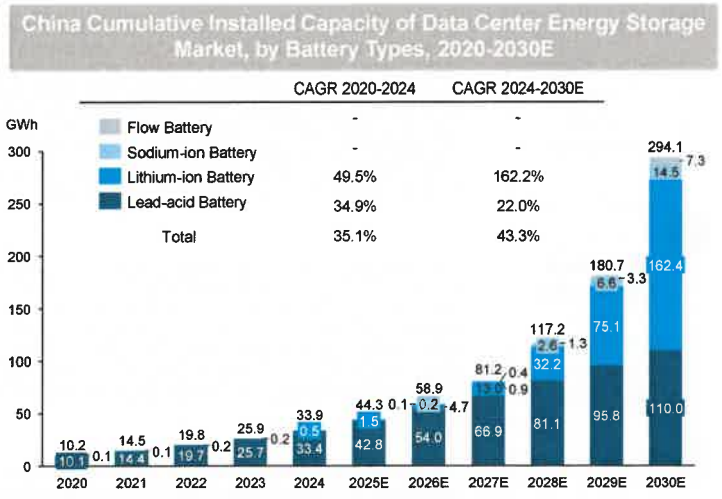
- The growing energy demands of data centers, propelled by the proliferation of artificial intelligence (AI) and big data analytics, are driven by the increasing complexity and scale of AI algorithms. This necessitates significant computational resources, resulting in heightened energy consumption across both traditional and modern computing platforms such as cloud and edge computing. Consequently, the global number of data center racks surged from 12.5 million units in 2020 to 33.9 million units in 2024, exhibiting a CAGR of 28.3%. With the rapid advancement of AI technology and its expanding applications across various industries, it is anticipated that the global number of data center racks will reach 181.3 million units by 2030, growing at a CAGR of 32.3% from 2024. China, serving as a primary driver of global data center expansion, accounted for 32.2% of global data centers in 2024. With additional support from the government, it is projected that the number of data center racks in China will reach 61.3 million by 2030, representing 33.8% of the global data center racks.

Source: MIIT, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Cumulative Installed Capacity of Data Center Energy Storage Market





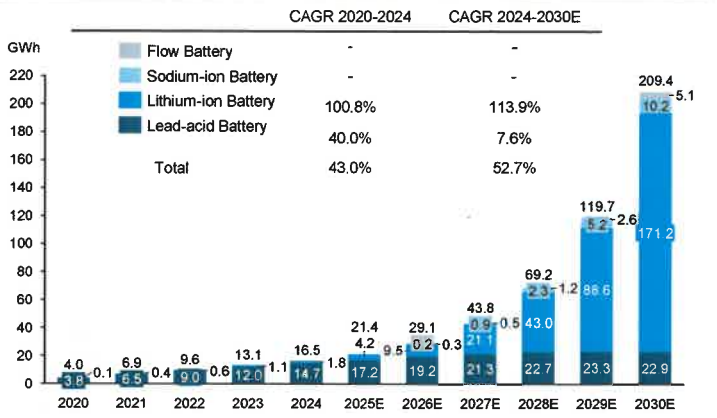
- Lead-acid batteries, despite their lower energy density and shorter cycle life, are mature and cost-effective compared to other battery types, making them suitable for cost-sensitive scenarios. Consequently, lead-acid batteries dominated the data center energy storage market, accounting for approximately 99.1% of the Chinese market in 2020. Meanwhile, lithium-ion batteries, known for their high energy density and long cycle life, are becoming the preferred choice for data center energy storage systems. The global cumulative installed capacity of lithium-ion batteries increased from 2.1 GWh in 2020 to 6.0 GWh in 2024, at a CAGR of 30.2%. This trend is even more pronounced in China, where the adoption of lithium-ion batteries for data center energy storage has grown at a CAGR of 49.5% from 2020 to 2024. In the future, it is expected that lithium-ion batteries will become the preferred choice, with a global cumulative installed capacity of 343.6 GWh and a Chinese cumulative installed capacity of 162.4 GWh by 2030, accounting for 60.9% of the global market and 55.2% of the Chinese market.

Source: Interviews with Industry Experts, Frost & Sullivan

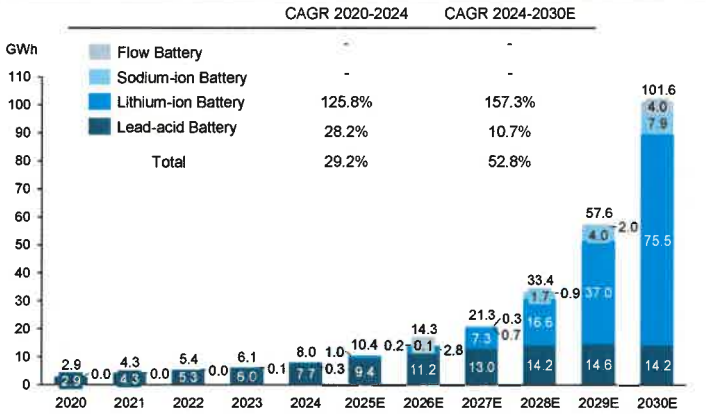
Overview of Global and China Telecom and Data Center Energy Storage Market

Added Installed Capacity of Data Center Energy Storage Market

Global Added Installed Capacity of Data Center Energy Storage Market, by Battery Types, 2020-2030E



China Added Installed Capacity of Data Center Energy Storage Market, by Battery Types, 2020-2030E



- Similar to cumulative installed capacity, the added installed capacity of data center energy storage has shown a consistent trend. In 2020, lead-acid batteries accounted for approximately 97.2% and 99.7% of the added installed capacity globally and in China, respectively. This trend persisted, with a CAGR of 40.0% globally and 28.2% in China between 2020 and 2024. From 2020 to 2024, the newly added installed capacity of lithium-ion batteries have grown at a rate of 100.8% globally and 125.8% in China. By 2030, it is expected that the added installed capacity of lithium-ion batteries will account for 81.8% globally and 74.3% in China. Besides lithium-ion batteries, other types such as sodium-ion batteries and flow batteries, which are still in the early stages of adoption, offer benefits like abundant resources and lower costs. These battery types also show promising potential as technology advances. It is anticipated that the added installed capacity for sodium-ion and flow batteries will reach 10.2 GWh and 5.1 GWh globally, and 7.9 GWh and 4.0 GWh in China by 2030.

Source: Interviews with Industry Experts, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Added Installed Capacity of Data Center Energy Storage Market

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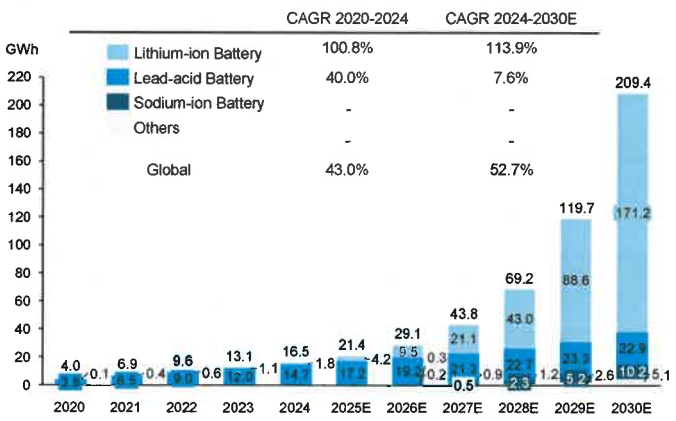
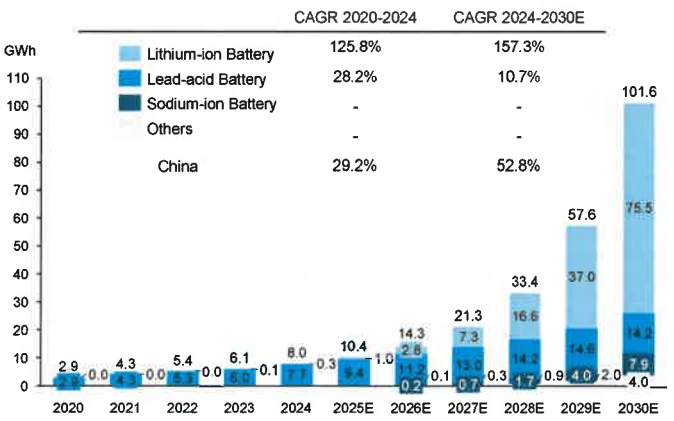
Added Installed Capacity of Data Center Energy Storage (Global and China), Breakdown of Energy Storage Technologies, 2020-2030E



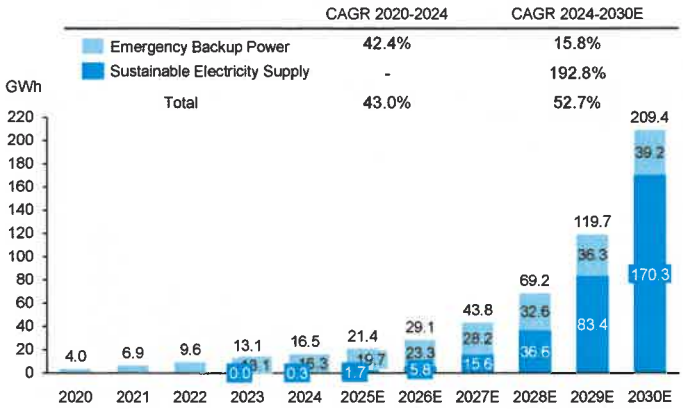


Source: Interviews with Industry Experts, Frost & Sullivan

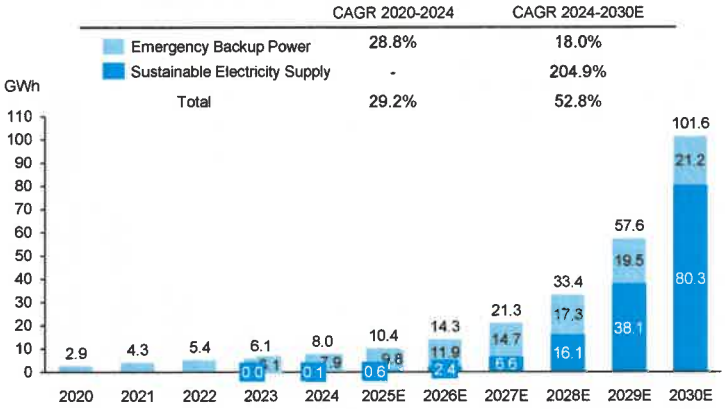
Overview of Global and China Telecom and Data Center Energy Storage Market

Added Installed Capacity of Data Center Energy Storage Market, by Functions

Global Added Installed Data Center Energy Storage Capacity, by Functions, 2020-2030E



China Added Installed Data Center Energy Storage Capacity, by Functions, 2020-2030E



- Backup power systems are essential for ensuring continuous operation during power outages or interruptions and have been the dominant type of energy storage in both the global and Chinese data center energy storage industries. In 2024, data center energy storage used as emergency backup power accounted for approximately 98.4% of the energy storage capacity in both global and Chinese data centers. It is projected that emergency backup power systems will continue their current rate of adoption, with a global CAGR of 15.8% and a China CAGR of 18.0% from 2024 to 2030, reaching 39.2 GWh globally and 21.2 GWh in China by 2030.
- Data center energy storage, used as a sustainable electricity supply, is primarily utilized for peak shaving and valley filling. This approach provides redundant power storage, reduces energy procurement costs, and improves electricity utilization efficiency. Consequently, it is beginning to gain popularity in the industry. Driven by the integration of renewable energy, the power capacity added installed as sustainable electricity supply shows significant growth, with a global CAGR of 192.8% from 2024 to 2030, reaching 170.3 GWh by 2030. In China, the power capacity added installed as sustainable electricity supply is projected to have a CAGR of 204.9% from 2024 to 2030, reaching 80.3 GWh by 2030.

Source: Interviews with Industry Experts, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Market Size of Global and China Data Center Energy Storage

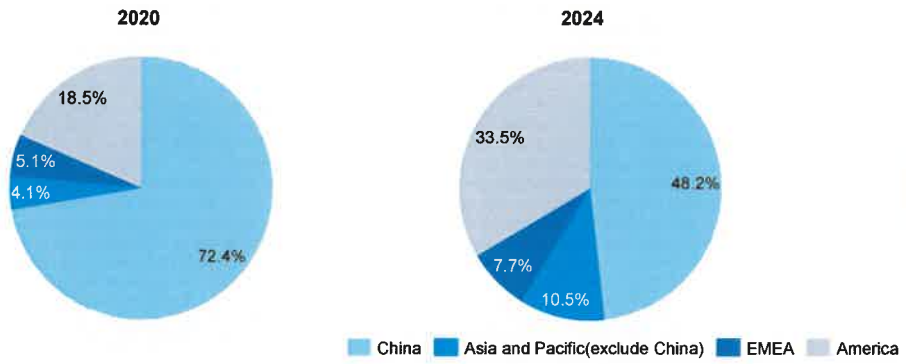
- The development of data center energy storage is significantly shaped by the increasing energy demands of data centers, fueled by the rise of AI and big data analytics. The escalating complexity and scale of AI algorithms necessitate immense computational resources, leading to heightened energy consumption across traditional and modern computing platforms like cloud and edge computing.
- The global number of data center racks surged from 12.5 million units in 2020 to 33.9 million units in 2024, exhibiting a CAGR of 28.3%. With the rapid advancement of AI technology and its expanding applications across various industries, it is anticipated that the global number of data center racks will reach 181.3 million units by 2030, growing at a CAGR of 32.3% from 2024. China, serving as a primary driver of global data center expansion, accounted for 32.2% of global number of data center racks in 2024. With additional support from the government, it is projected that the number of data center racks in China will reach 61.3 million by 2030, representing a CAGR of 33.3%.
- The increase in computational capacity from data center racks has exerted significant pressure on the energy requirements for data centers. The proportion of data center electricity demand in the global electricity demand is expected to increase from 4.0% in 2024 to 10.1% in 2030. Such a surge in energy needs poses challenges to existing energy supply systems, necessitating the adoption of energy storage technologies to ensure the stability of the power supply and enhancing energy efficiency within data centers. As the focus within the data center sector shifts towards addressing these energy challenges alongside computational demands, energy storage supports data center operations and contributes to broader goal of sustainable electricity supply by improving energy efficiency and facilitating integration with renewable energy sources. The growth of the data center energy storage sector is thus essential for the sustainable development of data center infrastructure.
- In the data center industry, there's a growing emphasis on deploying energy storage solutions to ensure reliable power supply and enhance energy efficiency through sustainable energy supply. Added installed capacity of global data center energy storage increased from 4.0 GWh in 2020 to 16.5 GWh in 2024, representing a CAGR of 43.0%, and it is expected to further increase to 209.4 GWh by 2030, representing a CAGR of 52.7% from 2024 to 2030. The added installed capacity of China data center energy storage increased from 2.9 GWh in 2020 to 8.0 GWh in 2024, representing a CAGR of 29.2%, and it is expected to further increase to 101.6 GWh by 2030, representing a CAGR of 52.8% from 2024 to 2030. The accelerated deployment of data centers and enhanced demand for sustainable energy supply will further fuel the robust growth of the data center energy storage market in Asia Pacific excluding China and EMEA. The added installed capacity of data center energy storage in Asia Pacific excluding China and EMEA is expected to increase from 1.7 GWh and 1.3 GWh in 2024 to 22.1 GWh and 10.9 GWh by 2030, representing CAGRs of 52.7% and 42.8%, respectively.
- Lead-acid batteries are relatively mature in technology and industry value chain with high safety level compared to other battery types, making them suitable for multiple application scenarios in data centers, especially under the scenario with high instantaneous discharge rate. Thus, lead-acid batteries will remain the growth trend, achieving the CAGR of 7.6% in the global data center energy storage market by added installed capacity from 2024 to 2030, respectively. By 2030, proportion for added installed capacity of lithium-ion battery among data center energy storage market is expected to account for 81.8% globally, driving by renewable energy initiatives utilization for electricity peak shaving and valley filling. Besides lithium-ion batteries, other battery types, such as sodium-ion batteries, which are still in the early stages of adoption but offer benefits like abundant resources and lower costs, show promising potential as technology advances.
- Therefore, in the data center energy storage market, lead-acid batteries are valued for their high safety level and mature technology to provide reliable backup power, particularly for large-scale data center applications. Lithium-ion batteries are valued for their longer life cycle to handle peak shaving and valley filling, supporting the sustainable electricity supply. In 2024, the market shares of lithium-ion batteries and lead-acid batteries in China's data center energy storage market by added installed capacity reached 3.3% and 96.7%, respectively. By 2030, the market shares of lithium-ion batteries and lead-acid batteries by added installed capacity in China are expected to 74.3% and 14.0%, respectively.

Source: Interviews with Industry Experts, Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Geographic Breakdown of Data Center Energy Storage by Added Installed Capacity

Geographic Breakdown of Data Center Energy Storage by Added Installed Capacity, 2020, 2024 and 2030E



- In 2020, China led the data center energy storage market with 72.4% of the added installed capacity, highlighting its dominant position supported by significant investment and government backing. The Americas followed with 18.5%, driven by substantial investment in the data center energy storage industry. EMEA (Europe, the Middle East, and Africa) accounted for 5.1%, and the Asia and Pacific region excluding China represented 4.1%. By 2024, with the rapid advancement of AI technologies, China's share decreased to 48.2%, while the Americas saw a substantial increase to 33.5%, reflecting a shift towards diversified investment. EMEA's share slightly increased to 7.7%, and the Asia and Pacific region excluding China grew to 10.5%, indicating rising investments in these regions. Looking ahead to 2030, as the demand for AI-related technology continues to grow and China advances its AI capabilities, China is projected to maintain its leading position with 48.5% of the market share. The Americas are expected to retain a significant share at 35.8%, indicating ongoing growth. EMEA's share is projected to decrease slightly to 5.2%, and the Asia and Pacific region excluding China is expected to increase to 10.5%.

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Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Development Drivers (1/2)

1

Industry Demand from Telcom Networks and Data Centers

- In the era of 5G telecom, artificial intelligence (AI), and big data, the industry's demand for energy storage is driven by the significant increase in power requirements needed for the vast transmission, storage, and processing of data from telecom networks and data centers.
- On the one hand, there will be increased demand from telecom network, driven by the rapid development of telecom networks. As modern communication infrastructure evolves, the demand for energy increases, necessitating robust solutions to ensure continuous and reliable service delivery. Furthermore, within the telecom energy storage industry, the commercial rollout and expansion of 5G networks have significantly amplified the power requirements of communication bases. Known for its ultra-fast response times and minimal latency (under one millisecond), 5G technology has become the dominant station type in markets like China. By 2030, China is expected to deploy an additional 8.0 million 5G base stations, bringing the total to approximately 12.2 million.
- On the other hand, there will be increased demand from data centers, attributable to the relevant workloads, such as AI and high-performance computing (HPC). Implementing these workloads often requires changes to rack and backup power infrastructure to ensure efficient, secure, and continuous power supply and cooling. In the future, with widespread deployment, accelerated adoption, and application of AI will further accelerate the implementation of data centers. It is projected that the global number of data center racks will reach 181.3 million units by 2030, growing at a CAGR of 32.3% from 2024.

2

Energy Transition

- The energy transition aims to shift to a low-carbon energy system by enhancing energy efficiency, decarbonizing power generation, and electrifying the economy to achieve net-zero carbon dioxide emissions. Key pathways involve transitioning from traditional high-pollution energy sources to renewable energy like solar, wind, hydropower, etc.. Energy storage technologies play a crucial role in minimizing energy waste caused by fluctuations in renewable energy supply. They alleviate the pressure of large-scale renewable energy grid connections, improve the absorption of renewable energy, support distributed power and microgrids, and drive the shift from fossil fuels to renewables. The energy transition is a global growing trend. At the end of 2024, more than 150 countries have made commitments to reach carbon neutrality in the mid-21st century, covering over 80% of global carbon dioxide emissions. In particular, China has set the "dual carbon" target, aiming to achieve peak carbon dioxide emissions before 2030 and strive to reach carbon neutrality before 2060. These initiatives taken by multiple countries have accelerated the development of the new energy and energy storage markets.

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Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Development Drivers (2/2)

3 Regulatory Support

- Regulatory frameworks and government support mechanisms, such as subsidies, tax incentives, and financial incentives for investments in energy storage projects, reduce upfront costs and accelerate market uptake, thus driving the adoption and deployment of energy storage systems. In European Union, energy storage has played important role in the European Green Deal and the Fit for 55 policy package, a set of policy initiatives aimed at ensuring the steps to carbon neutrality. These measures accelerate the adoption for the installation of renewable energy plants and co-located energy storage. In Germany, the cabinet canceled the renewable energy surcharge and exempt the value-added tax and income tax on electricity generation revenue associated with residential energy storage systems, effective in July 2022. In the United States, the White House included standalone energy storage in the investment tax credit (ITC) scope for the first time among the Inflation Reduction Act issued in August 2022. Regulatory reforms in China, such as streamlined permitting processes and grid interconnection standards, further facilitate the deployment of energy storage systems, enabling faster project development and implementation. For example, in August 2021, the PRC National Development and Reform Commission and the National Energy Administration issued the "Notice on encouraging renewable electricity generation enterprises to self-build or purchase peak shaving capacity to increase the grid-connected scale" (《關於鼓勵可再生能源發電企業自建或購買調峰能力增加並網規模的通知》), encouraging power generation enterprises to increase the grid-connected scale of renewable energy power generation installations through self-building or purchasing peak adjusting energy storage capabilities. As of December 31st, 2024, more than 20 provinces, autonomous regions, and municipalities in China have issued regional policies related to the mandatory deployment of energy storage alongside renewable energy projects. Operators of telecom base stations and data centers, with their extensive site resources and reliance on substantial energy storage for backup power, are poised to reap significant benefits from this policy. Data centers, in particular, are under increasing pressure to address their high energy consumption and rapidly growing demand for computing power by promoting green electricity usage and reducing carbon emissions. Thus, the installed data center energy storage capacity equipped with sustainable electricity supply functions in China is projected to reach 80.3 GWh by 2030, with a CAGR of 204.9% from 2024. In addition, the bidding policies of the Chinese telecom base station industry have undergone several major changes from 2020 to 2024, which have continued to impact the mechanisms and costs of energy storage projects. Furthermore, government-funded research and development programs spur technological innovation in energy storage technologies, driving down costs and improving performance.

4 Increased Efficiency and Declining Costs

- Increased efficiency and declining costs of electric energy storage technologies are primary drivers behind their increasing adoption and integration into modern energy systems. Technological advancements, including improvements in battery materials & structure, manufacturing processes, and energy management systems, have led to higher efficiency, longer lifespan, and enhanced safety features, contributing to the cost reductions in energy storage products. Driven by growing demand and larger production facilities, economies of scale allow manufacturers to spread fixed costs. For instance, the average price of LFP batteries decreased from RMB1.57/Wh in 2022 to RMB0.56/Wh in the fourth quarter of 2024, dropped by 64.3%.These declining costs make energy storage solutions increasingly viable for a wide range of applications, accelerating the transition towards a more sustainable, flexible, and resilient energy system.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Trends Analysis

1 AI and Big Data Technology Stimulate Market Demand

- Integrating AI and big data technology into various sectors has catalyzed a surge in market demand for computational power and energy, stimulating the growth of the data center energy storage market. The share of global electricity demand attributed to the electricity demand from data centers is expected to rise from 4.0% in 2024 to 10.1% in 2030. AI and big data applications, known for their intensive data processing needs, require vast amounts of computational power and continuous and reliable energy sources to operate efficiently. This dependency on constant power supplies makes energy storage a critical component in the infrastructure supporting these technologies.

2 Diversification and Parallel Development of Technical Routes

- Since lithium-ion batteries boast higher energy density and longer life cycle and lead-acid batteries are relatively more mature in industry value chain, the energy storage industry, especially in data center and telecom sectors, will witness the parallel development of lithium-ion, lead-acid and other multiple battery technologies, providing diversification of battery options and further improving energy storage performance. Lithium-ion battery will contribute to the major growth potential while lead-acid battery will still represent as one of the mainstream applications. Among other technical routes of batteries, sodium-ion batteries are expected to increase their energy storage market share due to their rich raw material resources, suitability for cold regions and high efficiency.

3 Continual Improvement on Battery Performance and Cost Reductions Through Technological Advancements

- The continuous advancements in technology and corresponding reductions in costs have significantly enhanced the performance and reliability of energy storage technologies, leading to decreased costs. This improvement in competitiveness promotes further market development and the application of energy storage solutions. One of the breakthroughs in this domain is the development of battery discharge rate in different working environment, since the energy storage system in data center requires high discharge capabilities and superior high-rate performance to satisfy instantaneous backup power demand in a short time period. Further, leading market participants engage in the research and development of solid-state battery technology, providing safer, higher energy density and longer life cycle options to meet diverse customer requirements. These technologies help lower energy costs and carbon footprints, supporting the broad application in energy storage markets.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Industry Barrier Analysis

1 **Customer Recognition Barriers**

- In the energy storage industries, customer recognition barriers can be critical for new entrants, especially when the primary downstream customers in the telecom and data center energy storage market include large telecom state-owned operators and equipment manufacturers, and large technology companies. These organizations command vast customer resources and substantial market shares, setting stringent requirements for their suppliers across multiple dimensions. They expect high product quality, cost-effectiveness, reliable delivery capacities, robust service support, compliance with regulations, and commitment to sustainability. To successfully navigate these barriers and secure trust and collaboration opportunities from such large-scale customers, suppliers must not only offer products and services that meet these high standards but also demonstrate reasonable pricing and cost structures to meet their customized needs.

2 **Capital Investment Barriers**

- Capital investment barriers in the energy storage industries are primarily due to the substantial financial outlay required for equipment procurement, system integration, and ongoing operations and maintenance. The initial costs associated with setting up production capacity of advanced energy storage systems that can handle the high demands of telecom and data center products are considerable. These systems not only need to be robust to ensure continuity in telecom and data center markets, but they also need to be sophisticated enough to integrate seamlessly with existing digital and energy infrastructures. Additionally, the operational costs, including the maintenance of complex systems that are essential for energy efficiency and reliability, further escalate the investment needed. Consequently, only enterprises with robust financial backing are typically able to enter the market and compete effectively.

3 **Technological Barriers**

- The energy storage industry faces significant technological barriers that stem primarily on sophisticated battery technology, energy management systems, and intelligent control algorithms. Companies that possess core technologies and patents enjoy significant competitive advantages in the market, delivering superior high-rate performance with better safety level and cost-effectiveness. Additionally, developing or acquiring these technologies entails substantial investment in research and development, often coupled with the need to navigate global complex patent landscapes and regulatory standards. The integration of these technologies into existing infrastructure demands not only technical adaptability but also compatibility with diverse global energy storage standards. As a result, the technological complexity not only restricts market entry but also challenges the scalability and adaptability of solutions within this sector.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Policy and Regulation Analysis - China

Laws and Regulations	Year of Issuance / Update	Issue Dept.	Description
《Action Plan for Accelerating the Construction of a New Power System (2024-27)》 《加快构建新型电力系统行动方案（2024—2027年）》	2024	National Development and Reform Commission, National Energy Administration and National Data Administration	This policy outlines plans to upgrade underutilized new energy power stations with advanced energy storage systems, improving operational efficiency and grid integration. It also focuses on building system-friendly new energy plants to enhance power supply security, aiming to increase renewable energy's reliable capacity contribution by over 10%.
Notification on Further Strengthening the Update and Application of Energy Conservation Standards 《关于进一步加强节能标准更新升级和应用实施的通知》	2023	National Development and Reform Commission, State Administration for Market Regulation	The policy emphasizes the acceleration in the development and revision of energy conservation standards specifically for new infrastructures like data centers and communication base stations. It mandates these facilities to meet energy efficiency standards, which supports the construction and widespread application of energy storage systems in the telecom sector.
Guidelines for Promoting the Development of the Energy Electronics Industry 《关于推动能源电子产业发展的指导意见》	2023	Ministry of Industry and Information Technology, Ministry of Education, Ministry of Science and Technology, National Energy Administration, among others	The policy promotes diversified energy supply models such as distributed energy storage and "Photovoltaic + Storage" systems. It specifically encourages the enhancement of energy electronics in new infrastructures like 5G base stations and new energy vehicle charging stations, thereby driving the development of energy storage within the telecom sector.
Opinions on Financial Support for Work Related to Carbon Peak and Carbon Neutrality 《财政支持做好碳达峰碳中和工作的意见》	2022	Ministry of Finance of the People's Republic of China	This opinion proposes to encourage pilot implementation in areas where fit for construction, develop new ESS, and accelerate the formation of the power development mechanism based on energy storage and peaking capacity as the basic support. Also, this opinion vigorously supports the development of NEVs, stabilizing the demand for LFP cathode material.
The "14th Five-Year Plan" New Energy Storage Development Implementation Plan 《“十四五”新型储能发展实施方案》	2022	National Development and Reform Commission, National Energy Administration	This plan promotes the diversified technological development, carrying out research on key core technologies, equipment and integrated optimization design of sodium ion batteries, new lithium-ion batteries, lead carbon batteries, liquid flow batteries, etc.
The 14th Five-Year Plan for Digital Economy Development 《“十四五”数字经济发展规划》	2021	State Council of the People's Republic of China	This policy underscores the integration and advancement of digital infrastructure with sustainable energy solutions. It promotes the use of renewable energy in data centers and supports innovations in energy storage that align with the rapid growth of telecom and data center services. This facilitates both technological advancements and sustainability in the rapidly evolving digital economy.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Policy and Regulation Analysis - Global

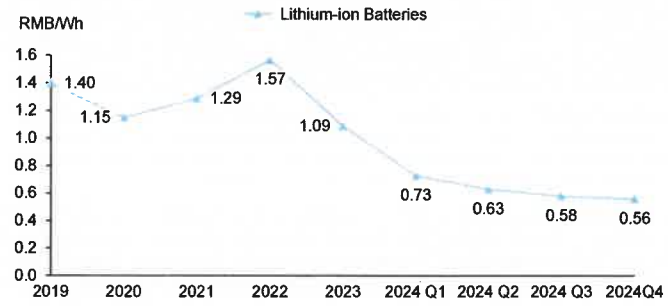
Country / Region of Issuance	Laws and Regulations	Year of Issuance / Update	Issue Dept.	Description
European Union	EU Code of Conduct on Data Center Energy Efficiency (15th Edition)	2024	European Commission	Establishes best practices for energy efficiency in data centers, which are critical for reducing the energy consumption of data center facilities and promoting sustainable practices in the telecom industry.
Republic of Korea	Green Energy and Energy Conservation Act	2021	Korean National Assembly	Focuses on increasing the use of renewable energy and enhancing energy efficiency across industries, including telecom. It encourages the adoption of energy storage systems to stabilize the integration of renewable energy sources in data centers and telecom networks.
India	Energy Conservation Building Code	2021	Bureau of Energy Efficiency	The policy broadly aimed at improving energy efficiency in commercial buildings, the ECBC includes provisions that encourage the integration of energy-efficient technologies in data centers, enhancing the overall efficiency of energy use in Telecom facilities.
European Union	EU Ecodesign Regulations for servers and data storage products	2019	European Commission	The policy sets mandatory requirements for the energy efficiency and environmental design of servers and data storage products. This ensures that these devices consume energy more efficiently, thus reducing overall energy demand and associated costs in data centers and telecom infrastructure. These regulations help drive the adoption of energy-efficient technologies and practices, ultimately supporting the sustainability goals of these sectors and encouraging innovation in energy usage optimization.
United States	Data Center Optimization Initiative (DCOI)	2019	Federal Government	Mandates federal data centers to optimize energy use by adopting advanced energy storage and management technologies, thereby improving efficiency and resilience in telecom and data center operations.
European Union	CLC/TS 50600-5-1 (EU Code of Conduct on Data Center Energy Efficiency)	2016	European Committee for Electrotechnical Standardization	Provides guidelines on the design and operation of data centers, including energy usage, which are critical for implementing efficient energy storage systems to support robust and sustainable telecom operations.

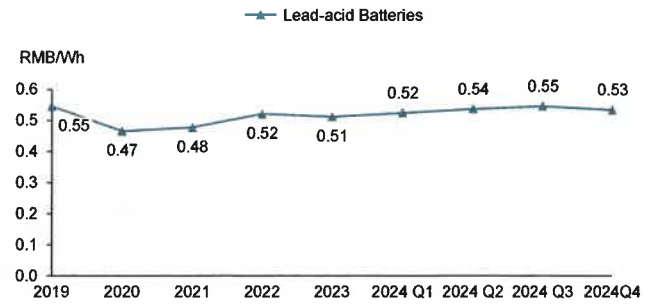
Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Average Price of Lithium-ion and Lead-acid Batteries - China

Average Price of Lithium-ion Batteries and Lead-acid Batteries (China), 2019-2024 Q4





- The price of lithium carbonate significantly affects the average selling price of lithium-ion batteries. Similar to the trend of lithium carbonate, the average market prices of lithium-ion batteries decrease from RMB1.57/Wh in 2022 to RMB0.56/Wh in the fourth quarter of 2024. In the future, the price of lithium carbonate is expected to be relatively stabilized following with a slight decrease due to softening demand sentiments in the long term. Regarding the future price trend of lithium-ion batteries, more advanced battery technology and improved economies of scale will play a significant role in further reducing costs. Thus, it is expected that the average price of lithium-ion batteries will be at the range from RMB0.55/Wh to RMB0.75/Wh in the next two years, while the price fluctuation trajectory is similar to that of raw materials, especially lithium carbonate.
- The price of lead ingots significantly affects the average selling price of the Group's lead-acid battery products. Similar to the trend of lead ingots, the average market prices of lead-acid batteries fluctuate from RMB0.47/Wh in 2020 to RMB0.53/Wh in the fourth quarter of 2024. Compared to lithium-ion batteries, lead-acid batteries enjoy a stable recycling supply chain. With current recycling costs of lead-acid batteries remaining at RMB0.25/Wh to RMB0.30/Wh, future prices will be largely influenced by the recycling system and lead ingot prices, thus the price of lead-acid batteries is likely to exhibit a gentle decrease due to its relatively low recycling costs. The average price of lead-acid batteries is expected to be relatively stable and remain at the range from RMB0.46/Wh to RMB0.56/Wh in the next two years, while the price fluctuation trajectory is similar to that of raw materials, especially lead ingots.

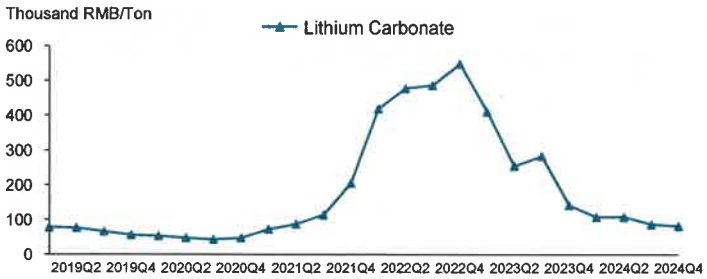
Note: The average price of lithium-ion batteries refer to the average price of 2-hour lithium-ion battery energy storage system.

Source: Frost & Sullivan

Overview of Global and China Telecom and Data Center Energy Storage Market

Average Price Trends of Main Raw Materials of Lithium-ion and Lead-acid Batteries - China

Average Price Trends of Main Raw Materials of Lithium-ion and Lead-acid Batteries in China, 2019 Q1-2024 Q4



- The prices of key raw materials are primarily driven by market supply and demand, as well as inventory levels. For lithium carbonate, main raw material of lithium-ion batteries, due to the limited and slow-growing production capacity and surge in demand from ESS and NEVs from 2020 to 2022, the average price escalated from RMB48.0 thousand per ton to over RMB482.4thousand per ton. The surge in demand for ESS has been driven by a combination of renewable energy transformation and electrification, mature technology and cost decrease, and favorable policies, in both China and overseas. Attributable to the balancing between supply and demand, the average price of lithium carbonate dropped to RMB272.3 thousand per ton in 2023. The price plunged mainly due to the increase in capacity and inventory level of lithium carbonate. Further in the fourth quarter of 2024, continuous rise in inventory level of lithium carbonate accelerated the drop in average price of lithium carbonate to RMB81.9 thousand per ton. As the supply and demand relationship gradually reaches equilibrium in the future, production capacity utilization rates of this industry will rise. Under the premise of economic stability, the price of lithium carbonate will tend to be stabilized and decrease slightly, and it is expected to fluctuate within the range of RMB70 thousand per ton to RMB110 thousand per ton in the next two years.
- Lead ingots, the primary raw material of lead-acid battery, account for nearly 60% of the total cost of lead-acid batteries, substantially influencing the price of lead-acid battery. After the short-term price drop of lead ingots in 2019, from 2020 to 2023, the price of lead ingots has shown a steady increase and price of lead ingot maintained at the price range from RMB14.0 thousand per ton to RMB17.5 thousand per ton. In the second quarter of 2024, due to the tight supply-demand relationship of lead ingots and the continued growth of lead demand in the battery industry, rise in the average price of lead ingots to RMB17.6 thousand per ton led to the short-term increase in the price of lead-acid batteries. This phenomenon gradually eased in the fourth quarter of 2024, with the average price dropping to RMB16.8 thousand per ton. With the continuous establishment of the lead recycling system, the price of lead ingots is projected to decrease steadily and revert to the price level between 2020 and 2023.

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Source: Wind, Frost & Sullivan

Agenda

Competitive Landscape of Global and China Telecom and Data Center Energy Storage Market

Competitive Landscape

Top 5 Global Data Center Energy Storage Battery Providers, 2024

Ranking	Company	Shipment Volume(GWh)	Market Share（%）
1	ENERSYS	2.9	17.5%
2	**SHUANGDENG GROUP 双登**	**2.7**	**16.1%**
3	EXIDE	1.9	11.5%
4	LEOCH 理士	1.5	9.1%
5	NARADA 南都	1.3	7.9%

According to Frost & Sullivan, competition in the global data center energy storage battery market is highly concentrated. In 2024, the total global added installed capacity for energy storage batteries in data center application reached 16.5 GWh, with the top five players holding a combined market share of approximately 62.0%. **Our company achieved a shipment volume of 2.7 GWh of energy storage batteries for data center application, ranking the second among global data center energy storage battery providers and the first among those based in China.**

Note: The shipment volume calculated here is consistent with the installation volume.

Source: Frost & Sullivan

Competitive Landscape of Global and China Telecom and Data Center Energy Storage Market

Competitive Landscape

Top 5 Global Telecom Energy Storage Battery Providers, 2024

Ranking	Company	Shipment Volume(GWh)	Market Share（%）
1	**SHUANGDENG GROUP 双登**	**4.0**	**9.2%**
2	LEOCH 理士	3.5	8.0%
3	EXIDE	2.8	6.4%
4	NARADA 南都	2.3	5.2%
5	ZTT 中天	1.9	4.3%

According to Frost & Sullivan, competition in the global telecom energy storage battery market is fragmented. In 2024, the total global added installed capacity for energy storage batteries in telecom application reached 43.9 GWh, with the top five players holding a combined market share of approximately 33.2%. **Our company achieved a shipment volume of 4.0 GWh, ranking the first among global telecom energy storage battery providers.**

Note: The shipment volume calculated here is consistent with the installation volume.

Source: Frost & Sullivan

Competitive Landscape of Global and China Telecom and Data Center Energy Storage Market

Competitive Landscape

Top 5 Global Telecom and Data center Energy Storage Battery Providers, 2024

Ranking	Company	Shipment Volume(GWh)	Market Share（%）
1	**SHUANGDENG GROUP 双登**	**6.7**	**11.1%**
2	LEOCH 理士	5.0	8.3%
3	EXIDE	4.7	7.8%
4	ENERSYS	4.6	7.6%
5	NARADA 南都	3.6	6.0%

According to Frost & Sullivan, competition in the global telecom and data center energy storage battery market is highly fragmented. In 2024, the total global added installed capacity for energy storage batteries in telecom and data center application reached 60.4 GWh, with the top five players holding a combined market share of approximately 40.7%. **Our company achieved a shipment volume of 6.7 GWh, ranking the first among global telecom and data center energy storage battery providers.**

Note: The shipment volume calculated here is consistent with the installation volume.

Source: Frost & Sullivan

Competitive Landscape of Global and China Telecom and Data Center Energy Storage Market

Competitive Landscape

Top 5 China-based Telecom and Data center Energy Storage Battery Providers in China, 2024

Ranking	Company	Shipment Volume(GWh)	Market Share（%）
1	**SHUANGDENG GROUP 双登**	**5.4**	**16.6%**
2	LEOCH 理士	3.0	9.3%
3	NARADA 南都	2.8	8.6%
4	SACREDSUN 圣阳	2.0	6.2%
5	ZTT 中天	1.7	5.2%

According to Frost & Sullivan, competition in the China telecom and data center energy storage battery market is highly fragmented. In 2024, the total China added installed capacity for energy storage batteries in telecom and data center application reached 32.4 GWh, with the top five China-based players holding a combined market share of approximately 45.9%. **Our company achieved a shipment volume of 5.4 GWh, ranking the first among China telecom and data center energy storage battery providers.**

Note: The shipment volume calculated here is consistent with the installation volume.

Source: Frost & Sullivan

Competitive Landscape of Global and China Telecom and Data Center Energy Storage Market

Company Profile

Notes:

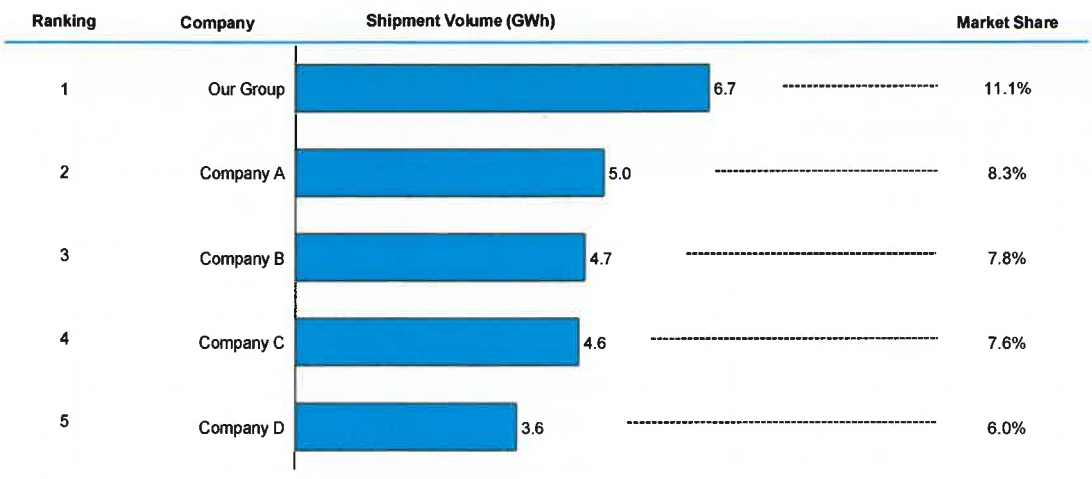
- *Established in 2000, EnerSys is a U.S.-based company listed on the New York Stock Exchange, specializing in the design, manufacturing, and sales of lithium-ion and lead-acid batteries and power systems, with its products widely used in telecommunications, data centers, industrial equipment, and renewable energy sectors.*
- *Established in 1947, Exide Industries Limited is a listed Indian-based company specializing in the production and sales of lead-acid batteries, with its products widely used in automotive, industrial, and renewable energy sectors.*
- *Established in 1994, Zhejiang Narada Power Source Co., Ltd. is a Chinese company listed on the Shenzhen Stock Exchange, specializing in the research, production, and sales of lead-acid and lithium batteries, with its products widely used in power, energy storage, and industrial sectors.*
- *Established in 2004, GS Yuasa International Ltd. is a Japan-based company listed on the Tokyo Stock Exchange, specializing in the research, development, production, and sales of lead-acid and lithium batteries, with its products widely used in automotive, motorcycle, industrial equipment, backup power supply, and aerospace sectors.*
- *Established in 1999, Leoch International Technology Limited is headquartered in China and listed on the Hong Kong Stock Exchange. The company is a global leader in battery manufacturing, focusing on the production of lithium batteries and lead-acid batteries.*
- *Established in 1998, Shandong Sacred Sun Power Sources Co., Ltd. is headquartered in China and listed on the Shenzhen Stock Exchange. The company is a high-tech enterprise focused on the research, development, production, and sales of batteries and energy storage systems. Sacred Sun produces lithium batteries and lead-acid batteries.*
- *Established in 1996, ZTT New Energy Co., Ltd. is headquartered in China and listed on the Shanghai Stock Exchange. The company is a comprehensive provider of new energy solutions, focusing on the production of lithium batteries, photovoltaic modules, wind power equipment, and energy storage systems.*
- *Established in 1988, Cospowers Technology Company Limited is an unlisted company headquartered in China. The company is a leading scientific and technological enterprise in the lithium battery industry which specializes in the research, development, production, and sales of batteries and energy storage systems.*
- *Established in 1994, Jiangsu Highstar Battery Manufacturing Co., Ltd. is an unlisted company headquartered in China. The company specializes in the research, production, and sales of lithium and lead-acid batteries, with its products widely used in power, energy storage, and industrial sectors.*

Source: Frost & Sullivan

Competitive Landscape of Global and China Telecom and Data Center Energy Storage M

Competitive Landscape - Global

Top 5 Global Telecom and Data Center Energy Storage Battery Providers, 2024



Notes:
(1) Established in 1999, Company A is headquartered in China and listed on the Hong Kong Stock Exchange. The company is a global leader in battery manufacturing, focusing on the production of lithium batteries and lead-acid batteries.

(2) Established in 1947, Company B is a listed Indian-based company specializing in the production and sales of lead-acid batteries, with its products widely used in automotive, industrial, and renewable energy sectors.

(3) Established in 2000, Company C is a U.S.-based company listed on the New York Stock Exchange, specializing in the design, manufacturing, and sales of lithium-ion and lead-acid batteries and power systems, with its products widely used in telecommunications, data centers, industrial equipment, and renewable energy sectors.

(4) Established in 1994, Company D is a Chinese company listed on the Shenzhen Stock Exchange, specializing in the research, production, and sales of lead-acid and lithium batteries, with its products widely used in power, energy storage, and industrial sectors.

- According to Frost & Sullivan, competition in the global telecom and data center energy storage battery market is competitive. In 2024, the total global added installed capacity for energy storage batteries in telecom and data center application reached 60.4 GWh, with the top five players holding a combined market share of approximately 40.7%. Our Group achieved a shipment volume of 6.7 GWh, ranking the first among global telecom and data center energy storage battery providers, with the market share of 11.1%.

Source: Interviews with Industry Experts, Frost & Sullivan

For IO Use

Competitive Landscape - China

Top 5 Telecom and Data Center Energy Storage Battery Providers in China, 2024

Ranking	Company	Shipment Volume (GWh)	Market Share
1	Our Group	5.4	16.6%
2	Company A	3.0	9.3%
3	Company D	2.8	8.6%
4	Company E	2.0	6.2%
5	Company F	1.7	5.2%

Notes: Sales to Chinese energy storage battery distributors are counted as added installed capacity in China.

Notes:
(5) Established in 1998, Company E is headquartered in China and listed on the Shenzhen Stock Exchange. The company is a high-tech enterprise focused on the research, development, production, and sales of batteries and energy storage systems. Sacred Sun produces lithium batteries and lead-acid batteries.

(6) Established in 1996, Company F is headquartered in China and listed on the Shanghai Stock Exchange. The company is a comprehensive provider of new energy solutions, focusing on the production of lithium batteries, photovoltaic modules, wind power equipment, and energy storage systems.

- According to Frost & Sullivan, the telecom and data center energy storage battery market in China is relatively competitive. In 2024, the total China added installed capacity for energy storage batteries in telecom and data center application reached 32.4 GWh, with the top five players holding a combined market share of approximately 45.9%. Our Group achieved a shipment volume of 5.4 GWh, ranking the first among telecom and data center energy storage battery providers in China, with the market share of 16.6%.

Source: Interviews with Industry Experts, Frost & Sullivan

Agenda

Overview of Global And China Electrical Energy Storage Industry

For IO Use

Brief Introduction of Global and China Electrical Energy Storage Industry

- The electrical energy storage industry includes (i) the power side, including power generation side and grid side, and (ii) the user side, including commercial, industrial, and residential uses. Power generation and grid-side energy storage have higher capacity and larger scales, and they have experienced rapid development over the past few years as their economies of scale have been readily formed. User-side energy storage features low capacity and is usually applied with distributed power generation equipment. Meanwhile, user-side energy storage generally requires precise management, which can adapt to the different consumption habits of the downstream users and enhance energy consumption efficiency.

- In line with the development trend of global energy storage industry, the market size of global electrical energy storage by added installed capacity increased from 10.8 GWh in 2020 to 207.9 GWh in 2024 at a CAGR of 109.5%. It is forecast that the market size of global electrical energy storage by added installed capacity will increase to 1,506.8 GWh in 2030, representing a CAGR of 39.1% from 2024 to 2030. The market size of China electrical energy storage by added installed capacity increased from 3.1 GWh in 2020 to 128.6 GWh in 2024 at a CAGR of 153.8%. It is expected that the market size of China electrical energy storage by added installed capacity will increase to 1,007.0 GWh in 2030, representing a CAGR of 40.9% from 2024 to 2030. In the realm of energy storage technologies, lithium-ion batteries will remain as the predominant types, representing 82.4% of the total added installed capacity of the global electrical energy storage industry in 2030, followed by sodium-ion batteries.

- The global electrical energy storage market is characterized by a relatively fragmented competitive landscape, with more than 10,000 existing and startup companies in the industry, covering products including energy storage batteries, battery management systems, power conversion system, etc. Success in this market is driven by several key factors: (i) customer recognition plays a crucial role, as trusted brands in this market are more likely to secure long-term customers; (ii) product reliability is also paramount, as energy storage battery must meet high standards of performance and safety; (iii) maintaining a cost advantage is vital for staying competitive, particularly in a price-sensitive market; and (iv) the ability to expand into international markets is essential for growth, as global demand for energy storage solutions continues to rise, driven by the transition to renewable energy and the need for grid stability.

Source: Frost & Sullivan

Overview of Global and China Energy Storage Market

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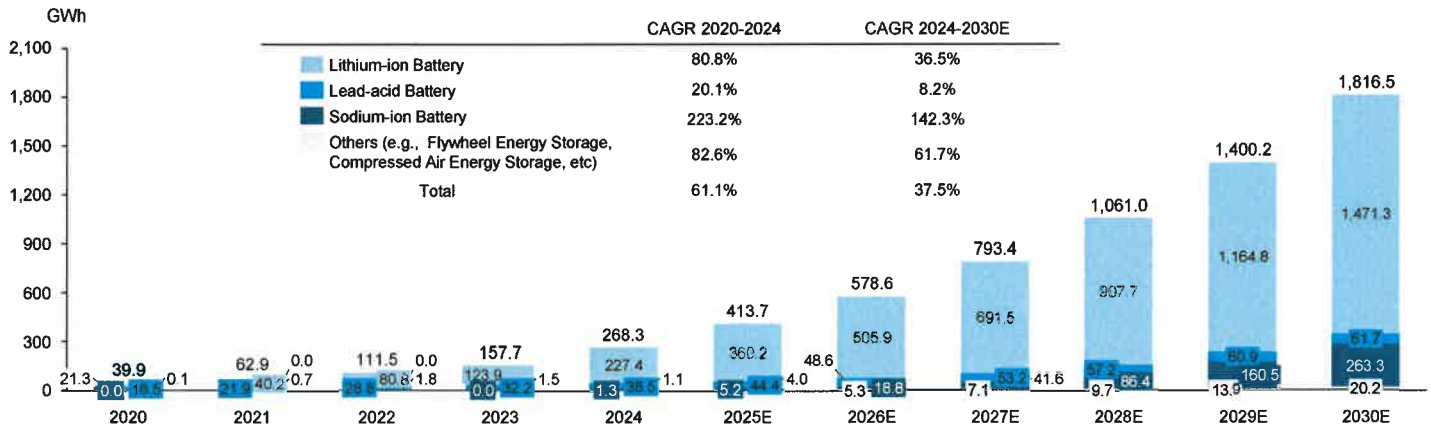
Market Size of Global Energy Storage by Added Installed Capacity

Added Installed Capacity of Global Energy Storage, Breakdown of Energy Storage Technologies, 2020-2030E



Source: International Energy Agency (IEA), China Energy Storage Alliance(CNESA), Frost & Sullivan

Overview of Global and China Energy Storage Market

Market Size of China Energy Storage by Added Installed Capacity

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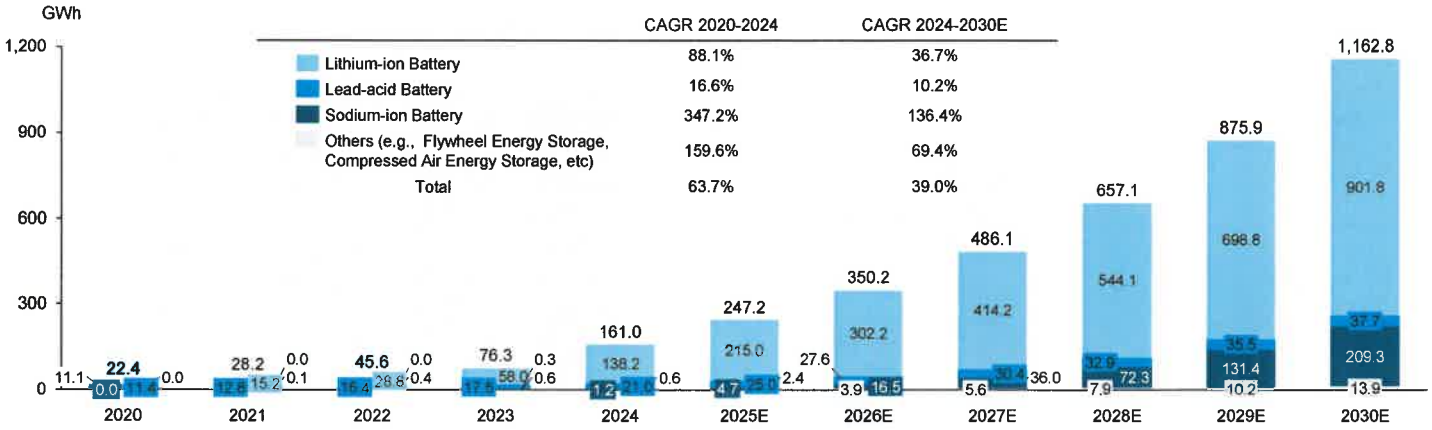
Added Installed Capacity of China Energy Storage, Breakdown of Energy Storage Technologies, 2020-2030E



Source: China Energy Storage Alliance (CNESA), Frost & Sullivan

Overview of Global and China Energy Storage Market

Production Volume and Sales Volume of Global Energy Storage Battery Market

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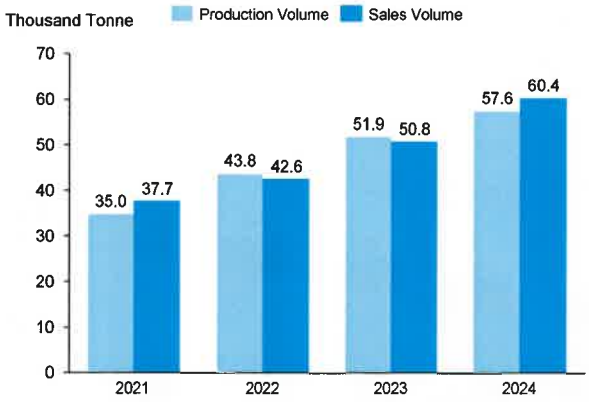
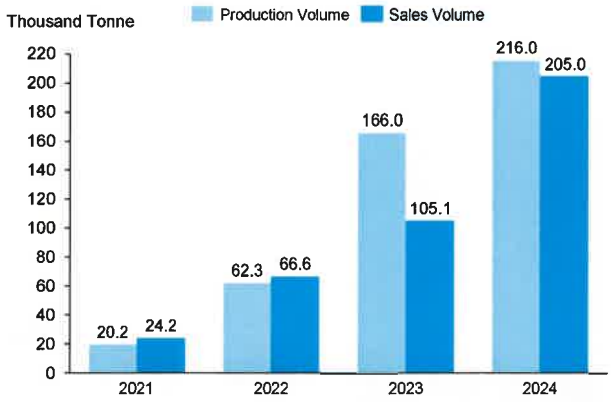
Global Telecom and Data Center Energy Storage Battery Production and Sales Volume, 2021-2024



Global Electrical Energy Storage Lithium-ion Battery Production and Sales Volume, 2021-2024



Notes: Global production volume and sales volume of electrical energy storage lead-acid battery is minor.

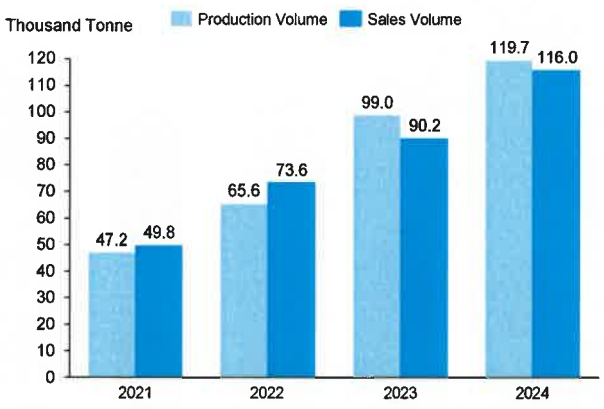
Source: China Energy Storage Alliance (CNESA), Interviews with Industry Experts, Frost & Sullivan

Overview of Global and China Energy Storage Market

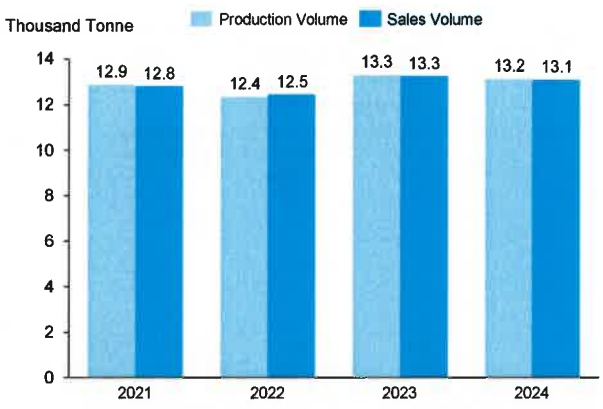
Production Volume and Sales Volume of Raw Material of Global Energy Storage Battery Market

For IO Use

Global Lithium Carbonate Production and Sales Volume, 2021-2024



Global Lead Ingots Production and Sales Volume, 2021-2024



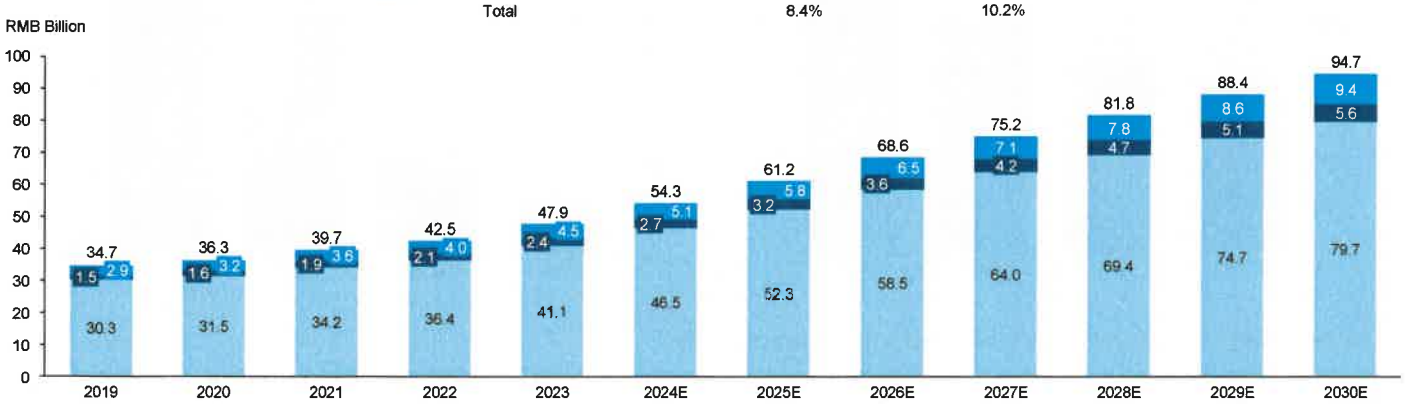
Source: National Bureau of Statistics, China Non-Ferrous Metals Fabrication Industry Association (CNFA), Shanghai Metals Market (SMM), Interviews with Industry Experts, Frost & Sullivan

Overview of Global UPS Market

Market Size of Global UPS Industry by Revenue

Market Size of Global UPS Industry by Revenue, Breakdown by Application, 2019-2030E

	CAGR 2019-2023	CAGR 2023-2030E
Transportation UPS	11.6%	11.2%
Electrical Engineering UPS	12.3%	13.0%
Others	7.9%	9.9%
Total	8.4%	10.2%



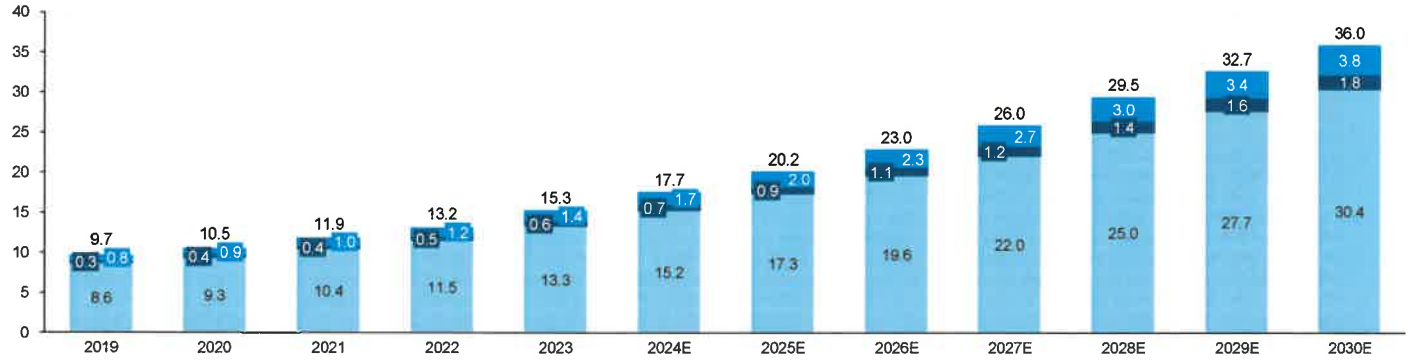
Source: CPSS, Frost & Sullivan

Overview of China UPS Market

Market Size of China UPS Industry by Revenue

Market Size of China UPS Industry by Revenue, Breakdown by Application, 2019-2030E

	CAGR 2019-2023	CAGR2024E-2030E
Transportation UPS	17.0%	15.0%
Electrical Engineering UPS	18.5%	17.0%
Others	11.4%	12.5%
Total	12.1%	13.0%



Source: CPSS, Frost & Sullivan

Appendix (1/11)

- According to Frost & Sullivan, in 2023, we ranked the first among global telecom and data center energy storage battery providers in terms of shipment volume, achieving a market share of 10.4%.
- According to Frost & Sullivan, in 2023, we ranked the tenth among global energy storage battery providers in terms of added installed capacity, achieving a market share of 3.4%. According to Frost & Sullivan, in 2023, we ranked the eighth among energy storage battery providers in the PRC market in terms of added installed capacity, achieving a market share of 5.8%.
- Notes:
- 1. Top 100 telecom operators and equipment manufacturers are ranked based on the top telecom equipment manufacturers ranking integrated by Frost & Sullivan from multiple open sources, annual report, and research database of Frost & Sullivan, and the top 100 telecom operators ranking provided by Dgtl Infra, a platform for digital infrastructure intelligence providing data on telecom, data centers, fiber, etc. The top 100 telecom operators and equipment manufacturers are selected based on several quantifiable factors including sales revenue, market capitalization, number of subscribers, number of employees, etc.
- 2. Based on the definition provided by China Academy of Information and Communications Technology (CAICT), self-owned data center companies are companies build, own and operate their own data centers, mainly telecom operators and cloud services providers. Top 10 Chinese self-owned data center companies are ranked based on China Academy of Information and Communications Technology (CAICT), International Data Corporation (IDC) and research database of Frost & Sullivan. Top 10 Chinese self-owned data center companies are selected based on several quantifiable factors including sales revenue, service range, investment in research and development, etc.
- 3. Top 10 Chinese third party data center companies are ranked based on "Top 10 Data Center Service Providers in China in 2024" launched by CAICT. Top 10 Chinese third party data center companies are selected based on factors including overall scale, capacity building, financial status, international layout, etc.

- According to Frost & Sullivan, global energy storage cumulative installed capacity is expected to increase from 478.5 GWh in 2023 to 6,393.0 GWh in 2030.
- According to Frost & Sullivan, the cumulative number of global telecom base stations is expected to increase from 17.8 million units in 2023 to 42.2 million units in 2030, which will drive the global added installed capacity of telecom energy storage to rise from 37.8 GWh in 2023 to 128.0 GWh in 2030.
- According to Frost & Sullivan, the proportion of global electricity consumption by data centers is expected to increase from 3.3% in 2023 to 10.1% in 2030.
- According to Frost & Sullivan, the global added installed capacity of data center energy storage is expected to increase from 13.1 GWh in 2023 to 212.2 GWh in 2030.
- According to Frost & Sullivan, in 2023, we ranked first in terms of shipment volumes in the global telecom base station energy storage market. In 2023, our market share in the global telecom market reached 9.7%.
- According to Frost & Sullivan, in 2023, we ranked first among Chinese companies in terms of shipment volumes in the global data center energy storage market. In 2023, our market share in the global data center market reached 12.5%.
- According to Frost & Sullivan, in 2023, we are one of the leading Chinese companies in terms of shipment volume of energy storage batteries in commercial and residential settings.
- According to Frost & Sullivan, such fluctuation in lithium-ion battery is generally in line with the market trend.
- According to Frost & Sullivan, the global energy storage battery market is competitive.
- To preserve relationships with our key customers and take effort to maintain its market share, we strategically accepted more competitive pricing terms which is also in line with prevailing market price according to Frost & Sullivan.

Source: Frost & Sullivan

Appendix (2/11)

- According to Frost & Sullivan, the average purchase price of LFP increased by approximately 84.2% in 2021, and the average purchase price of electrolytes (for lithium-ion batteries) increased by approximately 103.7% in 2021, resulting in an approximately 11.5% year-on-year increase in the per-unit cost of lithium-ion batteries, calculated by dividing the sum of raw material costs, manufacturing and labor costs, and other costs in the manufacturing process by production volume.
- According to Frost & Sullivan, the market for the telecom base station is highly concentrated with large State-Owned Enterprises occupying substantial market shares.
- According to Frost & Sullivan, in the near term, the market demand for energy storage products, including our lithium-ion batteries, will continue to be affected by the availability of government incentives.
- According to Frost & Sullivan, lead-acid has long been and continues to be a popular choice for energy storage in telecom base stations and data centers.
- According to Frost & Sullivan, in 2023, we ranked the first among global telecom base station and data center energy storage battery providers in terms of shipment volume, achieving a market share of 10.4%.
- According to Frost & Sullivan, graphite prices declined initially from RMB44,000 per ton in 2019 to RMB37,000 per ton in 2021 due to increased production capacity and efficiency gains. However, prices began rising from RMB37,000 per ton in 2021 and reached RMB47,000 per ton in 2022, driven by heightened demand from applications such as the electric vehicle sector, with future trends suggesting potential stabilization or slight decreases due to advancements in mining technology and evolving demand dynamics. Conversely, the average price of aluminum alloy steadily increased from RMB14,619 per ton in 2019 to RMB21,295 per ton in 2022, driven by growing downstream demand and limited supply, before experiencing a decrease in 2023 to RMB19,491 per ton, and the average price has rebounded to RMB20,437 per ton in 2024. Besides, prices of lead ingots and lithium carbonate also experienced fluctuations. After the short-term price drop of lead ingots in 2019, from 2020 to 2023, the price of lead ingots has shown a steady increase and price of lead ingot maintained at the price range from RMB14.0 thousand per ton to RMB17.5 thousand per ton. In 2024, the price of lead ingots rose to RMB17.6 thousand per ton in the second quarter and dropped back to RMB16.8 thousand per ton in the fourth quarter. Lithium carbonate prices first dropped to an average of RMB48.0 thousand per ton in 2020 and then, the price of lithium carbonate experienced significant growth between 2020 and 2022, and later dropped to RMB 81.9 thousand per ton in the fourth quarter of 2024, according to Frost & Sullivan.
- Furthermore, according to Frost & Sullivan, the global energy storage industry is expected to include various categories of products, including lithium-ion batteries, lead-acid batteries, sodium-ion batteries, and others (such as flywheel energy storage and compressed air energy storage). From 2023 to 2030, the global installed capacity of lithium-ion energy storage batteries is projected to grow from 123.9 GWh to 1,329.8 GWh, with a CAGR of 40.4%, significantly outpacing other technologies. During the same period, lead-acid energy storage batteries, benefiting from their mature technology and high safety, are expected to achieve steady growth, with new installed capacity increasing from 32.2 GWh to 72.3 GWh, with a CAGR of 12.2%. Sodium-ion batteries, known for their abundant resources, adaptability, and cost-effectiveness, are projected to see their global new installed capacity grow from initial commercialization to 132.6 GWh by 2030, with a CAGR of 211.5%. Other technologies, including flywheel energy storage and compressed air energy storage, are expected to grow from 1.5 GWh in 2023 to 142.3 GWh in 2030, with a CAGR of 91.8%. Technological advancements in alternative energy storage methods such as sodium-ion batteries, flywheel energy storage and compressed air energy storage will offer customers a broader range of product choices. However, we cannot guarantee that our efforts to keep pace with technological changes can succeed or our products will continue to be favored by our customers in the long term. If customers shift their preference to other energy storage products, our business, prospects, and financial position could be adversely affected.
- According to Frost & Sullivan, global shipments of the energy storage batteries used for telecom base stations and data centers increased from 37.7 GWh in 2021 to 50.9 GWh in 2023, reflecting a CAGR of 16.2%. It is projected to further rise to 340.2 GWh by 2030, with an anticipated CAGR of 31.2% from 2023 to 2030.

Source: Frost & Sullivan

Appendix (3/11)

- According to Frost & Sullivan, in 2023, we ranked the first among global telecom and data center energy storage battery providers in terms of shipment volume.
- During the Track Record Period, our gross profit margin and our inventory turnover rates were above industry average, according to Frost & Sullivan.
- According to Frost & Sullivan, in 2023, we ranked first in terms of shipment volume in global telecom and data center energy storage markets.
- According to Frost & Sullivan, in 2023, we ranked first among Chinese companies in terms of shipment volume in the global telecom base station energy storage market.
- According to Frost & Sullivan, safety and costs are the key considerations for energy storage batteries applied in data centers.
- According to Frost & Sullivan, in 2023, we ranked first among Chinese companies in terms of shipment volume in the global data center energy storage market.
- According to Frost & Sullivan, our use of distributors is in line with the industry norm.
- According to Frost & Sullivan, our good return policy with distributors is in line with the industry practice.
- As confirmed by Frost & Sullivan, having such a level of concentration is common in the energy storage batteries market due to the high concentration of market players in the telecommunication industry and data center industry.
- According to Frost & Sullivan, such price adjustment mechanism is common in the industry.
- According to Frost & Sullivan, having such overlap is common in the industry.
- According to Frost & Sullivan, in 2021, 2022, 2023 and the three months ended March 31, 2024, the market price of LFP cathode materials was RMB55.0 thousand per ton, RMB125.0 thousand per ton, RMB72.2 thousand per ton, and RMB36.5 thousand per ton, respectively.
- According to Frost & Sullivan, these metrics and measurements are in line with the norm of the energy storage industry, and our metrics are in the average range.
- We consistently perform safety reviews, maintaining a level II safety production standardization certificate, with incident rates below the industry average, as confirmed by Frost & Sullivan.
- According to Frost & Sullivan, economic influences such as fluctuating raw material costs and changes in demand can affect pricing and production strategies.
- According to Frost & Sullivan, average selling price of lithium-ion batteries are significantly impacted by the price of key raw material, including lithium iron phosphate and other ancillary materials.
- Average selling price of batteries used in electrical energy storage settings is generally in line with the industry trend, according to Frost & Sullivan.
- According to Frost & Sullivan, lead ingots, the primary raw material for lead-acid batteries, account for approximately 60% of their total production cost, making them a significant factor in determining battery prices. In the nine months ended September 30, 2024, the average price of lead ingots increased to RMB16,888.2 per ton, driven by a tight supply-demand balance and growing demand for lead.
- According to Frost & Sullivan, the energy storage battery industry is characterized by relatively long receivables turnover periods, primarily due to the composition of customers and the nature of projects.
- According to Frost & Sullivan, the market price of lithium-ion batteries decreased from RMB1.18 per Wh in 9M2023 to RMB0.65 Wh in 9M2024, and the market price of lithium carbonate decreased from RMB315.7 thousand per ton in 9M2023 to RMB100.6 thousand per ton in 9M2024.

Source: Frost & Sullivan

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- According to Frost & Sullivan, the cumulative volume of global 5G telecom base stations is expected to reach 25.0 million units till 2030, presenting a CAGR of 25.9% from 2023, and the added installed capacity of global telecom energy storage is expected to reach 128.0 GWh in 2030, representing a CAGR of 19.0% from 37.8 GWh in 2023. The lithium-ion batteries applied in telecom stations are expected to reach 75.2 GWh in 2030, representing a CAGR of 22.9% from 17.7 GWh in 2023. The market share of lithium-ion batteries amounted to 47.0% of the global telecom energy storage capacity in 2023, and is expected to reach 58.8% in 2030.
- According to Frost & Sullivan, the global number of data center racks is expected to reach 184.6 million units by 2030, growing at a CAGR of 32.7% from 2023. the global added installed capacity of data center energy storage is expected to increase from 13.1 GWh in 2023 to 212.2 GWh in 2030. The lithium-ion batteries applied in data center are expected to reach 173.1 GWh in 2030, representing a CAGR of 106.3% from 1.1 GWh in 2023. The market share of lithium-ion batteries amounted to 8.3% of the global telecom energy storage capacity in 2023, and is expected to reach 81.6% in 2030.
- According to Frost & Sullivan, the telecom and data center energy storage market has been in a rapid development phase. The added installed capacity of global telecom and data center energy storage is expected to reach 340.2 GWh by 2030, representing a CAGR of 30.7% from 50.9 GWh in 2023.
- According to Frost & Sullivan, while the average price of lead ingots increased from RMB15,431.4 per tons in 9M2023 to RMB16,888.2 per tons in 9M2024, mainly due to changes in the market demand-supply mechanism, as the market price of lead-ingot reached RMB18,317.7 per ton and RMB18,332.5 per ton in June and July 2024. The market price of lead ingots fell back to RMB16,562.5 per ton and RMB16,444.9 per ton in August and September 2024.
- **(1) Specialized Market Dynamics and Competitive Advantages in Telecom Base Station and Data Center Energy Storage.**
- **Segmented Product Landscape and Customization Needs**
- The energy storage market, particularly in the telecom base station and data center sectors, is highly segmented and characterized by diverse customer requirements. Unlike other sectors where products may trend toward standardization, this segment demands a high level of customization. Customers often require non-standard product specifications tailored to their unique operational needs. As a result, competition in this sector is not solely driven by production capacity or cost efficiency but rather by the ability to deliver high-quality, technologically advanced, and customized solutions with stable performance. This differentiation ensures that the telecom base station and data center energy storage market remains less commoditized compared to the broader lithium-ion or lead-acid battery markets.
- **Diverse Technology Landscape and Application-Specific Features**
- The telecom base station and data center sectors rely on a diverse range of energy storage technologies, each suited to specific application scenarios. While lithium-ion and lead-acid batteries dominate in these sectors, other emerging technologies, such as sodium-ion batteries, flywheel energy storage, and compressed air energy storage, are gradually gaining attention for their distinct advantages.
- In telecom energy storage industry, lead-acid batteries are widely used in base stations and their central equipment rooms which require high safety level. They remain popular due to their higher safety level, lower cost and well-established recycling systems. In data centers, lead-acid batteries continue to be the primary choice for emergency backup power systems, providing reliable and cost-effective solutions to ensure uninterrupted operation during outages. Their low cost and well-established recycling systems continue to make them a favored choice in these conditions. On the other hand, lithium-ion batteries are preferred in base stations requiring high discharge rate and customized needs, particularly in urban core areas where space is limited. Their higher energy density and lighter weight make them ideal for meeting the demands of compact and high-performance networks.

Source: Frost & Sullivan

Appendix (5/11)

- Additionally, lead-carbon batteries, a specific type of lead-acid battery, are frequently used in telecom base stations and data centers due to their ability to enhance the durability of conventional lead-acid batteries. This significantly extends the lifespan of the batteries, making them more reliable for critical infrastructure. Furthermore, wide-temperature energy storage batteries have emerged as a key development area, driven by the need for systems that can operate reliably in extreme environmental conditions.
- **Focus of Competition in the Sector**
- The competition in the telecom base station and data center energy storage market is fundamentally different from that in broader markets. It centers on technological innovation, the ability to meet customers' specific requirements, and ensuring stable product quality and manufacturing processes. While other sectors may prioritize cost reduction and scalability, this market places higher value on advanced technology, reliable performance, and tailored customer solutions.
- This application-specific focus has ensured that the telecom base station and data center sector has not yet entered a phase of high product homogeneity. Instead, companies in this space compete on their ability to offer differentiated, high-performance products that meet the unique demands of their clients. This dynamic underscores the favorable supply-demand balance in this sector, as customized and high-quality production capacity remains in strong demand.
- **(2) Analysis on Supply and Demand Dynamics of the Battery Products**
- The Company considers production volume a more accurate metric than production capacity for analyzing supply-demand dynamics in the energy storage industry. Production capacity reflects future planning and strategic investments, often misaligned with real-time market conditions. In contrast, production volume captures actual supply adjusted to meet current demand, providing a more reliable indicator. While production capacity, production volume, and sales volume data are included in Appendix I for reference, the Company emphasizes that production and sales volumes offer a clearer analysis of market dynamics.
- **Analysis on the trend shown in Appendix I**
- The data in Appendix I illustrates trends for lithium-ion and lead-acid batteries, both for telecom base stations and data centers and specifically the electrical energy storage lithium-ion batteries. Analyzing these trends reveals that production volumes generally have not exceeded sales volumes in 2024, maintaining a healthy balance across all segments.
- For electrical energy storage lithium-ion batteries, production volume increased steadily from 20.2 GWh in 2021 to 170.5 GWh in the nine months ended September 2024, while sales volume rose from 24.2 GWh to 159.9 GWh in the same period. The ratio of sales volume to production volume ("sale–to–production ratio") varied during this period, with a notable dip in 2023. This was primarily due to supply expansion driven by strong demand growth in prior years, coupled with a lag in adjusting production levels to align with the slower demand growth seen in 2023. Additionally, timing mismatches related to the construction cycle contributed to the lower ratio. However, this supply-demand dynamic gradually returned to normal in 2024, as evidenced by the sales-to-production ratio reaching 93.8% in the nine months ended September 30, 2024. By the year-end of 2024, production volume is estimated to reach 209.0 GWh, with sales projected at 197.2 GWh, maintaining a strong sales-to-production ratio of 94.4%. This indicates that sales have kept pace with production in 2024, avoiding any substantial or sustained oversupply issues.
- Within the telecom base and data center energy storage segment for lithium-ion batteries, production volume grew from 15.0 GWh in 2021 to 14.5 GWh in the nine months ended September 2024, while sales volume ranged from 16.0 GWh to 15.1 GWh in the same period. The sales-to-production ratio remained above 90.0% during the Track Record Period, reaching 104.1% in the nine months ended September 2024. For the full year of 2024, production is expected to increase to 20.5 GWh, with sales projected at 21.1 GWh, maintaining a ratio of 102.9%. This demonstrates strong demand within this segment, with sales consistently matching or exceeding production volumes.

Source: Frost & Sullivan

Appendix (6/11)

- In the telecom base and data center energy storage segment for lead-acid batteries, production volume rose from 20.0 GWh in 2021 to 26.0 GWh in the nine months ended September 2024, while sales volume increased from 21.7 GWh to 26.7 GWh. The sales-to-production ratio remained high, reaching 102.7% in the nine months ended September 2024. By the year-end of 2024, production is projected to grow further to 36.1 GWh, with sales expected to reach 36.8 GWh, maintaining a strong ratio of 101.9%. This consistency shows that sales volumes have closely tracked production, avoiding any significant excess.
- In conclusion, across all three scenarios—lithium-ion and lead-acid batteries, both for telecom base stations and data centers and specifically the electrical energy storage lithium-ion batteries—there is no evidence of significant oversupply in 2024. Sales volumes have consistently kept pace with production volume, maintaining strong sales-to-production ratios above 90% and often exceeding 100%. This reflects a healthy balance between supply and demand, suggesting that any concerns about oversupply in the broader energy storage market are temporary and not a result of structural imbalances.
- **Analysis on the trend shown in Appendix I – production capacity vs sales volume**
- Notwithstanding the limitation of value of the production capacity metric as discussed earlier, the data in Appendix I demonstrates that for both lithium-ion and lead-acid batteries, across overall production and the telecom base station and data center segments, production capacity has not significantly outpaced production volume or sales volume, and there is no indication of a sustained or significant trend of oversupply. According to the data released by the National Bureau of Statistics of China, the average capacity utilization rate in the manufacturing industry for enterprises above designated size in China is 74.8% in the nine months ended September 2024. In addition, according to the data released by the Federal Reserve, the average capacity utilization rate in the manufacturing industry in the United States is 77.0% in the nine months ended September 2024. Compared to the published capacity utilization rates in China and the U.S., the capacity utilization rates in all three scenarios for global lithium-ion and lead-acid batteries are better than the average situation in the U.S. Thus, the capacity utilization rate is considered within a reasonable and healthy range.
- While the capacity utilization rate (calculated as production volume divided by production capacity) has experienced some fluctuation during the Track Record Period, these changes are attributable to factors such as supply expansion to meet surging demand, the construction cycle of new facilities, and temporary mismatches in supply and demand. For example, in the global lithium-ion battery market for electrical energy storage, the capacity utilization rate was 80.8% in 2021, 88.0% in 2022, and lower at 79.0% in 2023 due to the rapid expansion of production capacity to meet projected long-term growth. However, the capacity utilization rate rebounded to 83.2% in the nine months ended September 2024, indicating a normalization of supply-demand dynamics. A similar trend is observed in the telecom base station and data center segments for both lithium-ion and lead-acid batteries.
- **The prevailing supply-demand balance in the lithium batteries and lead-acid industry is within a reasonable and healthy range.**
- Based on the analysis by Frost & Sullivan, the current supply-demand balance in the energy storage industry is within a reasonable and healthy range for the following reasons:
- **Expected Strong Growth**
- The energy storage industry is expected to experience sustained growth, supported by its applications in areas such as renewable energy integration, data centers, and telecom base stations. These markets continue to expand, driving consistent demand. Frost & Sullivan forecasts significant growth in the energy storage market, with the gap between capacity and sales anticipated to narrow.
- **Strong growth in key markets:**
- For example, in the data center energy storage and lithium-ion battery sectors, Frost & Sullivan forecasts robust growth driven by increasing energy storage requirements. (Refer to Appendix I and the revised pages for specific market growth data.) This growth is expected to absorb current capacity gaps and create additional demand.

Source: Frost & Sullivan

Appendix (7/11)

- **Stability in raw material markets:**
- The production and utilization rates of raw materials, such as lithium carbonate and lead ingots, have aligned with historical patterns of lithium-ion and lead-acid batteries, showing no significant deviations from past trends. These trends indicate that the energy storage supply chain has not been disrupted by potentially reduced downstream demand.
- **Limited high–quality supply:**
- Slowing supply growth, particularly in high-quality battery products, has contributed to maintaining a reasonable and healthy supply-demand balance in the energy storage industry. As the industry shifts toward higher technical requirements and stricter performance standards, manufacturers face increasing challenges in scaling production capacity to meet these demands. This has resulted in a more measured pace of supply growth, preventing oversupply and ensuring that market dynamics remain stable despite the robust demand for energy storage solutions.
- **(4) Basis for Conclusions of the Directors and Frost & Sullivan**
- Frost & Sullivan's conclusions are supported by extensive primary and secondary research:
- **Primary research:**
- Frost & Sullivan reviewed official reports and data from authoritative organizations such as CNESA, the National Bureau of Statistics, and the International Energy Agency (IEA). These reports confirm that current capacity utilization rates are within healthy ranges.
- **Secondary research and interviews:**
- Frost & Sullivan conducted interviews with leading industry players (e.g., Leoch International and Narada Power) to assess their production and sales ratios, capacity utilization rates, and views on market dynamics. These interviews confirm that capacity utilization rates are consistent with industry averages and do not indicate significant supply-demand imbalances.
- The Company respectfully requests not to disclose the production capacity of the lithium batteries and lead-acid batteries and their key raw materials during the Track Record Period in the Prospectus due to risk of misinterpretation. Disclosure of such data in the Prospectus may result in inaccuracies or misinterpretation by investors due to the complexity and variability of industry supply-demand dynamics. The Company believes that including this information could be misleading and does not serve the interests of potential investors.

Source: Frost & Sullivan

Appendix (8/11)

- **Stability in raw material markets:**
- The production and utilization rates of raw materials, such as lithium carbonate and lead ingots, have aligned with historical patterns of lithium-ion and lead-acid batteries, showing no significant deviations from past trends. These trends indicate that the energy storage supply chain has not been disrupted by potentially reduced downstream demand.
- **Limited high–quality supply:**
- Slowing supply growth, particularly in high-quality battery products, has contributed to maintaining a reasonable and healthy supply-demand balance in the energy storage industry. As the industry shifts toward higher technical requirements and stricter performance standards, manufacturers face increasing challenges in scaling production capacity to meet these demands. This has resulted in a more measured pace of supply growth, preventing oversupply and ensuring that market dynamics remain stable despite the robust demand for energy storage solutions.
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- Frost & Sullivan's conclusions are supported by extensive primary and secondary research:
- **Primary research:**
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- **Secondary research and interviews:**
- Frost & Sullivan conducted interviews with leading industry players (e.g., Leoch International and Narada Power) to assess their production and sales ratios, capacity utilization rates, and views on market dynamics. These interviews confirm that capacity utilization rates are consistent with industry averages and do not indicate significant supply-demand imbalances.
- The Company respectfully requests not to disclose the production capacity of the lithium batteries and lead-acid batteries and their key raw materials during the Track Record Period in the Prospectus due to risk of misinterpretation. Disclosure of such data in the Prospectus may result in inaccuracies or misinterpretation by investors due to the complexity and variability of industry supply-demand dynamics. The Company believes that including this information could be misleading and does not serve the interests of potential investors.

- The differing safety requirements of core customers in telecom base stations and data centers drive the distinct usage and applications of lithium-ion and lead-acid batteries, as each technology aligns with specific performance characteristics suited to their needs. Lead-acid batteries, with high safety level and mature recycling value chain, dominate traditional applications like emergency backup power. Meanwhile, lithium-ion batteries, with their advantages in energy density, life cycle, and adaptability, are increasingly being adopted for high energy consuming base stations and evolving data center energy needs, especially for sustainable electricity supply.
- In telecom energy storage industry, lead-acid batteries are widely used in base stations and their central equipment rooms which require high safety level. They remain popular due to their higher safety level, lower cost and well-established recycling systems. On the other hand, lithium-ion batteries are preferred in base stations requiring high discharge rate and customized needs, particularly in urban core areas where space is limited. Their higher energy density and lighter weight make them ideal for meeting the demands of compact and high-performance networks.

Source: Frost & Sullivan

Appendix (9/11)

- In data centers, lead-acid batteries continue to be the primary choice for emergency backup power systems, providing reliable and cost-effective solutions to ensure uninterrupted operation during outages. The rising computational capacity of data centers is significantly increasing energy demands, with data center electricity demand expected to grow from 3.3% of global electricity demand in 2023 to 10.1% by 2030. The recent explosion in computational capacity has led to a sharp increase in energy density requirements for storage solutions. Alongside this, data centers are increasingly adopting renewable energy sources, which require advanced energy storage solutions to ensure reliability and efficiency. This shift is accelerating the adoption of lithium-ion batteries in data centers, as their higher energy density and suitability for advanced applications such as peak shaving, valley filling, and other sustainable energy strategies position them as a key technology for the next generation of data centers.
- According to Frost & Sullivan, the energy storage battery industry is not expected to face significant or sustained oversupply, as robust demand growth and technological advancements continue to drive the market.
- According to Frost & Sullivan, the added installed capacity of global energy storage is projected to grow at a CAGR of 40.2% from 2023 to 2030, fueled by increasing penetration of renewable energy sources like solar and wind, grid modernization efforts, and the electrification of industries. This rapid growth creates substantial opportunities for advanced energy storage solutions, particularly those with higher energy density, longer cycle life, and enhanced safety features. For example, the increasing penetration of renewable energy globally has created strong demand for large-scale energy storage systems to stabilize grids and support intermittent renewable energy sources.
- It is respectfully submitted that the industry consultant has concluded the telecom and data center energy storage market for not haven countering oversupply during the Track Record Period of the Company, and the oversupply situation in the electrical energy storage market having been alleviated since 2024. In the near future, no significant oversupply is expected. The following are the basis for reaching these conclusions:
- (a) Referring to the data shown in Appendix I, ratios of sales volume to production volume in the telecom and data center energy storage market remained above 97% during the Track Record Period and exceeded 100% in 2021 and the nine months ended September 2024, indicating that there is no oversupply issue in this market sector. In the electrical energy storage market, the ratio of sales volume to production volume plummeted to 63.3% in 2023, exhibiting an oversupply condition. In the nine months ended September 2024, the ratio rose back to 93.8%, demonstrating no significant oversupply circumstance at present.
- (b) Global sales volume of lithium-ion energy storage market is projected to surge from 218.3 GWh in 2024 to 327.5 GWh in 2025, marking a 50.0% year-on-year increase. This growth is primarily driven by segmented product landscape and the customized needs for energy storage batteries. Meanwhile, curtailment of energy storage battery's capacity planning is expected to stabilize the supply and demand dynamics, with China's planned production capacity for energy storage lithium-ion batteries decreasing by nearly 55% in 2024 compared to 2023. The rapid growth in sales volume coupled with the slowdown in capacity planning will lead to a more concentrated market, averting oversupply scenario in the near future.
- Lead-acid batteries offer high safety level, high reliability, mature technology, and a well-established recycling system. Lithium-ion batteries possess higher energy density and longer life cycle. These characteristics align lithium-ion and lead-acid batteries with different downstream application scenarios, as their technical features make them suitable for distinct market segments.
- In the telecom energy storage market, lithium-ion batteries are increasingly implemented in base stations requiring high discharge rate and high energy consuming application scenarios. Lead-acid batteries still maintain its position in telecom energy storage market depending on their safety, reliability and maturity. In 2023, the market shares of lithium-ion batteries and lead-acid batteries in China's telecom energy storage market by added installed capacity reached 48.9% and 51.1%, respectively. By 2030, the market shares of lithium-ion batteries and lead-acid batteries by added installed capacity are expected to reach 60.3% and 35.7%, respectively.

Source: Frost & Sullivan

Appendix (10/11)

- In the data center energy storage market, lead-acid batteries are valued for their high safety level and mature technology to provide reliable backup power, particularly for large-scale data center applications. Lithium-ion batteries are valued for their intelligent battery capacity management and longer life cycle to handle peak shaving and valley filling, supporting the sustainable electricity supply. In 2023, the market shares of lithium-ion batteries and lead-acid batteries in China's data center energy storage market by added installed capacity reached 1.1% and 98.9%, respectively. By 2030, the market shares of lithium-ion batteries and lead-acid batteries by added installed capacity are expected to 73.5% and 14.5%, respectively.
- The surge in demand for ESS from 2020 to 2023 has been driven by a combination of renewable energy transformation and electrification, mature technology and cost decline, and favorable policies, in both China and overseas.
- This growth has been bolstered by the rapid expansion of renewable energy power generation. For example, from 2019 to 2023, global added installed capacity of PV and wind power grew from 175.3 GW to 507.0 GW, with a CAGR of 30.4%. The new electrification process will facilitate the large-scale and efficient development and utilization of renewable energy in the form of electricity, replacing fossil fuels and making renewable energy the primary energy source.
- The maturing lithium-ion battery technology has driven the rapid penetration of lithium-ion batteries into the energy storage industry. Enhanced product reliability fulfills the requirements of ESS. Although price of lithium-ion batteries remained high in 2022 due to the impact of raw material prices, the demand for ESS has surged with government subsidies and policy support to meet the rapidly growing needs of the new energy transition. As price of lithium-ion batteries has dropped significantly since then, demand of ESS has further expanded.
- Global favorable policies are essential for fostering the growth of the energy storage industry. On July 23, 2021, the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) issued the Guiding Opinions on Accelerating the Development of New Energy Storage, projecting that new energy storage would transition from its early commercial phase to large-scale deployment by 2025, and achieve full market integration and maturity by 2030. The EU has been driving the green energy transition through initiatives such as the Clean Energy for All Europeans Package (CEP) in 2019 and REPowerEU in 2022, with a particular focus on promoting the growth of the energy storage sector.
- This convergence of rapid renewable energy transformation, technological change and battery price drop, and robust global policy support, has laid a strong foundation for the rapid development of the energy storage industry, positioning it as a critical enabler of the ongoing energy transition, as confirmed by Frost & Sullivan.
- The global energy transition toward a low-carbon energy system is set to drive growth across all segments of the energy storage industry. As renewable energy sources such as PV and wind power gain prominence, energy storage systems play a critical role in managing their intermittent nature and ensuring grid stability.
- Electrical Energy Storage Sector:
- The increasing adoption of renewable energy sources has heightened the need for energy storage systems to maintain grid reliability. This transition is also accelerating the deployment of distributed energy storage solutions, such as solar rooftops and microgrids, which require efficient and dependable energy storage technologies to operate effectively.
- Data Center and Telecom Energy Storage Sector:
- Electricity costs constitute a significant portion of operational expenses for data centers and telecom operations, accounting for approximately 60% and 30% of their total operating costs, respectively. The integration of renewable energy infrastructures, such as solar photovoltaics, is reducing electricity expenses, while energy storage systems ensure uninterrupted operation for base stations and data centers. These systems also enable cost-saving strategies like peak shaving and valley filling, which further optimize operational efficiency. As the price disparity between peak and off-peak electricity rates continues to widen, the demand for energy storage systems in telecom and data center operations is expected to grow significantly, underscoring the pivotal role of energy storage across various sectors of the industry.

Source: Frost & Sullivan

Appendix (11/11)

- The "Notice on Encouraging Renewable Electricity Generation Enterprises to Self-Build or Purchase Peak Shaving Capacity to Increase the Grid-Connected Scale" is expected to significantly enhance the Group's business prospects by fostering growth in both the electrical energy storage sector and the telecom and data center energy storage market. This directive encourages power generation companies to acquire peak shaving storage capacities, enabling the seamless integration of renewable energy sources like PV and wind power into the grid and expanding the grid-connected capacity of renewable power.
- Operators of telecom base stations and data centers, with their extensive site resources and reliance on substantial energy storage for backup power, are poised to reap significant benefits from this policy. Data centers, in particular, are under increasing pressure to address their high energy consumption and rapidly growing demand for computing power by promoting green electricity usage and reducing carbon emissions. The notice's emphasis on accelerating renewable energy deployment will catalyze the expansion of sustainable energy supply systems for data centers, creating substantial opportunities for the Group to provide innovative energy storage solutions.
- As a result, the installed data center energy storage capacity equipped with sustainable electricity supply functions is projected to reach 77.4 GWh by 2030, with a CAGR of 259.4% from 2023. This rapid growth underscores the transformative potential of the policy in driving sustainable energy solutions and advancing the Group's market presence.
- According to Frost & Sullivan, in the third quarter of 2024, the average price of lithium-ion non-EV batteries in the U.S. (mainly lithium-ion energy storage batteries) reached approximately RMB1.46 per Wh, and the global average price of lithium-ion energy storage batteries was RMB0.87 per Wh, which is substantially higher than the average price of lithium-ion energy storage batteries in China. For the first quarter of 2024, the average selling price of the Company's lithium-ion batteries was RMB0.74 per Wh, which was lower than the industry average price in the U.S. and the global market. Assuming the U.S. government increases the tariff rate on lithium-ion non-EV batteries from 7.5% to 25.0% in 2026 as reported in the news articles, Chinese lithium-ion batteries manufacturers, including the Company, still possess the price advantage compared to energy storage batteries manufacturers in the U.S. and Global Market.
- Within the telecom base and data center energy storage segment, the ratio of sales volume to production volume ("sale-to-production ratio") remained above 97% during the Track Record Period. For electrical energy storage lithium-ion batteries, the sale-to-production ratio varied during this period, with a notable dip in 2023. This was primarily due to supply expansion driven by strong demand growth in prior years, coupled with a lag in adjusting production levels to align with the slower demand growth seen in 2023. Additionally, timing mismatches related to the construction cycle contributed to the lower ratio. This supply-demand dynamic gradually returned to normal in 2024, as evidenced by the sales-to-production ratio reaching 94.9% in the 2024.
- According to Frost & Sullivan, in 2024, we ranked the twelfth among global energy storage battery providers in terms of added installed capacity, achieving a market share of 2.5%.
- According to Frost & Sullivan, in 2024, we ranked the eleventh among energy storage battery providers in the PRC market in terms of added installed capacity, achieving a market share of 3.3%.

Source: Frost & Sullivan

Research Methodologies

- Frost & Sullivan is an independent global consulting firm, which was founded in 1961 in New York. It offers industry research and market strategies and provides growth consulting and corporate training. Its industry coverage includes automotive and transportation, chemicals, materials and food, commercial aviation, consumer products, energy and power systems, environment and building technologies, healthcare, industrial automation and electronics, industrial and machinery, and technology, media and telecom.
- The Frost & Sullivan's report includes information on global and China's on Energy Storage, Telecom and Data Center Energy Storage Industry.
- Frost & Sullivan has conducted detailed primary research which involved discussing the status of the industry with certain leading industry participants and conducting interviews with relevant parties. Frost & Sullivan has also conducted secondary research which involved reviewing company reports, independent research reports and data based on its own research database. Frost & Sullivan has obtained the figures for the estimated total market size from historical data analysis plotted against macroeconomic data as well as considered the above-mentioned industry key drivers.
- Frost & Sullivan's Market Engineering Forecasting Methodology integrates several forecasting techniques with the Market Engineering Measurement-based System. It relies on the expertise of the analyst team in integrating the critical market elements investigated during the research phase of the project. These elements include:
  - ✓ Expert-opinion forecasting methodology
  - ✓ Integration of market drivers and restraints
  - ✓ Integration with the market challenges
  - ✓ Integration of the Market Engineering Measurement trends
  - ✓ Integration of econometric variables
- In compiling and preparing the Report, Frost & Sullivan has adopted the following assumptions:
  - ✓ The social, economic and political environment of the globe is likely to remain stable in the forecast period
  - ✓ Related industry key drivers are likely to drive the market in the forecast period

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