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Rechargeable Batteries (OVERWEIGHT) Dialogue with the market #55: AI data centers

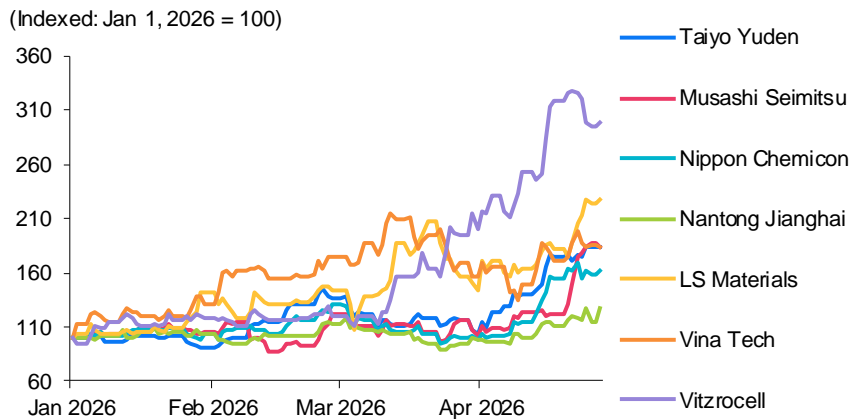
- Driven by the AI data center boom, lithium ion capacitor (LIC) manufacturers have put in strong stock performances since the beginning of the year.
- Investors are increasingly paying more attention to power management technologies within server racks—particularly those designed to absorb millisecond-scale power fluctuations.
- A 1 GW IT server needs backup battery capacity of 195 kWh.

WHAT'S THE STORY?

Introduction: In this, the 55th report in our Dialogue with the Market series, we examine the battery technologies tied to the ongoing AI data center expansion and the beneficiaries in this investment landscape. Early attention focused on energy storage system (ESS) makers among power infrastructure equipment makers for AI data centers. But the focus has now shifted to include backup power solutions inside server racks—supercapacitors (electric double-layer capacitors; EDLCs) and lithium capacitors (LICs)—as alternatives to conventional battery backup units (BBUs). To assess their potential, it is essential to understand how these technologies differ from conventional lithium-ion batteries in terms of performance characteristics and material composition. Equally important is estimating the size of the emerging demand for these components as backup power sources in AI data centers.

(Continued on the next page)

LIC-related listed companies stock performance in 2026



Source: Bloomberg, Samsung Securities

LIC-related stocks perform strongly amid AI data center boom: Several publicly traded capacitor manufacturers have put in remarkable performances this year, closely tied to the AI data center narrative. In Japan, Musashi’s stock has climbed 85% ytd. In Korea, LS Materials surged 128% ytd. Meanwhile, China’s Nantong Jianghai—a comparable listed player—gained just 27%, significantly lagging its Japanese and Korean peers. Adding to the momentum, Vitzrocell—a primary battery maker that also produces EDLCs—has attracted fresh investor interest as a potential entrant into this space. Its stock jumped an impressive 198% over the same period, outperforming all others.

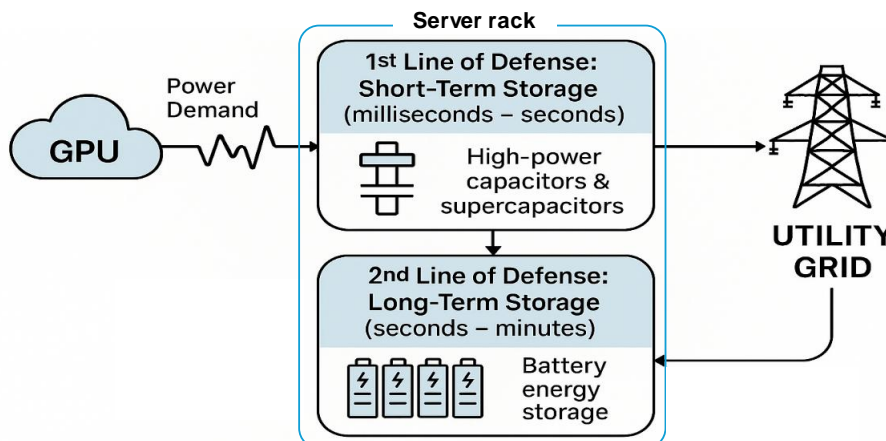
Issue (1) Three battery technologies inside AI data center server racks to stabilize power supply: The biggest challenge facing modern AI data centers is ‘pulse loads’ generated during generative AI computation. AI algorithms perform intense, short-duration calculations, which could trigger sudden, millisecond-scale spikes in GPU power demand, known as load reflection. These bursts can surge tens of megawatts in under a second, overwhelming traditional power systems and disrupting grid connectivity.

To prevent this, BBUs and supercapacitors embedded within server racks play a critical role in instantly supplying power during transient spikes, preventing voltage dips. While data centers previously relied on large, centralized uninterruptible power supply (UPS) systems, the trend is now shifting toward distributed energy storage at the rack level—designing power architectures that protect power quality on a per-rack basis, rather than at the facility level.

Generally speaking, BBUs, UPS, and ESSs are key backup power sources¹. These batteries provide instantaneous power and stabilize voltage and frequency until backup generators come online.

As AI computation volumes continue to grow, so too does the power consumption of the GPUs responsible for processing these workloads. In response, server-level BBUs are increasingly tasked with absorbing millisecond-to-second power fluctuations generated by GPUs. To enhance power stability, data centers are now supplementing BBUs with supercapacitors or LICs—devices specifically designed to neutralize millisecond-scale power transients.

Nvidia's multi-layer energy storage for AI data center power stabilization (based on server rack)

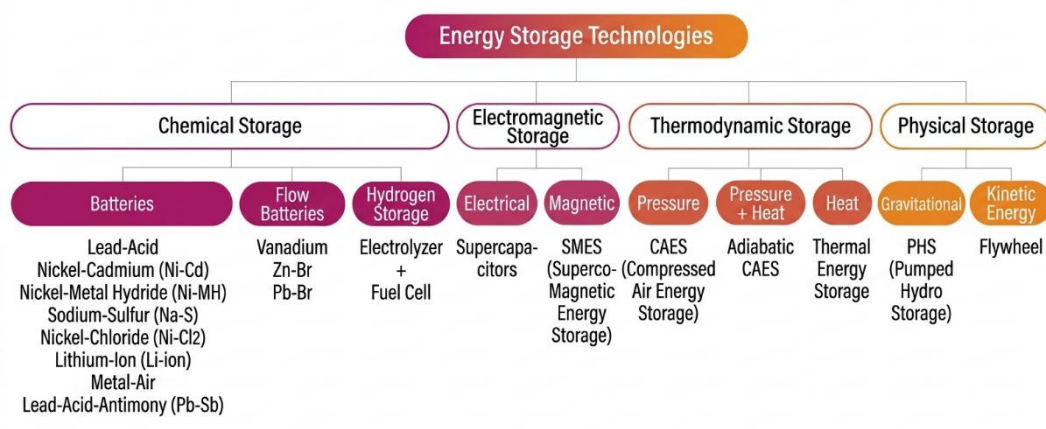


Source: Nvidia, Samsung Securities

¹ Samsung Securities, Rechargeable Batteries (NEUTRAL) - AI data centers and batteries (Nov 17, 2026)

Issue (2) Supercapacitors—same function, different physics: Energy storage technologies span a wide spectrum, but in capital markets, electrochemical storage—particularly lithium-ion batteries—dominates public awareness. Driven by economies of scale from EV adoption, lithium-ion systems now account for the vast majority of installed energy storage capacity worldwide. Supercapacitors, by contrast, operate on an electrostatic principle. While both store and release energy through charging and discharging, their core design differs significantly: supercapacitors use specialized electrode materials and lower nominal voltages, resulting in distinct performance profiles (energy density and power delivery).

Energy storage technologies

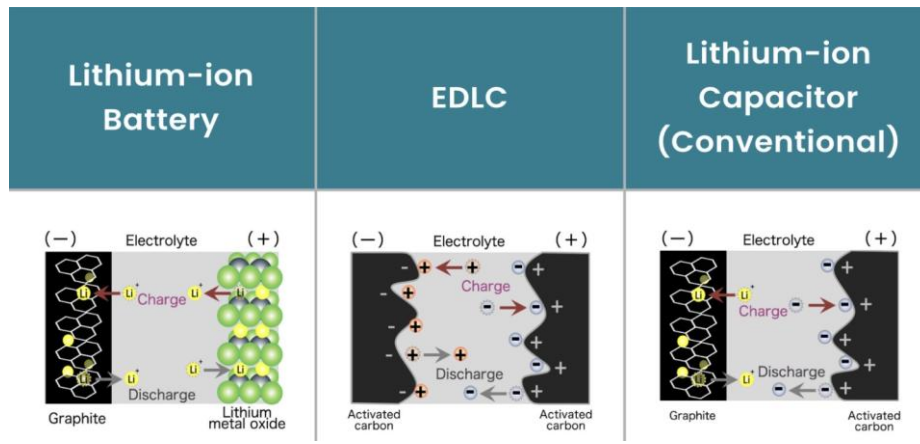


Source: Samsung Securities

In AI data center server racks, EDLCs, LICs, and BBUs are emerging to manage rapid power transients. Their technical characteristics and distinctions are as follows.

- Supercapacitors, also known as EDLCs, store far more energy than conventional capacitors like MLCCs—and charge and discharge much faster than lithium-ion batteries. EDLCs store energy electrostatically at the interface between electrodes and an electrolyte. Their high capacity comes from electrodes made of activated carbon, chosen for its extremely high surface area. Both the positive and negative electrodes use aluminum foil as the current collector. The electrolyte is typically sulfuric acid or potassium hydroxide, offering high ionic conductivity—but this comes at the cost of low operating voltage.
- LICs are hybrid energy storage devices that combine the high power density of EDLCs with the higher energy density of lithium-ion batteries. While EDLCs use activated carbon at both electrodes and store charge purely through physical ion adsorption/desorption—resulting in fast response times and long cycle life—LICs replace the negative electrode with lithium-doped carbon. This enables a partial electrochemical reaction at the anode, allowing LICs to store significantly more energy than conventional EDLCs. In 2024–2025, Flex—one of the world’s largest EMS providers—partnered with Japan’s Musashi to develop and deploy a 1 MW LIC-based system directly within server racks, targeting the challenge of unstable grid power delivery in AI data centers.

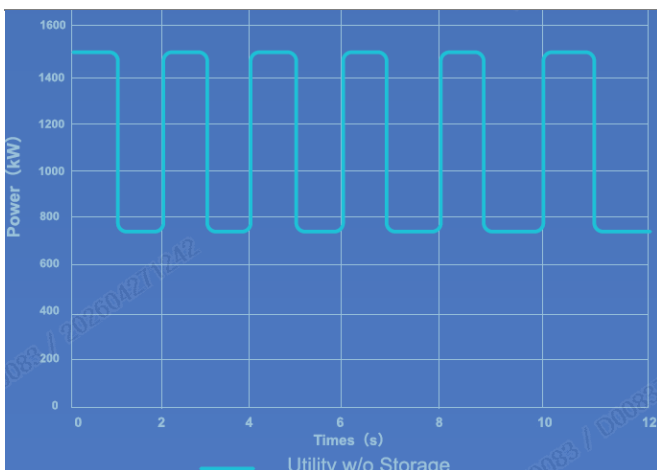
LIC structure characteristics and differences from EDLC and LIB



Source: JTEKT

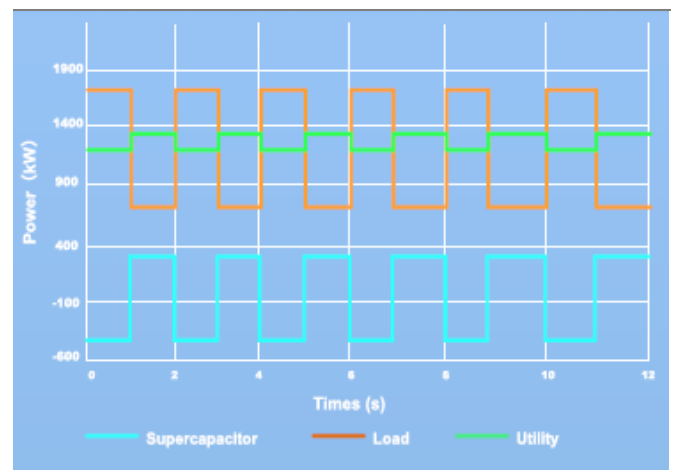
- BBUs leverage electrochemical mechanisms to deliver high energy density and maintain a stable voltage throughout most of the discharge cycle. Modern designs are shifting from traditional 1865 cylindrical cells to tabless 2170 cells, which reduce internal resistance and improve peak power delivery—critical for handling GPU load spikes. Yet, because BBUs rely on electrochemical reactions to release energy, there is a slight delay—resulting in momentary voltage spikes during sudden load changes. In contrast, LICs do not suffer from this lag but their voltage varies with state of charge (SoC), requiring a DC-DC converter to maintain consistent output to server rails.
- From an energy storage perspective: EDLCs excel at absorbing microsecond-to-millisecond spikes, while BBUs sustain power over seconds to minutes, and LICs sit in between. Accordingly, AI data centers are adopting a tiered, layered approach to transient power management: 1) during a power outage, BBUs provide backup power to bridge the gap until emergency generators come online; and 2) EDLCs or LICs are deployed directly at the server rack level to absorb rapid load transients (around one second) and voltage spikes caused by AI workloads, protecting both the BBU and servers from stress.

Power fluctuation stress without energy storage device



Source: Eaton

Power fluctuation stress with supercapacitor



Source: Eaton

Comparison of EDLC, LIC, and BBU (LIB)

Category	Supercapacitor (EDLC)	Lithium-Ion Capacitor (LIC)	Lithium-Ion Battery (LIB)
Energy Density	Low (~5-10Wh/kg)	Moderate (~20-50Wh/kg)	High (~150-300Wh/kg)
Power Density	Very high	High	Low
Nominal Voltage*	~2.7V to 3.0V	3.0V	3.7V
Cycle Life	>500,000-1,000,000 cycles	~100,000-500,000 cycles	~500-3,000 cycles
Self-Discharge	Relatively high	Very low	Very low
Charge Time	Seconds (1-10 sec)	Tens of seconds to minutes	Tens of minutes to hours

*Note: EDLC voltage declines linearly from maximum to 0V during discharge; thus, "rated voltage" is more appropriate than "nominal voltage" for practical use.

Source: Media, Samsung Securities

Three power consumption domains and battery types in AI data centers

Domain	Location	Battery Type	Cell Manufacturers
Domain 1	Server rack	EDLC, LIC	Japan: Musashi, JTEKT, Taiyo Yuden, Nippon Chemicon South Korea: Vina Tech, LS Materials, Vitzrocell China: Nantong Jianghai, SPS, Liyuan
		BBU	Japan: Panasonic South Korea: Samsung SDI, LG Energy Solution China: EVE Energy
Domain 2	Inside data center	UPS	Manufacturers in South Korea, China, Japan
Domain 3	Outside data center	ESS	Manufacturers in South Korea, China, Japan

Source: Samsung Securities

Issue (3) A 1 GW IT server needs backup battery capacity of 195 kWh: For a data center consuming 1.5 MW of power, a 50% load fluctuation (750 kW) would theoretically require 0.2 kWh of backup energy per second from storage devices like EDLCs, LICs, or BBUs. However, when accounting for voltage variations and losses from power conversion systems (such as PCS and inverters), the actual requirement rises to roughly 0.3 kWh per second. Scaling this up to a 1 GW facility, the required backup capacity becomes about 139 kWh in theory—or 195 kWh when accounting for system efficiency losses. If the goal is to absorb millisecond-level power spikes within server racks, using EDLCs or LICs can significantly reduce the required energy capacity compared to traditional batteries.

If the goal is to bridge the gap until backup generators start—typically several seconds—the required energy storage scales proportionally with duration. For an AI data center with a power demand of 100 GW², the energy storage needed within server racks to sustain operations during millisecond-to-second power transients would be around 14 MWh—or 19 MWh when accounting for system efficiency losses.

Estimated backup battery capacity (kWh) required for a 1.5MW data center server rack

Backup duration	50% load fluctuation	70% load fluctuation
500 milli-seconds	0.1042 kWh	0.1458 kWh
1 second	0.2083 kWh	0.2917 kWh
5 seconds	1.0417 kWh	1.4583 kWh

Source: Samsung Securities

² According to a US data center outlook report published by BNEF in Dec 2025, US data center power demand (based on load) is projected to rise from 41 GW in 2025 to 77 GW in 2030 and further to 106 GW by 2035 (refer to Samsung Securities, Rechargeable Batteries (NEUTRAL) - AI data centers and batteries (Nov 17, 2026))

Implications for rechargeable battery industry: Hyperscalers addressing AI data center power transients are increasingly exploring supercapacitors (alongside traditional lithium-ion batteries), as these devices react fast to quick power changes—making a hybrid configuration (supercapacitors and lithium-ion batteries), optimized for cost and performance from the operator’s perspective, the best solution. While the market for supercapacitors is growing, it will remain modest compared to the total backup battery demand for powering AI data centers. EDLC and LIC manufacturers can view the data center expansion boom as a new growth opportunity, but given the actual market size and intense competition among players, a careful assessment of underlying fundamentals is warranted.

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