JoERRE: ISSN: 2392-5353 (Printer)
Journal of economics studies and researches in renewable energies E-ISSN: 2661-7528 (Online)
2026, 13(01), 357-370, https://asjp.cerist.dz/en/PresentationRevue/466

Renewable Energy Storage for a Clean Energy Transition: The Chinese Model

Raouia lemmouchi, University of Batna 1, Algeria , raouia.lemmouchi@univ-batna.dz

Received: 09/04/2026 Accepted: 26/05/2026 Published: 10/06/2026

Abstract: This research analyzes the strategic drivers that have propelled China to its current dominance within the global renewable energy storage market. As a preeminent force in clean energy investment, China's trajectory has been shaped by a combination of ambitious climate targets, aggressive policy support, and the rapid scaling of wind and solar infrastructure. Institutional frameworks designed to foster innovation have simultaneously addressed the critical need for grid stability. Employing both descriptive and analytical methodologies, this study explores the various dimensions of the sector. The findings suggest that China's mastery of renewable energy has naturally facilitated its leadership in storage, positioning the state as the primary developer and exporter of these technologies. Ultimately, storage systems emerge as the structural backbone for energy transition and smart grid integration, essential for reducing fossil fuel dependency and mitigating environmental pollution.

Keywords: Energy, Transition, China, Energy Storage.
JEL Codes: Q42, Q48, O33, Q01, L94, O53.

Citation : lemmouchi Raouia. (2026). Renewable Energy Storage for a Clean Energy Transition: The Chinese Model, *Journal of economics studies and researches in renewable energies*, 13(01), 357-370.

Introduction:

Against the backdrop of the global energy transition, escalating energy crises, and urgent environmental challenges. And with the accelerating pace of industrialization and the continuous growth of the global population, the energy and environmental crises resulting from global warming have emerged as some of the most serious challenges. This not only threatens the balance of the ecosystem but also poses a serve risk to the sustainable development of Human society As the world largest developing country and foremost carbon emitter. China is actively advancing its energy transition and fostering an ecological civilization championing a model of development characterized by green circular and low carbon principles.

China has implemented a series of policies to support the energy storage industry development. In march 2022, National development and reform commission (NDRC)) and national energy administration (NEA) released the 14th five-year plan for the e development of energy storage, which set the target for ES, Local. (Tonglin, 2026, p. 03)

Energy storage provides the necessary flexibility to manage supply during peak demand or outages.

Based on the aforementioned context, the following research problem is identified:

Primary Question

What are the prevailing renewable energy storage technologies, and has China successfully established a new model for energy transition?

* **. Correspondant author**

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

Sub-Questions

- Does China truly dominate the global energy storage market?
- What are the growth rates of storage market?
- What is the economic impact of renewable energy storage technologies?

Study Objectives

- ✓ To provide a theoretical framework for energy transition and the necessity of storage solutions during supply interruptions.
- ✓ To highlight the shift toward energy storage as a vital step in eliminating carbon footprints.
- ✓ To Presente and analysis of the renewable energy storage market in China.

Significance of the Study

This study is significant because storage solutions represent the core solution for the stability of electrical grids, addressing the intermittent nature of solar and wind energy to ensure availability.

Methodology

The study employs descriptive and analytical approaches to characterize scientific phenomena, address research questions, and provide a comprehensive interpretation of the data.

Literature Review

Yu Liu, Wel Wu (The prospects of China energy storage technology development in China : long-term analysis of economic and environmental benefits) the main contribution of this study is the construction of a coupled energy storage computable general equilibrium (CGE) model based on the cost structure of energy storage and the application benefits on the power generation, grid and user side .this model is used to assess the economic and environmental feasibility of two energy storage technologies in China during 2017-2060 the results indicate that the deployment of energy storage will bring negative impacts on GDP and increase carbon mission in the short term. However the effect will reverse in the long run. In 2060 the deployment of energy storage will increase 520.34 billion CNY to GDP and reduce 36.99 million metric tons of carbon emissions.

Xiyue Lue (Energy Storage For Renewable Energy In China: A Review Of Development, Technological Progress, And Socioeconomic Considerations) this paper systematically reviews the status, geographical distribution, and technologies enhance the consumption capacity of renewable energy. The study finds that the combination of pumped-hydro on stallation and lithium-ion battery configurations constiues a pivotal mechanism for enhancing both system flexibility and stability .

Tonglin Jia, Yong Shuai (Empowering modern power systems with thermal energy storage in China: a comprehensive review) this study identifies three critical gaps ; (1) the absence pf mature TES materials and advanced devices ; (2) the lack of reliable pathways for high-efficiency thermal energy utilization ; (3) and limited insights into the role of TES in grid dispatch. Through in-depth discussion spanning materials, devices, systems, and mechanisms, this work aims to provide actionable insights and a foundational reference for realizing a next-

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

generation power system underpinned by advanced TES technology . The study finds that the construction of the modern power system dominated by renewable energy urgently requires advanced energy storage technologies that are low-cost, long-duration, low-carbon, and capable of flexible energy supply presenting unprecedented development opportunities for TES.

I. Theoretical Foundation

1. Fundamental Concepts: Energy, Renewables, and Transition

1.1 Energy

Energy serves as a cornerstone of production; its consumption is not only a prerequisite for industrial activity but also constitutes a distinct economic sector (Belkhdar, 2020, p. 226) The current energy transition represents more than a simple shift from finite to renewable resources; it is a fundamental restructuring of societal dependency toward sustainable, replenishing sources.

1.2 Renewable Energies

according to the IPCC, renewable energy is harvested from natural processes that replenish at a rate exceeding their consumption (Tahtouh, 2021, p. 93) These "clean" or "sustainable" energies, such as solar, wind, geothermal, and hydropower, offer promising alternatives to fossil fuels, driven by the urgent need to reduce CO_2 emissions (Lal, 2018, pp. 41-53).

Renewable energy is derived from continuous natural processes. These sources include solar radiation, geothermal heat, wind, waves, and biomass. They are characterized by being inexhaustible and often available at no cost for the raw resource. Conversely, traditional energy reliant on fossil fuels causes significant environmental degradation, contributing to global warming and associated health issues.

1.3 Renewable energy offers several advantages

it is a permanent and inexhaustible resource that produces clean energy free from impurities or waste. It safeguards human health, protects the environment, and creates numerous employment opportunities. Furthermore, it is characterized by lower operational costs compared to other energy types and helps mitigate natural disasters resulting from global warming. It does not produce acid rain, thereby protecting vegetation and various living species, particularly those threatened with extinction, while shielding water sources and aquatic life from pollution and contributing to global food security.

2. Sources of Renewable Energy

2.1 Hydropower

This renewable energy is derived from the movement of water, whether originating from waterfalls and dams at high elevations, or from the motion of sea and ocean waves driven by wind—where waves can generate between 10 and 180 kW per meter of coastline. It also includes tidal movements; these various aquatic dynamics are effectively harnessed to generate electrical power.

2.2 Biomass Energy

This energy is extracted from organic matter of plant, animal, and agricultural origin. These materials can be converted into biofuels through several processes, including fermentation, distillation, and both direct and indirect combustion.

2.3 Geothermal Energy

Generated from the latent heat within the Earth's interior, this thermal energy can be exploited and converted into other energy forms. For instance, the heat from thermal springs and hot groundwater is utilized in electricity generation.

2.4 Wind Energy

This refers to the kinetic energy of wind, which is primarily converted into electricity using large-scale turbines and fans installed in high-altitude areas. The movement of air currents

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

rotates the turbine blades, driving the connected generators to produce electricity for lighting and industrial operations.

2.5 Solar Energy

As the primary source of energy, heat, and light on Earth, solar energy is utilized by capturing solar radiation through photovoltaic cells and converting it directly into electrical energy. (Moulferaa, 2025, pp. 689-691)

II. Energy Storage (ES)

Energy storage is employed to counter the intermittency and variability in renewable energy sources such as solar and wind by providing buffer capacity. Energy storage enables energy to be effectively stored for later usage one application of energy storage is catering for energy demand this process entails charging these devices during off-peak demand conditions and discharging them during peak demand conditions. Another application is to provide more stable, controlled and efficient energy outputs from renewable energy resources by directly coupling these energy storage devices. Various on the nature of energy release Short-term power release is typically provided through supercapacitors medium -term is through batteries and long -term is through fuel cells. (Nishkar R, 2021, p. 21)

1.Storage Technologies

Currently The main Energy storage technologies are PHS, compressed air storage CAES flywheel energy storage FES Lithium-ion batteries, and supercapacitors.

Storage solutions may be categorized by duration into short-term high-frequency, medium-short duration, and long-duration categories, each with distinct technical characteristics and application scenarios. Among all technologies, pumped hydro storage represents the most commercially mature, while electrochemical energy storage, mainly based on lithium-ion batteries is developing rapidly, China has now formed a development pattern based on pumped hydro storage technology and dominated by lithium-ion battery energy storage, technology the cumulative installed capacity of lithium-ion battery energy storage is continuing to grow rapidly. Based on data from the energy national administration of China at a press conference, in 2025 newly installed independent energy storage will reach 35.43 million KW with lithium-ion battery storage occupying a dominant position, accounting for 96.1% of the installations. (Liu, 2026, p. 100)

Gravity then returns the water to the lower reservoir when power is required, driving turbines during the descent. Modern systems are now replacing fossil-fuel-derived energy with renewables to power this process, making it the most prevalent method for utility-scale electricity storage today. (Lambert, 2024)

According to the International Energy Agency (IEA), pumped storage is the most widely deployed energy storage technology globally, representing 90% of global capacity in 2020. As of May 2023, China leads the world in operational pumped storage capacity with 50 GW, accounting for 30% of the total global capacity. (Gomstyn & Jonker, 2024)

mainly includes pumped storage, compressed air energy storage, and flywheel energy storage. Pumped hydro storage (PHS) stores electrical energy in the form of potential energy in water.

It is a large -scale energy storage technology widely applied in power systems, playing a key role in peak-shaving, valley-filling, emergency backup, and improving power quality. The basic principle of pumped hydro-storage is to use surplus electricity during periods of low demand to

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

drive a pump that transfers water from a lower reservoir to an upper reservoir for storage**.** (guo, 2025, p. 4)

1.1 Mechanical energy storage systems

these ESSs convert Kinetic and /or potential energy into electrical power. One of the earliest kinds of energy with numerous uses is MES. It is easily preserved for extended periods. It is easily transformed into and out of many types of energy; Flywheels, compressed air energy storage (CAES), and pumped hydroelectric energy storage (PHES) are a few examples. PHES and CAES are primarily utilized for load-following applications and are usually found in very large, front-of-the-meter transmission-level installations. However, flywheels can also be utilized in behind-the-meter applications, such as continuous power delivery.

1.2 Electric Energy Storage Systems

these are short-term devices that store power in either the magnetic field of superconductors or the electric filed of supercapacitors. These are mostly employed in the power industry to preserve high power quality. (shoaib, 2025, p. 09)

1.3 chemical energy storage

Chemical energy storage envelopes all technologies where the electrical energy is used to produce chemical compounds which can be stored and used when needed for energy generation. Most chemical compounds which are used as energy storage media has higher energy density than pumped hydro and CAES and this makes them an ideal energy storage medium. These are several chemical compounds which are currently been considered for energy storage application. They include: hydrogen methane, hydrocarbons, methanol, butanol and ethanol. (Mathew, 2016, p. 320)

1.4 Thermal Energy Storage

These systems operate by causing a shift in the materials phase or by generating a temperature differential that can last for hours or even seasons. Large front-of-the-meter in stallations are where they are most frequently utilized. They are usually used in conjunction with concentrated solar power (CSP) facilities and employ molten salt as a medium when utilized to store and generate electricity rather than to meet heating and cooling needs (Elalfy, 2024, p. 54)

1.5 Hybrid Energy Storage Systems

The term hybrid ESS (HESS) describes the combination of two or more ESSs used to gain the best features in a single application while utilizing the benefits of each ESS. Not all of the features can be offered by a single ESS type. Applications for HESSs include grid-tied HESS in municipal or provincial use, fuel-cell-powered electric vehicles, hybrid electric vehicles, large-scale wind. deferent HESS combinations are supercapacitors and batteries, SEMSEMES and batteries, flywheel and batteries, compressed air and supercapacitors, and thermal energy storage and batteries (Mohammed, 2018, p. 06)

3. Benefits of Energy Storage

Energy storage has lots of benefits. It is important in energy management it helps to reduce energy wastage and increasing the energy utilization efficiency of process systems storage of secondary energy forms such as heat and electricity helps to reduce energy wastage and increase the energy utilization efficiency pf process systems. Storage of secondary energy forms such asheat and electricity helps to reduce the quantity of primary energy forms (fossil fuels) consumed to generate them. This in turn not only lower CO2 and other greenhouse gas

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

emissions together with the associated global warming but also help to conserve fossil fuels which are believed to be exhaustible it can also play a crucial role in increasing the penetration of renewable clean and intermittent energy resources such as wind energy solar and marine tidal current to the grid as well as help in load shifting Energy storage helps in power system planning operation and frequency regulation it helps too maintain energy systems stability improve power quality in micro-grid systems as well as match demand with supply (Mathew, 2016, p. 315)

4. Renewable Energy as a Path to Affordable Clean Energy

Renewable energy enables nations to mitigate the impacts of climate change, build resilience against price volatility, and reduce overall energy costs. Solar and wind technologies represent a significant turning point; these resources are abundant in many developing countries and are highly cost-competitive. When paired with battery storage, they provide a consistent and reliable electricity supply. Furthermore, hydropower remains one of the most cost-effective sources of clean energy for consumers. Solar mini-grids also offer the potential to provide high-quality, uninterrupted electricity to approximately half a billion people in underserved communities, serving as the most economical solution to bridge the energy access gap by 2030. Energy consumption accounts for more than three-quarters of global greenhouse gas emissions. Consequently, the energy transition requires large-scale financing for renewable energy integration and energy efficiency projects, alongside the gradual phasing out of fossil fuels.

To achieve a universal energy transition, investments in developing countries must increase sevenfold, reaching between $1 and $2 trillion annually by 2030. Approximately one-third of this capital is expected to come from the private sector. To attract these investors, countries must strengthen their electrical utilities, which facilitate the transmission and distribution of new renewable power, and establish robust regulatory frameworks and oversight institutions for clean energy development.

However, many developing nations face fiscal constraints and limited access to financing, making the high upfront costs of renewable energy and efficiency projects difficult to manage. Additionally, macroeconomic uncertainty and political instability often discourage private sector participation in these sectors. (World Bank, 2026)

5. The Chinese Experience

For decades, China has pursued a new energy model to meet its developmental requirements by investing heavily in renewable energy. This strategy aims to diversify the national energy mix and provide energy services to remote regions. Internationally, China’s reliance on renewables responds to global environmental concerns, while its massive capacity in this sector has secured it a prominent global position. To achieve this, China established specialized institutions and adopted a national strategy to enhance sector efficiency, building the infrastructure necessary to ensure timely, high-quality public service through various large-scale projects. (Boufetsh, 2018, p. 98)

China has committed to peaking carbon emissions by 2030 and achieving net Zero carbon emissions by 2060, to achieve its low-carbon transformation, the country has been rapidly developing renewable energy technologies, resulting in a substantial augmentation in renewable energy capacity by 2023 this capacity had reached 1516 GW. Comprising 51.9% of the country s overall installed power generation capacity. (Liu, et al., 2025)

JoERRE:
Journal of economics studies and researches in renewable energies
2026, 13(01), 357-370,
ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

In December 2020, the Chinese President announced new climate commitments: building more than 1,200 GW of solar and wind capacity by 2030 and ensuring that non-fossil fuels account for 25% of primary energy consumption by that same year. This serves as the first step toward China's goal of achieving carbon neutrality by 2060. According to the National Energy Administration (NEA), China's wind and solar sectors grew rapidly between 2010 and 2020, with installed wind capacity increasing ninefold, from 31 GW to 280 GW. Today, China leads the world in the manufacturing of solar panels and wind turbines, accounting for approximately 72% and 45% of global totals, respectively.

Solar energy is the fastest-growing renewable source in China due to supportive government initiatives and rising investments. The Chinese solar market is categorized into photovoltaic (PV) and concentrated solar power (CSP). (Mordor Intelligence, 2026) Between 2015 and 2020, China added an annual average of 31 GW of wind and 38 GW of solar power. If these trends are extrapolated, wind and solar capacities are projected to reach 580 GW and 650 GW, respectively, by 2030. This abundance of renewable potential is the primary driver behind China's efforts to develop high-capacity, high-efficiency storage technologies to meet both domestic and global demand. (Hafiz & Al-Aqoun, 2021, p. 1098)

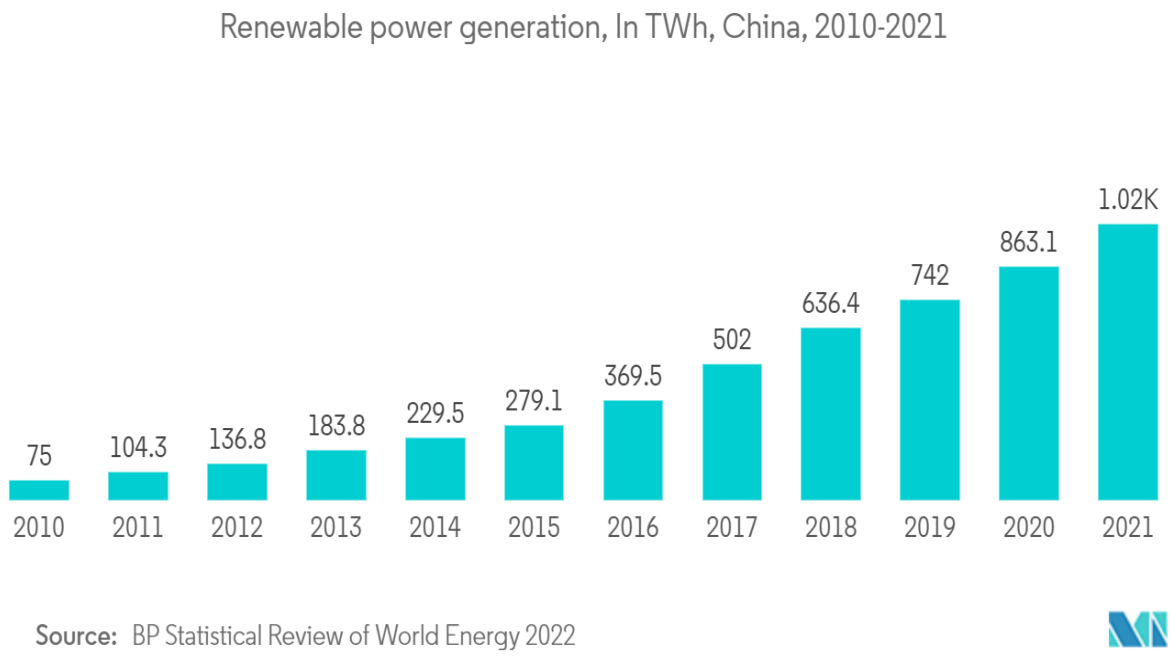


Figure (01): The Renewable Energy Market in China: Cumulative Installed Renewable Energy Capacity (GW), China, 2010–2021.
Source: Mordor Intelligence, published in 2025.

Based on the figure, it is evident that renewable energy capacity witnessed a significant upward trend from 2010 to 2021. By 2021, China emerged as the global leader in the renewable energy sector, with its total energy capacity reaching 1.02 TW. Within the framework of the 13th Five-Year Plan, China introduced the "Energy Revolution" initiative, aimed at developing a clean, low-carbon, safe, and efficient energy system by 2050. This initiative has since catalyzed substantial growth across the nation's renewable energy industries.

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

6. Drivers for Developing Renewable Energy Storage Technologies in China

The primary objectives of policies designed to promote and develop renewable energy can be summarized as follows:

6.1 Achieving Sustainable Economic Growth

Since its integration into the global economy, China's GDP has approximately doubled every seven years, driven largely by manufacturing and heavy industries. This expansion led to a surge in fossil fuel consumption, resulting in significant economic and environmental costs. Recognizing that this model was unsustainable, the Chinese government implemented a strategy focused on the development of renewable energy and its corresponding storage solutions.

6.2 Ensuring Energy Security

Rapid economic growth has escalated both domestic and international demand for coal and oil. Projections indicate a 60% increase in China's energy demand between 2010 and 2035. As the world's second-largest oil importer, China has sought to develop non-fossil energy sources to mitigate energy security concerns. Consequently, investing in renewables and storage technologies is viewed as the definitive key to national energy security. (IEA, 2012, p. 53)

6.3 Regional Economic Development

Approximately 70% of China's population resides in rural areas, consuming nearly 50% of traditional renewable energy resources. This often results in severe indoor pollution that threatens public health and ecosystems. Therefore, utilizing modern renewable energy and storage methods serves as an effective mechanism for providing clean energy to rural regions. (Boufetsh W. , 2018, p. 100)

7. Analysis of the Energy Storage Market in China

China s new energy storage additions and year-on-year -growth rates consistently ranked first globally. In 2022 China's new energy storage additions reached 7.3 GW/15.9GWh, with power capacity doubling and energy increasing 2.8-foldyear-on-yar. This marked the first time China surpassed the United States to become the global leader.in 2024, global newly installed capacity reached 45.6 GW. (Yuan, et al., 2026)

The transition to sustainable energy is significantly supported by advancements in battery storage technology. Expected cost reductions of 50% to 60% by 2030, due to manufacturing and materials improv-ments, will enhance battery storage s economic viability for grid and renewable energy support. Moreover, the capacity of stationary battery storage is predicted to rise from 2GW in 2017 to approximately 175 GW by 2030, marking a significant increase in deployment potential for these technologies. (Eduar, 2025, p. 03)

China has unveiled an action plan to accelerate the development of "new types" of energy storage between 2025 and 2027. This effort supports the transition to green energy and ensures the stability of next-generation power systems. The plan aims to achieve more than 180 GW of installed capacity for new energy storage by 2027, which is expected to generate direct project investments of approximately $35 billion. (Xinhua, 2025)

China Energy storage technology mix witnessed noticeable changes where pumped hydro storage accounted for less than 40% for the first time while the new-type energy storage represented by lithium batteries saw explosive growth According to incomplete statistic from China energy storage alliance (CNESA) by the end of 2025 China s cumulative installed

JoERRE:
Journal of economics studies and researches in renewable energies
2026, 13(01), 357-370,
ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

capacity of power storage reached 213.3GW among which pumped hydro storage shared 31.3% while the new-type cumulative energy installations represented by lithium battery accounted for over two thirds. Through the incomplete statistic in 2025 China released over 40 national, industry and local standards on energy storage these standards cover energy storage planning and designing equipment testing grid connection and operation safety management and emergency response providing important support to guide high-quality industry development, guarantee the safety of energy storage power stations, and promote the energy structure transformation and the green and low-carbon development across industrial value chain (Alliance (CNESA), 2026)

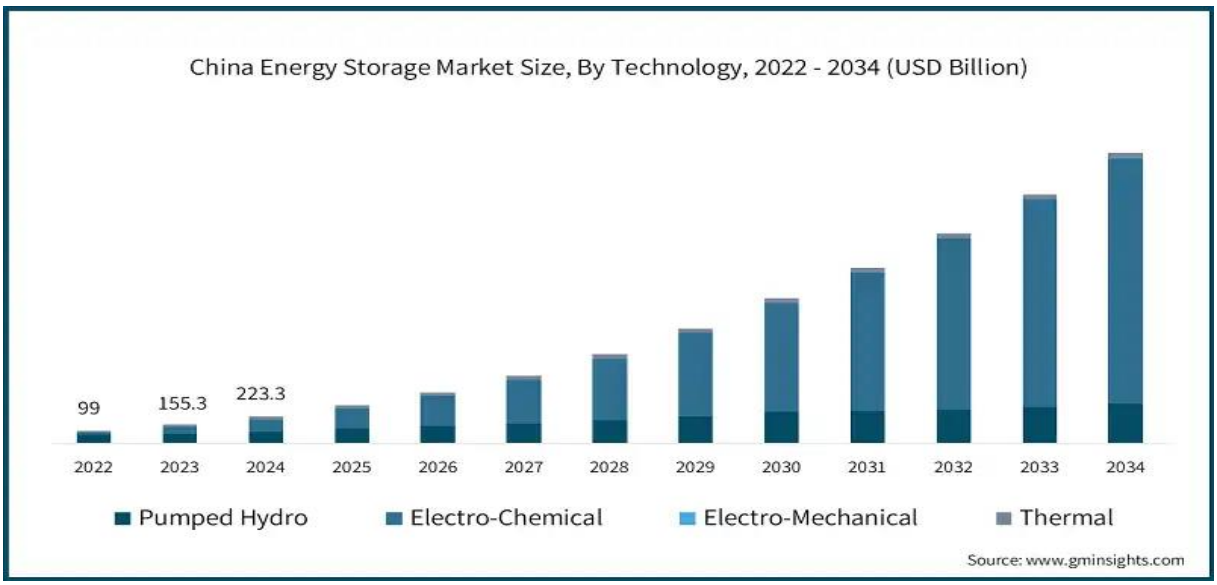


Figure (02): The Energy Storage Market Size in China (2022–2034).
Source: Global Market Insights (GM Insights), published in 2025. Unit: US Dollars (USD) (accessed 2026).

Starting from 2022, the energy storage market in China has been valued at $99 billion, $155.3 billion, and $223.3 billion respectively. It is projected to reach $2.45 trillion by 2034, with a compound annual growth rate (CAGR) of 4.25% between 2025 and 2034. This trajectory is fueled by the nation's aggressive pursuit of renewable energy and carbon neutrality, alongside the rising integration of wind and solar power. Within this framework, electrochemical batteries, particularly lithium-ion, are expected to maintain market dominance .

Furthermore, the energy storage market is estimated at $295 billion in 2025 and is forecasted to hit $465 billion by 2030, reflecting a CAGR of 9.53% during the 2025–2030 period. This expansion is attributed to several factors, including:

- ✓ lower costs of ES. Local government support policies for ES.
- ✓ Many provinces have issued a policy stipulating that new wind power and photovoltaic projects must be equipped with ES (Chazarra, 2018, p. 227)
- ✓ The accelerated electrification of transport, which reinforces the current growth path as In June 2024, the State Grid Corporation of China (State Grid Corp) announced the commencement of the final phase of the Xiamen energy project in Fujian Province. The project successfully installed three units between October 2023 and March 2024. With

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

all four units now operational, the Xiamen pumped-storage power station is fully complete, boasting a total capacity of 4.1GW.

- ✓ The global surge in electric vehicle (EV) sales is also driving demand for electrochemical storage, specifically lithium-ion. For instance, China sold over 12.50 million passenger Evs, with Battery Electric Vehicles (BEVs) accounting for approximately 58% of sales, while Plug-in Hybrid Electric Vehicles (PHEVs) represented 42%. Due to high demand from automakers and consumer electronics, researchers are prominently investing in emerging technologies, such as sodium-sulfur, which are currently in the early stages of development.
- ✓ Solar energy is increasingly capturing a significant share of the power industry's growth. In 2024, China added over 350 GW of wind and solar capacity. This growing adoption of solar energy is expected to further drive the demand for thermal energy storage systems.

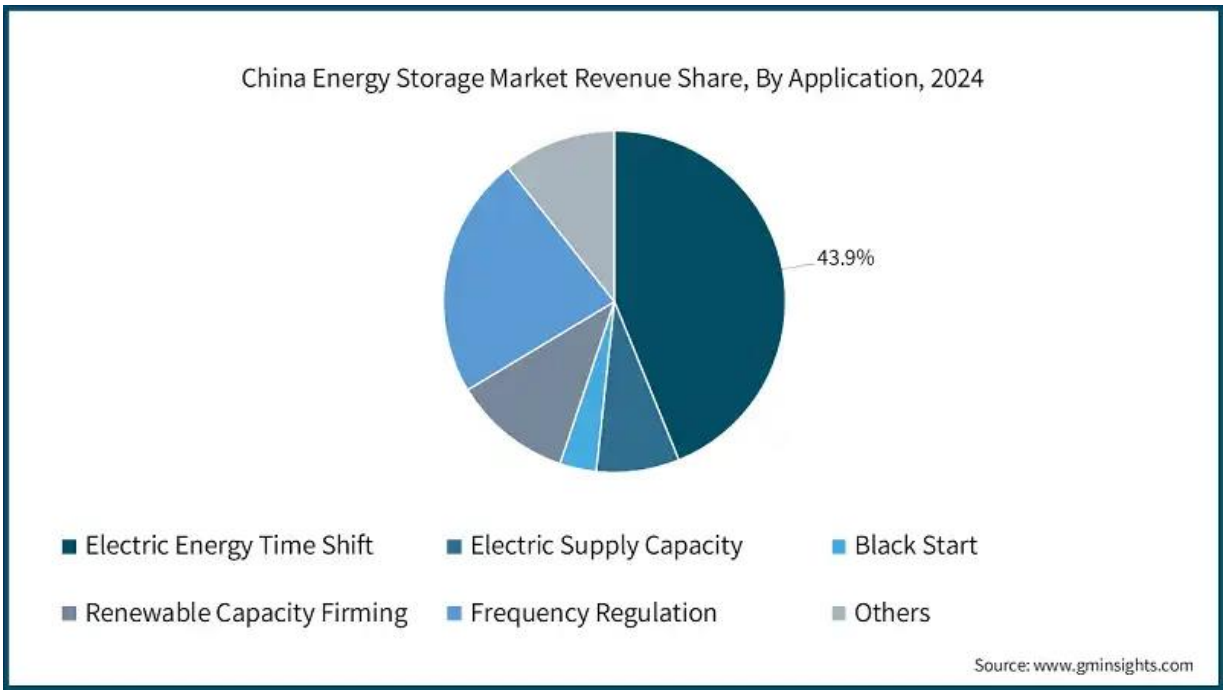


Figure (03): Energy Storage Market Revenue in China, 2024
Source: Global Market Insights, published in 2024 (accessed 2026).

The Chinese energy storage market is segmented by application into electric energy time-shifting, electric supply capacity, renewable capacity firming, and frequency regulation, among others. The electric energy time-shifting segment accounted for more than 43.9% of the revenue share in 2024.

The increasing frequency of cyclones and natural disasters has led to a rise in power outages and electricity costs. For instance, the average cost of industrial electricity shifted from approximately 0.084 USD/kWh in 2024, representing a slight increase in China. Furthermore, total electricity consumption in China grew by about 6.7% in 2023, a trend likely to further stimulate the demand for energy shifting solutions.

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

Due to the rising adoption of electric vehicles (EVs), driven by a preference for eco-friendly transportation and favorable government policies, the Chinese energy storage market is expected to witness higher demand. In 2024, BYD, one of China's largest EV manufacturers, announced record sales of 4.3 million units, bringing the company closer to the top global position in the EV industry.

Economic and Social Impacts of Renewable Energy Storage

Energy storage plays a vital role in economic and social transformation by enhancing the stability and flexibility of power systems. As the world transitions toward sustainability, storage balances the intermittent supply of renewables, bolsters energy security by providing reserves during outages, and contributes to economic growth by optimizing consumption and reducing costs.

1. Accelerating the Energy Sector Transition

Storage technologies are fundamental to advancing a low-carbon system. They address challenges associated with integrating renewables, specifically volatility and intermittency, thereby ensuring greater grid stability.

2. Enhancing Renewable Integration

The variability of wind and solar energy poses a challenge for grid integration, as generation depends on weather, time, and seasonal changes. This often leads to a mismatch between supply and demand, resulting in "curtailment", where excess energy is wasted because the grid cannot absorb it. This phenomenon reduces efficiency and causes economic losses. Storage systems act as a link; they absorb excess production during peak generation and release it during periods of low production, ensuring a higher utilization rate of renewable resources and enhancing the economic viability of green projects.

3. Ensuring Power Supply Stability

As systems shift away from fossil fuels, maintaining a reliable supply becomes more complex. Energy storage serves as a rapid-response resource during sudden demand spikes, such as heatwaves or extreme cold. Mobile energy storage systems further ensure continuity during localized outages, preventing the heavy economic losses associated with grid congestion.

4. Ensuring Energy Security

Storage facilitates the shift from centralized to distributed energy systems, where power is generated and consumed locally. Distributed resources, including residential battery storage and rooftop solar, reduce dependence on large central grids and empower consumers to manage their own energy, thereby enhancing overall grid resilience.

Challenges Hindering Renewable Energy Storage

- **Structural Supply-Demand Imbalance**

A primary obstacle facing the energy storage industry is the structural imbalance between market availability and technical requirements. Currently, the market is dominated by low-cost solutions, such as small-scale lead-acid batteries, which have seen rapid deployment due to their cost-effectiveness for short-term applications. However, these systems are insufficient for long-duration, utility-scale storage. In contrast, advanced solutions, including long-duration batteries, flow batteries, and power-to-gas systems, are essential for ensuring grid stability and mitigating the intermittency of renewable energy, yet these technologies remain in various stages of developmental maturity.

ISSN: 2392-5353 (Printer)
E-ISSN: 2661-7528 (Online)
https://asjp.cerist.dz/en/PresentationRevue/466

- **Prohibitive System Costs:** High capital expenditure continues to act as a significant barrier to sectoral growth. Energy storage technologies, particularly batteries, involve substantial costs related to development, manufacturing, and large-scale deployment. For instance, lithium-ion batteries, which currently dominate the market, still require high capital investments. Key cost drivers include the price of raw materials such as lithium, cobalt, and nickel, which are often extracted from geopolitically unstable regions, leading to supply chain vulnerabilities. (Xue & wang, 2025, pp. 10-15)

III. Conclusion

The energy storage sector in China has experienced rapid growth, emerging as a dominant force in the global market. By 2023, China accounted for 47% of new global energy storage projects. The growth of this sector is determined by a combination of technological advancements, material costs, electricity pricing dynamics, and strategic policy interventions. While innovations in lithium-ion, compressed air, and hydrogen storage have improved efficiency and scalability, challenges regarding cost and resource dependency persist.

Findings

- the expansion of renewables and EVs is driving market demand, yet the mismatch between supply and demand complicates large-scale implementation. Policy support, including subsidies, regulatory frameworks.
- China's energy storage growth is determined by a combination of technological advancements, material costs, electricity price dynamics, market demand, and policy interventions.
- pricing mechanisms, remains pivotal. For the Chinese economy and society, energy storage is indispensable; it reduces fossil fuel reliance, mitigates grid instability, and fosters economic growth by creating new industrial chains and employment opportunities.
- Technological innovation should enhanced through AI.AI-driven predictive modeling can optimize material selection, enhance battery performance and reduce system inefficiencies. Automation and machine learning technologies can significantly shorten research and development cycles enabling quiker commercialization of advance storage solutions.

Recommendations

- Prioritize the development of renewable energy storage technologies to eliminate reliance on traditional sources and reduce the national carbon footprint.
- Establish a sustainable green economic system involving all societal stakeholders as a shared responsibility.
- more comprehensive policy framework should be constructed. A well – structured and adaptive policy system is essential for fostering the development of energy storage.

VI. References:

1. Alliance (CNESA), C. E. (2026). Key energy storage standards to watch in 2026 highly recommended for industry reference. The 14th Energy Storage International Conference and Expo. CIECC Beijing, China.
2. Belkhdar, A. (2020). The Future of Energy in Light of the Global Shift Towards Clean Energy. Economic Alternative Journal, 226.
3. Boufetsh, W. (2018). Energy Policy Frameworks in China. 100.
4. Boufetsh.W. (2018). Renewable Energy in China: Lessons Learned. Journal of Economic Development, 3(6), 98.
5. Eduard Enasel, G. D. (2025). Storage solutions for renewable energy: A review. Energy Nexus ELSEVIER, 03.
6. Elalfy, D. (2024). Comprehensive Review of Energy Storage Systems Technologies, Objectives, Challenges, Future Trends. Energy Storage Review, 54.
7. Energy, G. G. (2018). Engineering Research and Applications, 41–53.
8. Global Market Insights. (2026, January 14). Energy Storage Market. Retrieved from https://www.gminsights.com
9. Gomstyn & Jonker. (2024). Defining Energy Storage. IBM Insights. Retrieved from IBM. [Online]
10. guo, S. (2025). Advancements in Energy-Storage Technologies: A Review of Current Developments and Applications. Sustainability 2025, 17, 8316. https://doi.org/10.3390/su17188316
11. Hafiz, & Al-Aqoun. (2021). Sustainable Development and Investment in Green Technology: The Case of China. Journal of Human Sciences, 21(1), 1098.
12. IEA. (2012). World Energy Outlook. Paris: IEA/OECD, p. 53.
13. Lal, K. (2018). Green globalization as green technology and renewable energy. *International Journal of Engineering Research and Applications*, 8(9), 41–53.
14. Lambert, S. C. (2024). Six Innovative Methods for Energy Storage. Retrieved from https://kustreview.com/ar/
15. Liu, X. (2026). Energy Storage for Renewable Energy in China: A Review of Development, Technological Progress, and Socioeconomic Considerations. Proceedings of the 4th International Conference on Mechatronics and Smart Systems. DOI: 10.54254/2755-2721/2026.33098, p. 100. College of Aerospace and Civil Engineering, Harbin Engineering University, Harbin, China.
16. Liu, Y., Wu, W., Zhang, N., & Jiang, D. (2025). The prospects of energy storage technology development in China: Long-term analysis of economic and environmental benefits. *Journal of Energy Storage,12*.
17. Manuel Chazarra a, J. I.-D. (2018). Economic viability of pumped-storage power plants participating in the secondary regulation service. Applied Energy, 227.
18. Mathew Aneke, M. W. (2016). Energy Storage Technologies and Real Life Applications – A State of the Art Review. White Rose Research. Retrieved from https://eprints.whiterose.ac.uk/id/eprint/154479/
19. Mohammed faisal, M. A. (2018). Review of energy storage system technologies in microgrid application: Issues and Challenges. IEEE Access (Special Section on Advanced Energy Storage Technologies and Their Applications), 6.
20. Mordor Intelligence. (2026, February 5). China Energy Market Industry Analysis. Retrieved from https://www.mordorintelligence.com/

21. Moulferaa, N. (2025). Clean Energy as a Driver for Sustainable Development: Perspectives and Opportunities. Journal of Legal and Economic Research, 689–691.
22. Nishkar R, N. (2021). Conceptual framework of microgrid and virtual power plants with renewable energy resources. Modeling and Control Dynamics in Microgrid Systems with Renewable Energy Resources, 21.
23. shoaib Ahmed, A. A. (2025). Energy Storage Systems: Scope, Technologies, Characteristics, Progress, Challenges, and Future Suggestions — Renewable Energy Community Perspectives. Energies, 09.
24. Tahtouh, M. (2021). The Contribution of Power Purchase Agreements in Reducing Renewable Energy Costs. Journal of Economic Studies and Research for Renewable Energies, 93.
25. Tonglin Jia, Y. S. (2026). Empowering modern power systems with thermal energy storage in China: A comprehensive review. Renewable and Sustainable Energy Reviews, 03.
26. World Bank. (2026). Energy Sector Overview and Sustainable Trends. Retrieved from www.worldbank.org/ar/topic/energy/overview
27. Xinhua. (2025, September 12). Xinhua News. Retrieved from arabic.news.cn
28. Xue, & Wang. (2025). The Development of the Energy Storage Industry in China: Challenges and Opportunities. Energies, 18/1512, 10–15.
29. Yuan, B., Zhang, Q., & Xu, C. (2026). The evolution of policies for new energy storage in China (2005–2024): An analysis based on policy instruments. Energy Storage, 1251.