247 ENERGY

Supercapacitor or Lithium-Ion? A Buyer's Guide

Comparing commercial and industrial energy storage on safety, cycle life, temperature range, power, and total cost of ownership.

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October 2025

FOREWORD

A Comparison Worth Making

Most commercial and industrial storage decisions start from an unexamined assumption: that storage means lithium-ion. Lithium has earned its position. It is energy-dense, widely available, and well understood. But the fact that it is the default is not the same as it being the right choice for every application, and the assumption is rarely tested against the alternatives.

I write this paper to test it. 247 Energy builds storage on supercapacitor technology, so I have a position, and I will be clear about it. A comparison is only useful if it is honest about where each technology wins and where it does not. A buyer who is told that one option is better in every respect has been sold to, not informed. My aim here is the opposite: to set out the dimensions that actually matter for an industrial site, to compare the two technologies on each, and to be candid about the cases where lithium remains the better fit.

The dimensions that matter are not abstract. They are safety, because storage often sits close to people and stock. Cycle life, because a site that cycles hard every day wears equipment out. Temperature tolerance, because real installations are not climate-controlled laboratories. Power and response, because many industrial uses are about delivering or absorbing power quickly rather than storing energy for hours. And materials, because the supply chain behind a technology is now a commercial and reputational exposure, not just an engineering detail.

On most of these dimensions the comparison runs differently from what the lithium default would suggest. That is the case I want to make, with the numbers attached, so that a buyer can weigh it for themselves.

James Troch, Chief Executive Officer, 247 Energy

THE CONTEXT

The Lithium Default and Its Hidden Costs

Why the obvious choice is not always the right one

Lithium-ion came to dominate stationary storage by way of consumer electronics and electric vehicles, where its high energy density in a small, light package is decisive. Those qualities carried it into grid and industrial storage, and for genuinely energy-dense, space-constrained, long-duration applications they still matter. The problem is that the qualities that make lithium ideal for a phone or a car are not the qualities most commercial and industrial storage actually needs.

An industrial peak-shaving installation does not care much about weight or volume. It sits in a yard or a plant room where space is not the binding constraint. What it cares about is whether it is safe next to a warehouse full of stock, whether it will still hold its capacity after years of daily hard cycling, whether it will work through a cold snap or a heatwave, and what it costs to own over its full life. On exactly these points the lithium default carries costs that are easy to overlook at purchase and expensive to discover later.

The first hidden cost is safety. Lithium cells can enter thermal runaway, a self-sustaining reaction in which a failing cell heats its neighbours until the pack burns. The risk is low per unit but real at scale, and it shapes everything around the installation: fire suppression, spacing, siting away from occupied buildings, and insurance terms that reflect the hazard. These are not edge cases. They are standard design constraints that add cost and limit where a system can go.

The second hidden cost is degradation. A lithium pack loses capacity with every cycle and with time, and the loss accelerates under heavy use and temperature stress. A system rated for a certain capacity on day one delivers less each year, so buyers must either oversize at purchase or accept a shortening useful life. For a site that cycles once or more a day, the gap between the rated life and the real life can be the difference between a sound investment and a disappointing one.

The third hidden cost sits in the supply chain. Lithium and cobalt are mined and processed in concentrated, sometimes contested, locations, under conditions that increasingly draw scrutiny. A storage purchase is now also a supply-chain and reputational decision. None of these costs make lithium a bad technology. They make it a technology whose true cost is higher, and whose ideal use is narrower, than the default assumption suggests.

DIMENSION ONE

Safety

Thermal runaway as a present risk versus a physical impossibility

Safety is where the two technologies differ most fundamentally, because the difference is not one of degree but of mechanism. Lithium-ion stores energy chemically, and under abuse, defect, or overheating a cell can begin an exothermic reaction that feeds itself. Once thermal runaway starts it is hard to stop, and it can propagate through a pack. The industry manages this risk well with engineering, but management is necessary precisely because the risk is inherent to the chemistry.

Supercapacitors store energy physically, in the separation of charge rather than in a chemical reaction. There is no chemical conversion to run away. The result is that thermal runaway is not mitigated, it is absent. A supercapacitor module generates far less heat in operation and is far less sensitive to ambient temperature, and the catastrophic failure mode that defines lithium fire risk is simply not present. This is a difference in kind, and it changes what becomes possible.

> ***With supercapacitors, thermal runaway is not mitigated. It is absent. The failure mode that defines lithium fire risk is not part of the physics.***

The practical consequences are large. Storage that cannot enter thermal runaway can be sited close to occupied buildings and valuable stock without the spacing and suppression that lithium demands. It is suitable for environments lithium struggles to enter at all, including ATEX-classified areas where explosive atmospheres may be present and any ignition risk is unacceptable. The same property simplifies insurance and permitting, because the underwriter and the authority are assessing a lower-hazard asset.

For many industrial sites this single dimension reframes the decision. A technology that removes fire risk as a design constraint does not just lower a probability. It removes a whole category of cost, restriction, and worry from the installation. For a buyer siting storage next to people, that is often worth more than any other single property.

DIMENSION TWO

Cycle Life and Degradation

How long the asset actually lasts under hard use

The headline capacity of a storage system is what it can deliver when new. The number that determines the return on investment is how long it keeps delivering it. Here the two technologies diverge sharply, and the divergence grows with how hard the system is worked.

Lithium-ion degrades with every charge and discharge, and faster under deep cycling, high rates, and temperature stress. Commercial lithium iron phosphate systems, the safer and longer-lived lithium variant, are typically rated from several thousand up to around ten thousand cycles before capacity falls to the point of replacement. For a site cycling once a day that is a useful but finite life. For a site cycling several times a day for peak management, the rated life arrives sooner than the financing assumed.

Supercapacitor storage degrades far more slowly, because there is no chemical reaction wearing the cell out with each cycle. 247 Energy warrants its modules for ten thousand cycles or ten years, with a projected lifetime of up to fifty thousand cycles and a cycle life that exceeds fifteen thousand cycles at twenty-five degrees Celsius. Against conventional lithium-ion or LFP that is a materially longer working life, and the advantage widens the harder the system is cycled, because frequent deep cycling is exactly what shortens a lithium pack and barely troubles a supercapacitor.

The investment implication follows directly. A longer-lived asset spreads its capital cost over more years and more cycles, and it avoids the mid-life replacement that a shorter-lived system forces. For a high-cycle application such as peak shaving, where the system works hard every day, the difference in lifetime cycles is not a specification detail. It is the largest single driver of the cost per useful cycle over the life of the asset.

DIMENSION THREE

Temperature and Operating Range

Performance in the real world, not the laboratory

Storage specifications are quoted at a comfortable reference temperature, usually around twenty-five degrees Celsius. Real installations rarely stay there. A unit in an unconditioned plant room, a yard, or an outdoor enclosure sees cold mornings, hot afternoons, and seasonal swings, and temperature is one of the strongest influences on how a storage system performs and ages.

Lithium-ion is sensitive to temperature at both extremes. Cold reduces the energy it can deliver and the rate at which it can charge. Heat accelerates degradation and, past a point, raises safety risk. Keeping a lithium system within its comfortable band often requires active heating and cooling, which adds cost, consumes energy, and introduces another system that can fail.

Supercapacitor storage tolerates a far wider operating range. 247 Energy modules operate safely between minus twenty and plus fifty-five degrees Celsius, and because they generate little heat and run no temperature-sensitive chemical reaction, they hold up across that range without the conditioning a lithium system needs. For an installation that must work reliably through a real climate rather than a controlled one, the wider range removes both a performance limit and a maintenance burden.

> ***Real installations are not climate-controlled laboratories. Storage that works from minus twenty to plus fifty-five degrees removes a limit that lithium meets with heaters and chillers.***

The effect compounds with the cycle-life point. Temperature stress is one of the main accelerators of lithium degradation, so a system run hot ages faster as well as performing worse. A technology largely indifferent to temperature therefore protects both the performance and the lifetime of the asset at once, which is why operating range belongs alongside safety and cycle life as a dimension that genuinely matters.

DIMENSION FOUR

Power and Response

When the job is power, not energy

Storage is often discussed as if its only purpose is to hold energy for later. Many industrial applications are about something different: delivering or absorbing power quickly. Smoothing a sharp load, catching a regenerative surge, covering the instant a supply drops, or shaving a brief peak are all power tasks, measured in seconds and minutes rather than hours. On these tasks the comparison again favours the supercapacitor.

Supercapacitors charge and discharge extremely fast, because moving charge physically is quicker than driving a chemical reaction. A 247 Energy system can take a full charge in around six minutes given a suitable supply, and it switches between charging and discharging effectively instantly. For an application standing in for a grid connection or covering a momentary loss of supply, that instant response is not a convenience. It is the function.

Lithium-ion can deliver power too, but pushing it hard shortens its life and raises its temperature, so high-power duty trades against longevity and safety. The supercapacitor has no such trade. High-power, high-frequency duty is the work it is built for, and doing it does not wear the asset out. For peak shaving, power quality, and fast backup, that alignment between the task and the technology is the point.

This is also where an honest comparison must mark the boundary. For storing large amounts of energy over many hours, lithium-ion remains more energy-dense per unit of volume and weight, and for that long-duration, energy-heavy role it is often the better choice. The supercapacitor wins decisively on power, response, cycle life, safety, and temperature. It does not claim to win on raw energy density for long-duration bulk storage. A serious buyer matches the technology to the job rather than assuming one answer for all of them.

DIMENSION FIVE

Materials and Supply Chain

What the technology is made of, and what that exposes you to

A storage purchase used to be judged on performance and price alone. It is now also judged on what the product is made of and where those materials come from, because supply chains carry commercial, regulatory, and reputational exposure that buyers are increasingly expected to account for.

Lithium-ion depends on lithium and, in many chemistries, cobalt. Both are mined and processed in concentrated locations, some subject to serious scrutiny over environmental and labour conditions. That concentration creates price volatility and supply risk, and the conditions create ESG exposure that can attach to the buyer as much as to the manufacturer. None of this is hidden, but it is easy to leave out of a purchase decision focused on capacity and cost.

247 Energy supercapacitor modules contain no rare or expensive metals and require no polluting production process. The technology is built on carbon-based, nano-augmented materials rather than scarce mined metals, which removes a layer of price volatility, supply concentration, and ESG exposure from the asset. For a buyer accountable for the provenance of what they install, that is a measurable reduction in risk, not a slogan.

The materials point also feeds back into cost and longevity. A technology that does not depend on scarce metals is less exposed to the price swings those metals are prone to, and one that degrades slowly needs replacing less often, so less material is consumed over the life of the installation. Across safety, lifetime, temperature, power, and materials, the same pattern recurs: for the conditions most commercial and industrial sites actually face, the supercapacitor answers the dimensions that matter.

THE VERDICT

Reading the Comparison Honestly

Matching the technology to the job

The purpose of a comparison is a decision, and an honest comparison points to different decisions for different cases. Supercapacitor and lithium-ion are not simply better and worse versions of the same thing. They are tools with different strengths, and the right choice depends on what the installation is for.

> ***Supercapacitor and lithium-ion are not better and worse versions of the same thing. They are different tools, and a serious buyer matches the tool to the job.***

Where the job is power and frequent cycling, supercapacitor storage is the stronger fit on almost every dimension that matters. Peak shaving, power-quality support, fast backup, regenerative capture, and any duty that cycles hard every day play to its long life, its instant response, its safety, and its temperature tolerance. These are also the most common needs on commercial and industrial sites, which is why the supercapacitor deserves to be the default for that work rather than the exception.

Where the job is to store a large quantity of energy and release it slowly over many hours, the higher energy density of lithium-ion still tends to win, and a buyer with that requirement should weigh it accordingly. The two are not mutually exclusive. Hybrid designs that pair a supercapacitor for power and cycling with a battery for bulk energy are well established, and 247 Energy supercapacitor modules are designed to integrate with existing lithium-ion systems rather than only to replace them.

The mistake to avoid is the one this paper began with: assuming that storage means lithium without testing the assumption against the job at hand. For the power-intensive, high-cycle, safety-sensitive applications that dominate commercial and industrial sites, that assumption is usually wrong, and the cost of not testing it shows up later in fire constraints, mid-life replacements, climate conditioning, and supply-chain exposure that the right technology would have avoided.

Total Cost Over the Whole Life

Why purchase price is the wrong number to compare

Comparisons that stop at purchase price mislead, because the cheapest system to buy is often the most expensive to own. The number that matters is the total cost over the full life of the installation, including replacement, conditioning, safety provision, insurance, and the value of the years the asset keeps working.

On that basis the dimensions in this paper convert directly into money. A longer cycle life defers or removes mid-life replacement. The absence of thermal runaway lowers the cost of suppression, spacing, siting, and insurance. A wide operating range removes the energy and capital cost of heating and cooling. Slow degradation means the system delivers closer to its rated capacity for longer, so it need not be oversized at purchase to compensate. Each of these is a line in the cost of ownership that the supercapacitor reduces or removes.

For high-cycle commercial and industrial duty, the result is that a supercapacitor system whose purchase price may sit alongside or above a lithium equivalent can cost meaningfully less to own over its life, because it lasts longer, needs less around it, and degrades less along the way. The right comparison is not what the two cost to buy, but what they cost to run for as long as the site needs them.

That is the case for testing the lithium default rather than accepting it. The technology that wins on the dimensions that matter, and on the total cost that follows from them, is frequently not the one the default would pick. For a buyer willing to look past purchase price to the life of the asset, the comparison is worth making in full.

Storage Built for the Dimensions That Matter

247 Energy develops, builds, and operates energy storage for commercial and industrial sites, built on nano-augmented supercapacitor technology rather than conventional lithium-ion. The technology is chosen for exactly the conditions this paper describes: sites that cycle hard, sit close to people and stock, work through real temperature ranges, and need power and response rather than only stored energy.

The modules contain no rare or expensive metals and cannot enter thermal runaway, so they can be sited safely close to occupied buildings and are suitable even for ATEX-classified areas where explosive atmospheres may be present. They operate from minus twenty to plus fifty-five degrees Celsius, run quietly at around fifty-five decibels, and switch between charge and discharge instantly. 247 Energy warrants them for ten thousand cycles or ten years, with a projected lifetime of up to fifty thousand cycles, materially longer than conventional lithium-ion or LFP under hard use.

The systems are available in rack-mounted and containerised configurations, in form factors from one kilowatt to ten megawatts, and they are designed to integrate with existing lithium-ion installations as well as to stand alone. This lets a site adopt the technology where it fits best, whether replacing a lithium system, complementing one, or building new.

Beyond on-site storage, 247 Energy develops, builds, and co-invests in utility-scale battery energy storage parks rated at 100 MW and above, with a current European pipeline spanning two regions and five countries and a combined capacity of 505 MW / 2,025 MWh. We retain skin in the game in the assets we develop, and we work with co-investors and partners who share a long-term view of energy infrastructure.

For operators weighing a storage decision, and for partners interested in the technology or in co-investment, we welcome direct engagement. We can discuss specific applications in detail, from sizing a system for a high-cycle site to integrating supercapacitor storage with existing equipment, under appropriate confidentiality arrangements. Our aim is to help buyers match the technology to the job rather than to the default.

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