



The Future of Energy Storage (POV: Cost)

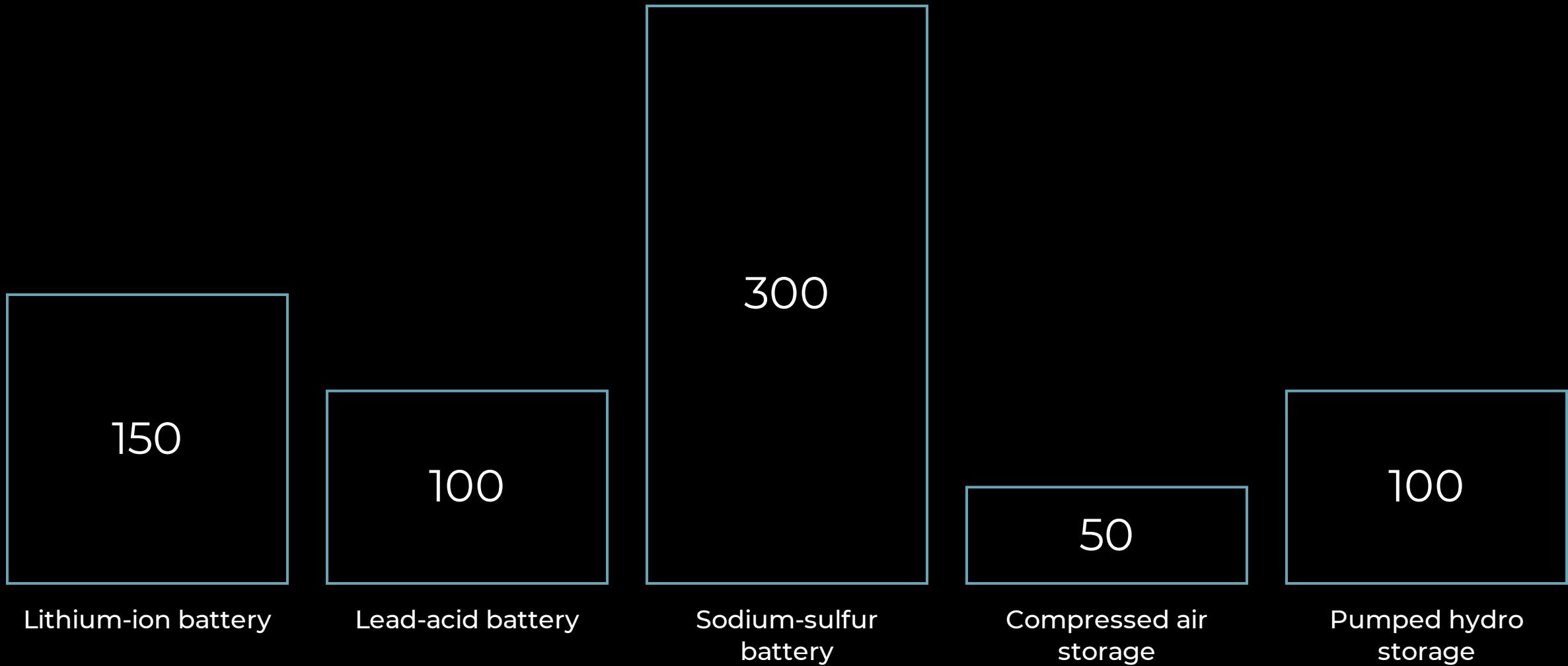
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Energy storage technologies are critical for enabling the widespread adoption of renewable energy and transitioning away from fossil fuels. By storing excess renewable energy when supply exceeds demand, energy storage provides grid stability and flexibility. Key applications include electric vehicles, utility-scale storage to shift peak loads, and behind-the-meter storage for homes and businesses.



Types of Energy Storage

Cost per kWh in US dollars



Key Players in Energy Storage



TESLA

Panasonic

LG Chem



SAMSUNG SAMSUNG SDI

CATL

SK innovation

EnerSys®

DURACELL

Japanese Companies Discuss the Alternative to the Recent Alternative Approaches

Panasonic



HITACHI



IMITSUBISHI



NEC



nichicon

SONY



TOSHIBA

Lithium-Ion Batteries

Lithium-ion batteries work by moving lithium ions between a positive electrode (cathode) and a negative electrode (anode) during charging and discharging. The electrodes are separated by an electrolyte that allows lithium ions to move freely between the electrodes while preventing electrical shorts. Lithium-ion batteries have high energy density, low self-discharge, and no memory effect compared to other battery chemistries.



Cost Trends

1995

First lithium-ion
battery
commercialized by
Sony

2020

Average lithium-ion
battery pack price falls
below \$100/kWh

2008

Tesla builds first
lithium-ion battery
Gigafactory

Grid-Scale Energy Storage Projects



Hornsdale Power Reserve. South Australia

The Hornsdale Power Reserve is a 150 megawatt hour lithium-ion battery energy storage system in South Australia. It is connected to the Hornsdale Wind Farm and helps stabilize the grid.



Bath County Pumped Storage Station. Virginia, USA

The Bath County Pumped Storage Station is a pumped-storage hydroelectric power station with a capacity of 3,003 MW. It is the largest pumped storage power station in the world in terms of capacity.



Tianhuangping Pumped Storage Power Station. China

The Tianhuangping Pumped Storage Power Station has a capacity of 1,800 MW. It is the second largest pumped storage power station in China and helps meet peak demand.

Applications of Energy Storage

Electric Vehicles

Batteries provide energy to power electric motors in vehicles like cars, buses, trains, ships and airplanes.

Grid Energy Storage

Large battery systems help stabilize the electric grid by storing energy during low demand and discharging during high demand.

Consumer Electronics

Batteries power mobile phones, laptops, cameras and other portable consumer electronics.

Home Energy Storage

Residential battery systems can store solar energy and provide backup power during outages.

Industrial

Factories and industrial facilities use batteries to smooth production, store renewable energy and provide backup power.

Military & Aerospace

Advanced batteries provide power for communications, vehicles, weapons systems and satellites.

Future Opportunities

Energy Storage System Deployments

Battery Storage Revenue Growth

Grid-Scale Storage Capacity Additions

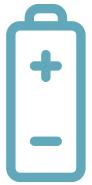
Behind-the-Meter Storage Adoption

Challenges Facing Energy Storage



High costs

Many storage technologies remain expensive compared to fossil fuels.



Low energy density

Most storage methods cannot hold large amounts of energy in a small space.



Geographical constraints

Some technologies only work in certain locations or conditions.



Long charge times

Many batteries take hours to fully charge which limits applications.

While costs are falling, key limitations of energy storage like density and charge times remain challenges to widespread adoption.



Conclusion

The future of energy storage looks bright, with continued improvements in battery technology enabling wider adoption of electric vehicles and more renewable energy storage. Key trends include solid state batteries with higher energy density, longer lifetimes, and faster charging times. Wider access to energy storage can accelerate the transition away from fossil fuels.

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