247 ENERGY

The C-Rate Ceiling

High-Power Storage Beyond the Lithium Limit

Why most storage systems never exceed 0.5C, what caps the discharge rate of every lithium iron phosphate system, and where physically stored energy changes the answer.

James Troch
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FOREWORD

A Number the Industry Does Not Print

Read the specification sheet of almost any grid-scale battery system on the market and you will be told how many hours it runs. Two hours. Four hours. Eight hours. What you will almost never be told, in a single clean figure, is how fast that system can actually move power. That figure is the C-rate, and across the dominant chemistry of the storage industry it has quietly become the number nobody volunteers, because for nearly everyone selling lithium iron phosphate the answer is the same.

I want to be careful and fair about this from the outset. For the large majority of storage projects being built today, a modest C-rate is exactly right. Shifting solar energy into the evening, trading the daily price spread, firming a wind farm, holding capacity in reserve: these are energy problems measured in hours, and a system that discharges over two to four hours serves them well and economically. A faster system would be capability the project never uses, paid for and left idle. We do not pretend otherwise, and any honest engineer in this field will tell you the same.

Our position is narrower and, I think, more useful. We built our technology for the applications that lithium cannot serve at all: the ones that need power in seconds rather than energy over hours. There the chemistry of a conventional battery runs into a hard physical wall, and no amount of clever packaging moves it. Our supercapacitor systems do not share that wall, because they store charge in a fundamentally different way. This paper explains where that line sits, why it sits there, and what it is worth to be on the right side of it.

The case is not that faster is always better. It is that when an application genuinely demands high power, there is today a real and defensible gap in the market, and it exists precisely because the most common chemistry is physically unable to close it.

James Troch
Chief Executive Officer, 247 Energy

THE METRIC IN DISGUISE

The Industry Markets in Hours, Not in Rate

Every battery storage system has two ratings that matter together: how much energy it holds, measured in megawatt-hours, and how fast it can deliver that energy, measured in megawatts of power. The relationship between the two is the C-rate. A system rated to discharge its full capacity in one hour operates at 1C. Discharge the same capacity over two hours and the rate is 0.5C. Push the full discharge into six minutes and the rate is 10C. Rate and duration are simply two ways of describing the same physical quantity, one the reciprocal of the other.

This is why a duration figure is a C-rate statement wearing different clothes. When a manufacturer advertises a four-hour system, it is telling you, without using the word, that the product operates at 0.25C. When the fastest standard product in a catalogue is a two-hour configuration, the catalogue is telling you its ceiling is 0.5C. The information is there. It is simply expressed in the form least likely to invite the follow-up question: and how much faster can it go?

The convention is a reasonable response to the fact that most buyers are sizing storage for energy applications, where hours of runtime is the intuitive and relevant number. But the convention has a side effect. It trains an entire market to evaluate storage on duration and to treat power capability as a given, when in fact power capability is the dimension on which the dominant chemistry is most sharply constrained, and the dimension on which the available technologies most differ.

Once you start reading duration figures as rate figures, a striking pattern appears across the major suppliers. The fastest standard utility products converge on the same narrow band. They do not advertise a high C-rate option because, for the chemistry they share, there is no high C-rate option to advertise. The silence is not marketing discipline. It is the sound of a physical limit that every lithium iron phosphate integrator runs into at roughly the same place.

WHAT C-RATE MEASURES

Power, Energy, and the Speed of Release

It helps to separate the two things a storage system stores and sells. Energy is the total quantity of electricity held, the size of the reservoir. Power is the rate at which that electricity can be pushed out, the width of the outlet. A large reservoir with a narrow outlet holds a great deal of energy but releases it slowly. A smaller reservoir with a wide outlet holds less but can empty it in a rush. The C-rate is the formal measure of how wide the outlet is relative to the size of the reservoir.

A useful picture is a warehouse served by a single road. The warehouse is the battery capacity, fixed in size. The C-rate is the flow limit of the road leading out of it. A low C-rate is a quiet country lane: goods leave steadily over many hours. A high C-rate is a wide motorway: the entire stock can be cleared in minutes. Crucially, widening the road does not change how much the warehouse holds. It changes only how quickly the contents can be moved when they are needed in a hurry.

Why the distinction decides the application

Some jobs are reservoir jobs. Storing midday solar to release across the evening peak is about holding a large quantity of energy and letting it out gently over hours. A low C-rate is not a weakness here. It is a match to the task, and pursuing a higher one would add cost without adding value. The reservoir is what matters, and the narrow outlet is entirely adequate.

Other jobs are outlet jobs. Catching a sudden frequency dip on the grid, absorbing the surge when a large industrial load switches on, charging a vessel or a fleet in the time it takes to load cargo: these are about delivering a great deal of power in a very short window. Here the size of the reservoir is almost beside the point. What decides whether the system can do the job at all is how fast it can move power, which is to say its C-rate. And it is precisely on this axis that conventional batteries hit their wall.

THE CHEMISTRY OF THE LIMIT

Why Lithium Iron Phosphate Cannot Be Hurried

Lithium iron phosphate, the chemistry that now dominates stationary storage, earns its place through safety, cost, and long cycle life. Those same properties come bound to a constraint on rate. The cathode has an olivine crystal structure, and that structure gives the material low electronic conductivity and a slow rate of lithium ion diffusion. Charge and discharge depend on ions physically threading their way into and out of the crystal lattice. The lattice only lets them move so quickly, and that speed limit is built into the material itself.

Push a cell to discharge faster than its internal transport can comfortably sustain and several things go wrong at once. The cell has a naturally high internal resistance, so forcing more current through it generates more heat through resistive losses. The voltage sags under the load, reducing the usable energy that actually reaches the application. The added heat accelerates chemical degradation, which raises resistance further, which generates still more heat. It is a reinforcing loop, and it is the reason that sustained high-rate operation shortens the life of a lithium cell far faster than gentle cycling does.

This is a property of the chemistry, not a choice made by any particular manufacturer. It explains a fact that would otherwise look like coincidence: no major lithium iron phosphate integrator ships a standard product with a high sustained C-rate, and none can simply release one. The fastest mainstream utility systems sit at roughly half a C to one C in continuous operation. A given cell can deliver a brief burst above that, but the system rating, the number a project can actually rely on hour after hour, stays low because the chemistry keeps it there.

The honest framing matters here, because a careful reader will rightly resist any claim that lithium can never exceed one C. It can, for short pulses. What it cannot do is sustain a high rate as a continuous, rated, warrantied capability without paying in heat, degradation, and lost life. The ceiling is real, it is shared across the market, and it is a feature of the periodic table rather than of any company's product roadmap.

> ***Across the lithium storage market, the fastest standard product discharges in two hours. That is not a coincidence of design. It is the ceiling of the chemistry.***

A NECESSARY PERSPECTIVE

Most Systems Never Need to Go Faster

It would be easy to read everything above as an argument that high C-rate is simply better, and that every project should want it. That is not the argument, and overstating the case would do the reader a disservice. For most of the storage being deployed across the world right now, a C-rate of around 0.5C is not a compromise. It is the correct engineering answer, and a higher rate would be wasted on the task.

Consider what most grid-scale storage is actually for. Daily energy arbitrage, shifting cheap midday power into expensive evening hours, plays out over a span of hours and asks nothing of a high discharge rate. Peak shaving that flattens a facility's demand curve across an afternoon is an energy exercise, not a power sprint. Renewable firming, capacity reserve, and load shifting all share the same shape: large quantities of energy moved patiently over time. For this entire category, which is the bulk of the market by megawatt-hours, a two-to-four-hour system does the job well and at the lowest sensible cost.

This is why the duration-led framing of the industry, for all that it obscures the rate question, is not dishonest at its root. It reflects where the demand actually is. The majority of buyers are solving energy problems, and for energy problems the relevant question really is how many hours the system runs. A vendor who built every product for ten C would be selling expensive capability that most customers would never call upon.

Our point is therefore not that the market is wrong to be comfortable at half a C. It is that a distinct and growing set of applications sits entirely outside that comfortable zone, and that these applications are not served by stretching the dominant chemistry but by stepping outside it. The interesting question is not whether faster is always better. It is what you do when the application genuinely needs power that lithium cannot provide.

THE COST OF SPEED

High Power Has to Be Paid For in Conversion

There is a second reason high C-rate is not something to reach for casually, and it has nothing to do with chemistry. It is economics. A higher C-rate means more power for the same quantity of stored energy, and power has to be converted before it can reach the grid. That conversion is the job of the power conversion system, the inverter and associated electronics, and the power conversion system is sized to power, not to energy. Double the C-rate of a given energy store and you roughly double the conversion capacity it requires.

The consequence is that a high-rate system carries far more power electronics per unit of stored energy than a slow one. A ten C system needs, in round terms, twenty times the conversion capacity per megawatt-hour of a half C system. That capacity is real hardware with real cost. High C-rate, in other words, is never a free upgrade bolted onto an existing design. It is a deliberate specification, chosen because the application demands the power, and paid for in the conversion layer.

Two separate tests every high-power system must pass

It is worth being precise about where the two constraints sit, because they are independent and they are often confused. The first test is at the cell: can the storage medium physically deliver the current at the required rate, sustained, without destroying itself? The second test is at the power electronics: is there enough conversion capacity to turn that current into usable grid power? A system must pass both to deliver high power in practice.

This is the heart of the distinction between the two technologies. Lithium iron phosphate fails the first test before the second is ever reached. No quantity of additional power electronics can extract a sustained ten C from a cell whose chemistry will not surrender it. A supercapacitor passes the first test by its nature, which leaves only the second: a known, sizable, but entirely solvable engineering cost. With lithium the wall is physical and immovable. With supercapacitors the cost is a line item you scale to the need.

> ***A high C-rate is not a free upgrade. The cell has to deliver the current, and the power electronics have to convert it. Lithium fails the first test before the second is even reached.***

BEYOND THE CEILING

The Work That Only High-Power Storage Can Do

If most applications are content at half a C, the ones that are not tend to be the ones the grid increasingly depends on. Fast frequency response is the clearest example. When supply and demand fall briefly out of balance, the grid frequency moves within seconds, and the storage that arrests it must inject or absorb a large amount of power almost instantly. This is a power task of the purest kind, and the value lies entirely in the speed of the response, not in the hours of energy behind it.

Synthetic inertia and ramp support belong to the same family. As rotating thermal generation retires and is replaced by inverter-based wind and solar, the grid loses the physical inertia that once smoothed sudden changes. Storage can stand in for that lost inertia, but only if it can move power fast enough to matter in the moment a disturbance occurs. A system limited to half a C is simply too slow to perform this role well, regardless of how much energy it holds.

Industrial and mobility loads that spike

Away from the transmission grid, a parallel set of needs is growing on industrial sites. Cranes at a port, large welding operations, and heavy machinery draw sharp, brief surges of power that punish a connection sized for the average load. A high-power store sitting behind the meter can absorb and supply these spikes from a small energy footprint, shaving the peaks that drive demand charges and protecting the local connection. The asset stays small because the job is about power, not hours.

Fast charging completes the picture. Charging an electric vessel during a short cargo turnaround, or a fleet during a brief depot window, requires delivering a large amount of energy in a small amount of time, which is by definition a high C-rate task. Here a storage buffer that can itself charge and discharge at high rate decouples the charging event from the grid connection, allowing fast charging on sites where the grid alone could never supply the instantaneous power. In every one of these cases, the conventional battery is not merely less efficient. It is the wrong tool, because the task lives on the far side of a ceiling it cannot cross.

THE SUPERCAPACITOR DIFFERENCE

Storing Charge Without the Diffusion Bottleneck

A supercapacitor stores energy in a fundamentally different way from a battery. Rather than driving ions into a crystal lattice through a chemical reaction, it holds charge physically at the surface between an electrode and an electrolyte. There is no intercalation, and therefore no diffusion bottleneck to set a speed limit. The rate at which the device can accept and release charge is a property of the storage mechanism itself, and that mechanism is inherently fast. This is why a supercapacitor can operate at C-rates a battery cannot approach, and do so as a continuous, rated capability rather than a fragile burst.

The figures follow directly from the physics. The 247 Energy supercapacitor is available in cells rated from two C for performance applications to ten C for ultra-performance applications, up to twenty times the sustained discharge rate of a standard utility battery system. Because there is no resistive heating loop to manage and no lattice to fatigue, the same property that delivers the rate also delivers the longevity: the technology is built for around one million cycles with negligible calendar ageing, and operates across a wide temperature band without the careful thermal management a lithium system demands.

Safety is part of the same story rather than a separate claim. Thermal runaway, the self-sustaining overheating that makes a lithium fire so dangerous, depends on an energetic chemical reaction inside the cell. A supercapacitor has no such reaction to run away with. The absence of thermal runaway is therefore a physical impossibility rather than a mitigation that engineering has to maintain, which removes an entire category of risk from any site where the technology is deployed, and removes it by design.

What this means for the investment case

The strategic shape of the opportunity follows from everything above. The storage market competes most fiercely where the dominant chemistry is good enough, which is the broad middle ground of multi-hour energy shifting. It competes far less, because it largely cannot compete at all, in the high-power segment that lithium iron phosphate is physically unable to serve. That segment is not shrinking. The forces driving it, grid volatility, the retirement of inertia, the electrification of heavy and mobile loads, are all strengthening. A technology that addresses it directly occupies a position that competitors cannot reach by iterating on their existing products.

This is the foundation of the 247 Energy proposition. We are not trying to win the energy-shifting market on price, where lithium is a capable and entrenched incumbent. We are addressing the power applications that sit beyond its reach, with a technology whose advantage there is structural rather than incremental, and which carries safety and longevity benefits that matter even where the rate itself is not the deciding factor.

> ***The market competes hardest where lithium is good enough. The opportunity sits where it is not, and that is ground the dominant chemistry cannot reach by improving.***

TIMING

Why the Window Is Open Now

The demand for high-power storage is not a distant prospect. It is arriving with the structural change already under way in electricity systems. As renewable generation displaces conventional plant, grids become both cleaner and more volatile, with faster swings and more frequent frequency events. The services that stabilise such a grid, fast frequency response, synthetic inertia, rapid ramping, are power services, and they reward exactly the capability that conventional storage cannot provide. The need is growing in step with the energy transition itself.

At the same time, the straightforward energy-shifting applications are beginning to saturate. As more multi-hour storage is built, the easy returns in that segment compress, and the basis of competition shifts. Differentiation moves from holding energy, where every supplier can compete, toward delivering power and guaranteeing safety, where they cannot all follow. The market is maturing toward the dimensions on which a high-power, intrinsically safe technology is strongest.

There is a first-mover logic in this. The high-power niche is, for now, lightly contested, precisely because the incumbents are anchored to a chemistry that cannot address it. That will not remain true indefinitely. Establishing technology, references, and relationships in this segment while it is still open is materially easier than entering it once it is crowded. The advantage of acting early is not merely commercial timing. It is the chance to define a category before others arrive to contest it.

None of this rests on the energy-shifting market faltering. It will continue to grow, and lithium will continue to serve it well. The case is simpler and more durable than that: alongside the large and familiar market for energy, a distinct market for power is emerging, the dominant chemistry cannot reach it, and the moment to take a position in it is while the ground is still open.

247 Energy NV

247 Energy NV is a Belgian energy technology company that develops, builds, and co-invests in advanced energy storage and on-site power. The company works across three connected activities: supercapacitor energy storage for commercial and industrial sites, containerised on-site power generation, and the development of utility-scale storage parks. The common thread is a focus on the parts of the energy problem where conventional technology falls short, particularly where power, safety, and longevity are decisive.

The company carries a development pipeline of 505 MW across Belgium and surrounding markets, advancing utility-scale storage from origination through to construction. That pipeline reflects a deliberate strategy of building, not merely supplying. 247 Energy retains its own capital alongside that of its partners in the projects it develops, so that its interests are aligned with the long-term performance of each asset rather than with a one-time sale of equipment.

For high-power applications, the supercapacitor technology described in this paper offers a route that the dominant battery chemistry cannot follow: sustained C-rates up to ten times capacity, around one million cycles of service life, a wide operating temperature range, and the structural absence of thermal runaway. Where an application is defined by power rather than by hours of energy, this is not an incremental improvement on lithium. It is a different answer to a different question.

We welcome conversations with capital partners, project developers, and industrial operators who recognise the same opportunity: that the high-power edge of the storage market is real, growing, and reachable only with technology built for it. The invitation is to explore where that capability fits a specific need, and to do so while the segment is still being defined.

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