PEAK

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How Sodium-Ion Resets the Economics of AI Data Center Power

+$3.2B

Incremental value creation for AI data center over 30 years.

No

Scheduled maintenance, with a passive thermal system and no moving parts.

80%

Lower auxiliary power, with no active cooling, unlocking more power for compute.

Q1 ’27

Commercial production begins at Peak’s Sacramento factory, built for an initial 4 GWh/yr.

Executive summary

AI data centers have a power problem. Turbines struggle to manage millisecond load swings, interconnection queues stretch for years, and an aging grid has little room for the volatile new large loads all created by growing AI demand. To smooth these loads, accelerate interconnection, and support grid reliability, data centers need energy storage. The question now is which energy storage technology is the best fit for AI data centers.

Lithium iron phosphate (LFP) is the dominant technology for stationary storage, and for good reason. LFP cell costs have reduced significantly over the last decade, and its supply has been reliable at scale. However, LFP has drawbacks that hit data centers especially hard: active cooling draws power and adds cost, poor capacity retention forces large overbuilds or augmentation, and thermal management adds complexity to the balance of system, the leading source of Battery Energy Storage System (BESS) unreliability and safety failures.

Passively cooled sodium-ion BESS built on a sodium iron phosphate pyrophosphate (NFPP) chemistry addresses these drawbacks directly. Modeled against LFP, Peak's 2-hour NFPP system delivers:

- **$3.2B value over 30 years** for a 1 GW AI data center campus with 2 GWh of storage: $2.8B from more power for compute, $0.3B from lower O&M and $0.1B from lower capex.
- **28 GWh more energy for compute every year**, from 80% lower auxiliary power from passive cooling and 2.0% higher round-trip efficiency: more tokens per watt.
- **A 30-year performance guarantee on augmentation-free power infrastructure**, enabled by exceptional lifetime performance.
- **Zero scheduled maintenance and higher uptime**, from a passive thermal system with no moving parts.
- **Silent DC battery units, reduced fire risk** and fewer maintenance visits, helping operators be better neighbors.
- **A path to a secure domestic supply chain** built on abundant American soda ash, free of the chokepoints that make lithium-ion vulnerable.

Peak's product has operated reliably in the field since August 2025 and is backed by an industry-leading 30-year performance guarantee. Commercial production begins in Q1 2027 at Peak's Sacramento factory, scaling from 4 GWh to 15 GWh of annual capacity by 2030.

SECTION 01

Why AI data centers need energy storage

1.1 AI loads swing faster than turbines can follow

Many large AI campuses start off-grid, powered by their own turbines or renewables. Turbines are a common choice for baseload power because their output is steady. This same attribute makes turbines poorly suited for AI loads, which can swing by 50% of nameplate power within milliseconds. With no broader grid to absorb those swings, an islanded site's voltage and frequency move with the load, risking turbine mechanical durability and data center power quality. If a turbine trips, even the fastest backup generators take several seconds to reach full load.

BESS paired with a power conversion system closes both gaps. Together, they respond in milliseconds, smoothing load swings that turbines can't follow, and providing full ride-through power if a turbine trips. That responsiveness also firms up the power for sites that depend upon solar and wind.

1.2 Interconnection queues strand capacity

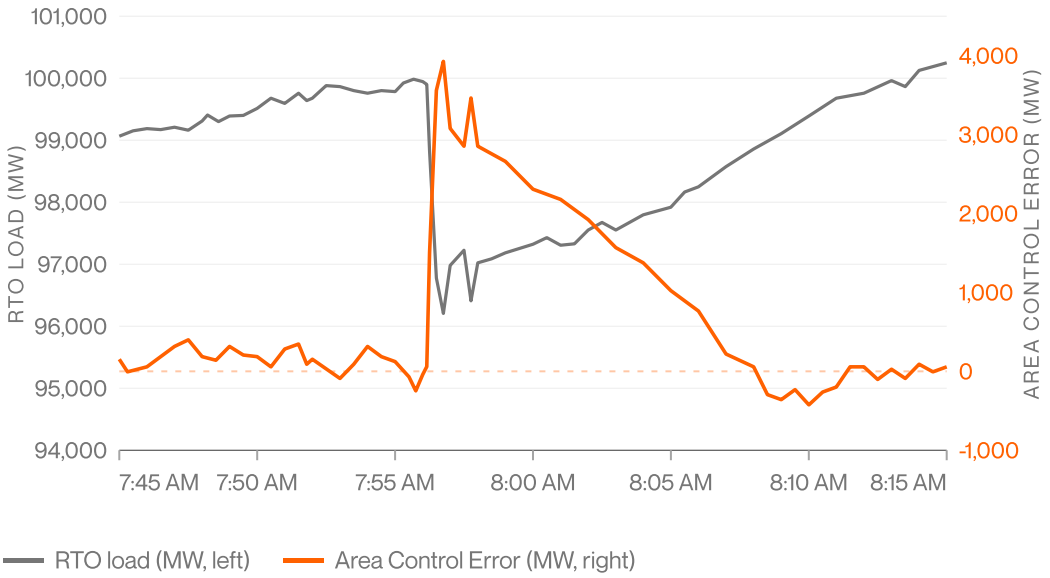
Grid connection has a clear economic advantage over islanded operation, but many large campuses must start islanded because grid access is delayed. ERCOT received 225 new large-load interconnection requests in 2025 alone, for a planning process built to handle 40–50 at a time.

Regulators are opening a faster path for loads that can curtail on request: in June 2026, FERC ordered all six jurisdictional grid operators to justify or reform their large-load interconnection rules, and encouraged new transmission services that let flexible loads connect earlier. BESS delivers that flexibility by allowing the load to sit on the battery, letting data centers connect sooner while enabling backup power when the grid goes down.

1.3 Changing grid conditions increase volatility

Accelerating plant retirements, combined with faster-than-expected load growth, are putting grid reliability under mounting pressure. The U.S. Department of Energy's

2025 Resource Adequacy Report warns that, if planned retirements proceed, the risk of power outages could increase as much as a hundredfold by 2030. At the same time, the growing share of variable renewable generation and rising demand from data centers are introducing greater volatility into power system operations. For instance, as shown in Figure 1, on July 22, 2026, a fault on a 230 kV line in northern Virginia caused nearly 3,900 MW of data center load to trip, the largest load-loss event PJM has experienced.



Regional Transmission Organization (RTO)

The operator of the high-voltage grid and wholesale power market across a region. Here: PJM Interconnection.

Area Control Error (ACE)

Made up of Interchange Error and Frequency Error, it shows how far off the grid is from equilibrium at any given moment. A positive ACE means the area is over-generating, so it needs to ramp generation down. A negative ACE means it's under-generating and needs more supply.

Figure 1. July 22, 2026, Dominion Load Transfer Event. Source: Wharton, PJM Operating Committee, August 6, 2026. Adapted by Peak Energy.

BESS deployed at these sites could have changed that outcome. When the fault occurred, on-site batteries could have carried the computing load through the brief voltage dip by injecting reactive power to boost the local voltage, allowing the facilities to stay connected to the grid rather than switching to UPS and diesel backup power. With co-located BESS, the grid can see smooth power draw while the BESS absorbs the load swings, rides through grid disturbances, and offsets data center demand during the grid's peak demand times.

1.4 Flexible loads benefit the community

Data centers are often blamed for rising retail electricity prices, but a June 2026 EPRI and Watershed paper finds the opposite: from 2015 to 2024, data center growth caused residential rates to fall by about 0.4% for every 10% increase in capacity. Higher system utilization spreads fixed grid costs across a larger volume of electricity sales, which can help decrease rates for customers. But the authors caution that this depends on the grid's ability to keep building, and that supply constraints could reverse the effect. That's where flexibility matters. Data centers that can provide grid flexibility on demand put less strain on constrained grids, buying time for new capacity to come online. BESS gives data centers that flexibility, making them better neighbors to the communities they share a grid with.

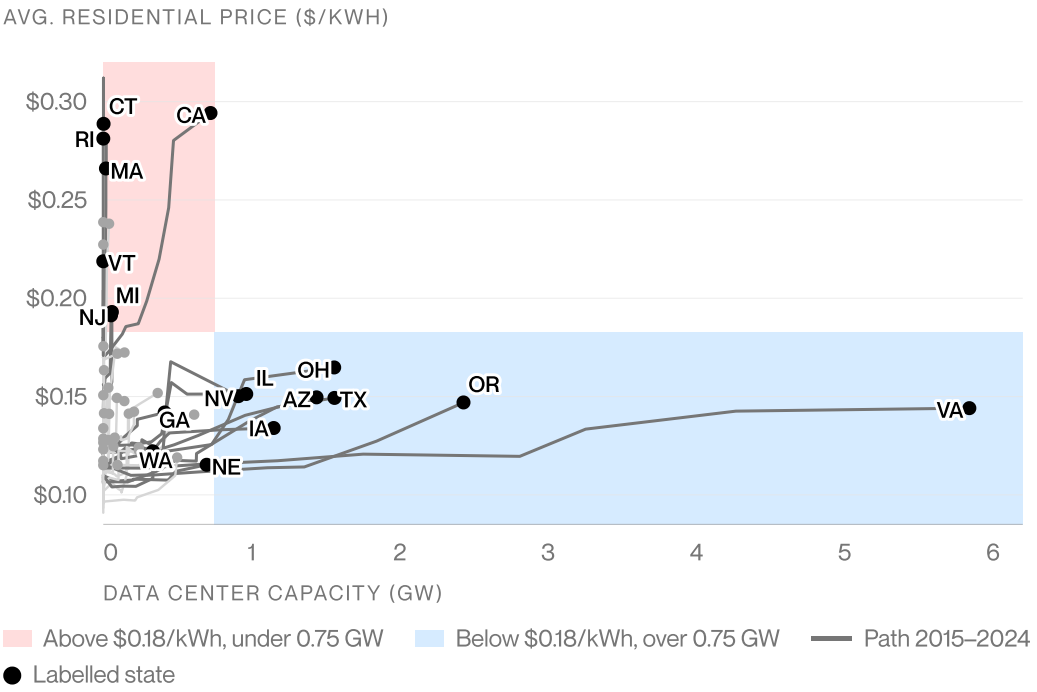


Figure 2. US states with less data center capacity tend to have higher average residential electricity prices. Source: Watten, Bistline & Blanford, EPRI/Watershed, 2026. Adapted by Peak Energy.

SECTION 02

How sodium-ion outperforms LFP at AI scale

For a 1 GW data center with 2 GWh of storage managing an AI training load, as represented in Figure 3, Peak's BESS unlocks 28 GWh of additional energy for compute every year versus LFP, totaling $2.8B of additional data center revenue over 30 years. Peak's BESS also generates savings of $0.3B from lower O&M costs and $0.1B from lower capex.

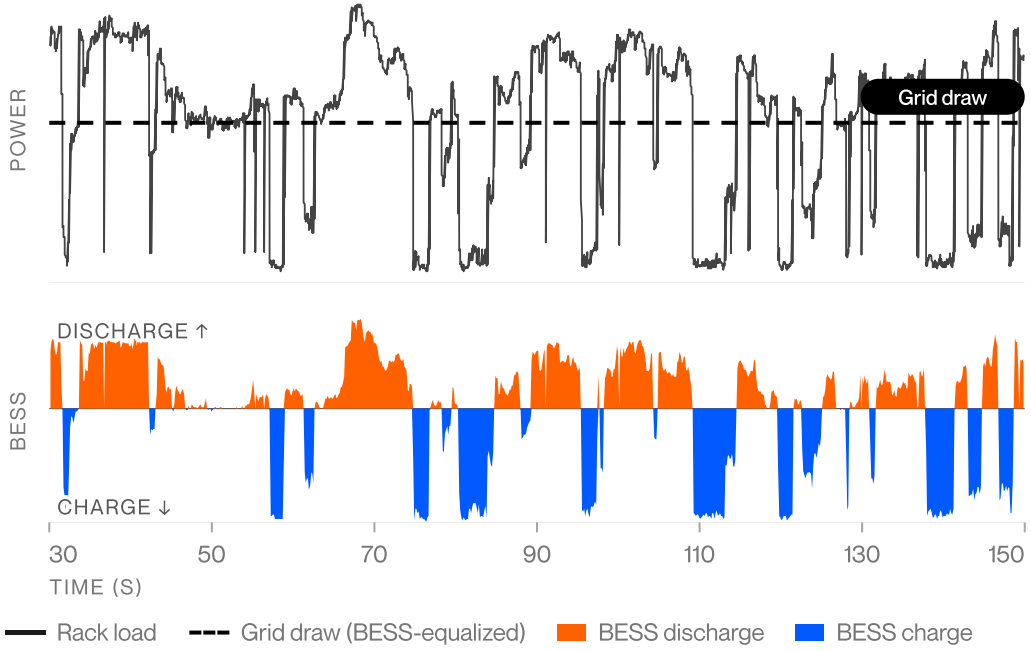


Figure 3. Illustrative AI data center load profile. BESS (bottom) absorbs the rack-side load swings (top), holding grid power draw constant. Source: Customer-supplied profiles and Peak's lab testing.

2.1 Active cooling burns power meant for GPUs

Securing new power generation or interconnection can take several years, therefore every watt the storage system wastes is a watt that never reaches a GPU.

No power spent cooling the battery.

In Texas, the chillers, fans and pumps in a traditional LFP BESS draw an average of 1.5 MW per 1 GW data center under representative AI loads. Peak has no active cooling and 80% lower auxiliary load, so the same energy goes to compute instead.

More energy out of every cycle.
Under representative AI pulse duty cycles mimicking a 2-hour system, cell-level lab tests show a 2.0% improvement in round-trip efficiency: jumping from 97.1% for LFP to 99.1% for equivalent NFPP cells.

2.2 LFP's high degradation forces augmentation on a system that prioritizes uptime

A typical front-of-meter LFP capacity guarantee is approximately 70% of original capacity after 20 years. As a result, LFP projects must either overbuild significantly up front, at a commensurate capex increase, or restore capacity later through augmentation, bringing construction crews back to the site to keep the required capacity available.

Data center applications can be more demanding. The short-duration battery cycling that helps smooth AI training loads can result in up to 10x the capacity throughput per year relative to a front-of-meter application – straining LFP in both calendar (time) and cycling (throughput) rated life. As seen in Figure 4, NFPP at even the more challenging 45°C and 60°C environments outperforms LFP at 25°C and 45°C, respectively, because Peak's NFPP is far less susceptible to LFP's three main degradation mechanisms:

- **Iron dissolution:** LFP's cathode can shed iron into the electrolyte. NFPP's cathode is inherently more stable.
- **Graphite exfoliation:** LFP's graphite anode layers peel apart under cycling. NFPP's hard carbon anode is isotropic and doesn't cleave.
- **Mechanical fatigue:** LFP electrodes expand and contract, cracking particles. NFPP's open structure reduces that stress.

As a result, customers of Peak systems can achieve best-in-class 30-year augmentation-free projects.

2.3 LFP's cooling system and materials add cost

An estimated 10–15% of LFP BESS balance of system (BOS) cost comes from thermal management. With no active cooling, no moving parts and fewer components, Peak removes the BOS costs associated with thermal management. Minimal auxiliary power requirement also reduces expensive low-voltage power conversion and eliminates the need for any centralized compute that would have otherwise controlled the thermal system.

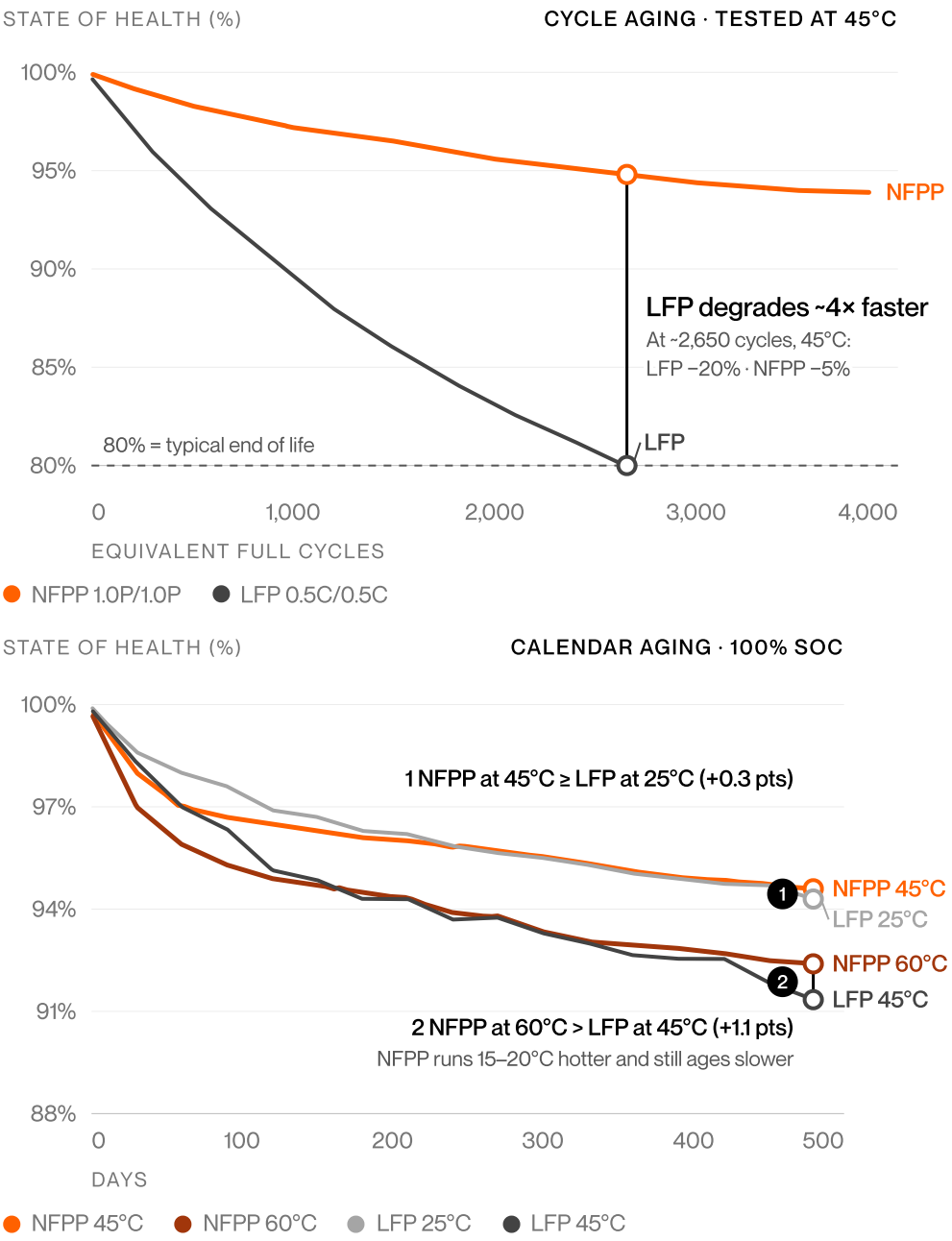


Figure 4. NFPP versus LFP performance under cycle aging (state of health vs. equivalent full cycles) and calendar aging (state of health vs. time). Source: Peak cell testing data and published LFP performance data.

LFP's materials also set a higher cost floor. In NFPP, sodium replaces lithium, aluminum replaces copper in the negative current collector, and the hard carbon anode can be made from inexpensive coal or petroleum byproducts. Industry projections show NFPP and LFP cell prices reaching parity in 2028, with NFPP's advantage widening from there.

2.4 LFP's flat voltage curve forces overbuild

Any error in estimating a battery's state of charge (SOC) forces oversizing by the same margin. An AI data center BESS managing training or inference loads sits at the

same SOC for much of its life, using voltage and current sensors to maintain SOC. At an equivalent throughput of one cycle per day, 0.5% current sensor offset can produce more than 7% SOC error in a week. Voltage readings would normally compensate for this drift, but LFP's voltage curve is notoriously flat and high hysteresis in the relevant SOC window, making it uniquely challenging to understand just how full the battery is.

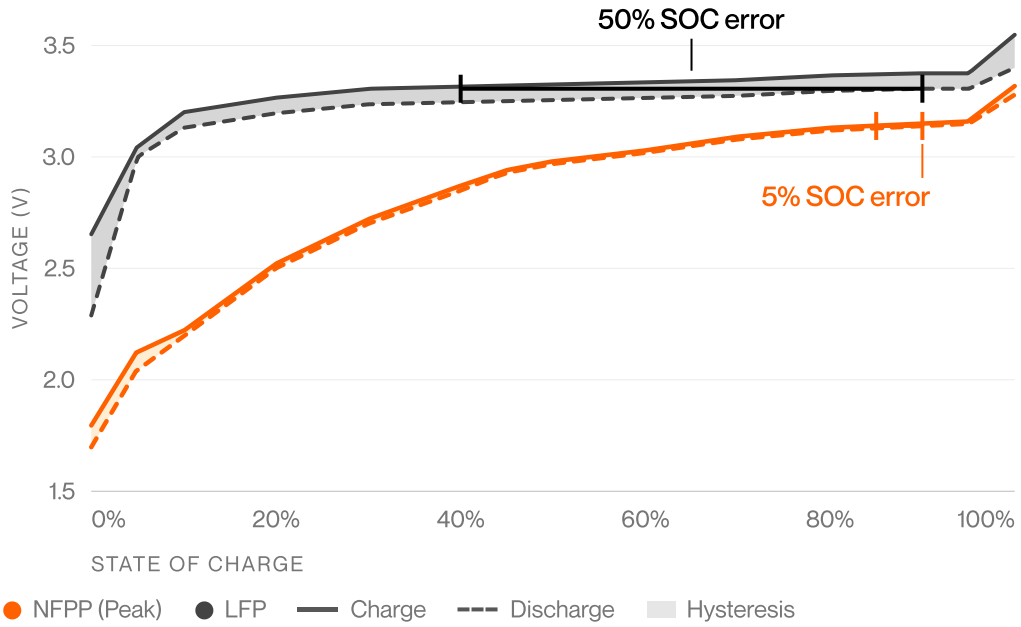


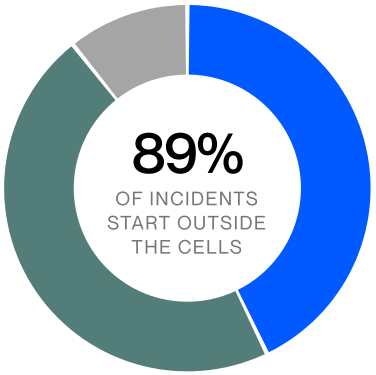
Figure 5. Cell voltage versus state of charge for NFPP and LFP. LFP's SOC error band is 10x wider than NFPP's. Source: Peak cell testing data and published LFP performance data.

Peak's NFPP chemistry has a steep, low-hysteresis curve (Figure 5). That cuts voltage-based SOC error roughly 10x from LFP's 50% to NFPP's 5%, thereby significantly reducing the overbuild associated with that uncertainty.

2.5 Cooling and safety systems drive most BESS failures

Most BESS defects aren't in the cells. Factory audits find 72% at the system level, with fire detection and suppression defects in 28% of inspected units, faulty auxiliary circuit panels in 19% and thermal management defects in 15%. Safety incidents follow the same pattern (Figure 6), originating mostly in balance of system failures, such as coolant leaks and moving parts that lock or overheat, and in controls failures tied to wiring, coolant and safety systems. Peak's passive design removes most of these failure modes, enabling best-in-class uptime and lower safety risk that critical infrastructure requires.

The passive design also cuts maintenance. Lazard's estimate of US BESS O&M costs nearly tripled from $1.9–2.4/kWh-yr in 2020 to $3–8.2/kWh-yr in 2025, and



Balance of system — Cooling failures such as coolant leaks, and moving parts that lock or overheat.	43%	12
Controls — Failures tied to wiring, coolant and safety systems.	46%	13
Cells and modules — Failures that start in the battery cells or modules themselves.	11%	3

Share of incidents · number of incidents

Figure 6. Breakdown of BESS safety incidents, by category. Source: EPRI, 2024. Adapted by Peak Energy.

much of that rising cost is due to the balance of system. With no filters to replace and no pumps, fans or coolant systems to fail, Peak's system has zero scheduled maintenance, reducing DC block O&M costs by 80% over a project lifetime.

2.6 Community concerns turn permitting into schedule risk

Noise complaints, safety concerns and daily disruptions from maintenance events are recurring themes at community hearings. Local opposition has delayed and stopped data center build-outs. Peak helps developers ease concerns on all three fronts. Regarding noise, Peak's DC battery unit has no fans or chillers, so it runs silently. Regarding fire risk, NFPP is more thermally stable, with a higher self-heating temperature of 141°C versus 94°C for LFP, and it releases 43% less flammable hydrogen gas during thermal runaway. And with no augmentation and zero scheduled maintenance, far fewer trucks come to the site. Together with a battery's potential to decrease diesel or gas-fired generation and improve air quality, these benefits mean the community gains from Peak's technology in multiple ways.

2.7 Lithium-ion's supply chain is concentrated abroad

China controls 80% of global lithium-ion cell manufacturing capacity, and the mining and refining of lithium, cobalt, nickel and graphite are concentrated in China and a handful of other countries. Sodium-ion avoids those minerals. Its key ingredient comes from soda ash, and the United States holds the world's largest natural reserves in Wyoming's Green River basin. That means far less exposure to chokepoints, export controls and tariffs for a more secure and US-centered supply chain, and more manufacturing value kept at home.

SECTION 03

Proven in the field, guaranteed on paper, in production in Q1 2027

3.1 Proven technology in the field

Deployed and operating.
Peak is grid-connected at multiple sites. The earliest deployment in Colorado, commissioned in August 2025, has delivered over 1,200 cycles above rated energy at a measured 96.8% unit-level DC round-trip efficiency on full P/4 cycles, with no measurable capacity fade.

AI-load validation.
Peak's sodium-ion cells have run continuous AI data center training duty cycles since December 2025, demonstrating favorable degradation comparable to the calendar fade shown in Figure 4.

3.2 Contracted and guaranteed

First customer.
Project delivered in ERCOT in September 2026.

Over $2.5 billion.
In Peak's contracted customer pipeline with leading IPPs and utilities.

Performance guarantee.
Industry-leading 30-year performance guarantee.

3.3 Scaling production in America

California gigafactory.
Peak begins producing systems in its 190,000 sq ft Sacramento, California factory in Q1 2027. It has an initial capacity of 4 GWh/yr, scaling to 15 GWh/yr by 2030.

Fully domestic sodium-ion cells.
The need for domestic cells is critical with today's supply chain and policy risks. Peak is answering the need through its flagship partnership with General Motors, covering investment and joint development of a next-generation NFPP cell for fully domestic sodium-ion cells in the second half of 2028.

Closing

AI data centers need multi-hour storage in order to run islanded, connect to the grid sooner, and support an aging grid. Choosing passively cooled sodium-ion over LFP is worth $3.2B over 30 years for a 1 GW campus with 2 GWh of storage, and delivers five advantages:

01	**A better neighbor** Silent DC battery units, lower fire risk and fewer maintenance visits help developers and operators ease community concerns.
02	**Lower lifetime cost** Highly simplified system, longer life chemistry, low auxiliary power draw and zero scheduled maintenance mean a lower total cost of ownership.
03	**Higher uptime, guaranteed for 30 years** No augmentation and fewer system-level failure modes mean superior project-level availability.
04	**More tokens per watt** No cooling load and higher round-trip efficiency mean 28 GWh more energy available for revenue-generating compute every year.
05	**An American supply chain** Built from domestically abundant materials to power the AI era on American soil.

References

1. Li, Y. and Li, Y., AI Load Dynamics—A Power Electronics Perspective, University of Alberta, February 2025, arXiv:2502.01647v2.
2. Hossain, F., et al., Limiting the Impact of AI Data Centers on Fatigue Life of Thermal Turbine Generators in the Grid, May 2026, arXiv:2605.01173.
3. Choukse, E., et al. (Microsoft, OpenAI, and NVIDIA), Power Stabilization for AI Training Datacenters, 20 August 2025, arXiv:2508.14318.
4. Caterpillar, Caterpillar Adds 1.5 MW Standby Power Node to Growing Portfolio of EPA-Certified Fast Response Natural Gas Generator Sets for Mission Critical Applications, press release, 5 January 2022.
5. Abudyak, Y., Alizadeh, M. and Sun, W., Mitigating Data Centers Load Risks and Enabling Grid Support Functions through Grid-Forming Control, IEEE Power & Energy Society General Meeting, 2026.
6. RaboResearch, The Marathon: Can Behind-the-Meter Data Center Power Solutions Endure the Decade in the US?, Rabobank, June 2026.
7. ERCOT, System Planning and Weatherization Update, Board of Directors Meeting, Item 16.2, 8–9 December 2025; Walton, R., ERCOT's Large Load Queue Jumped Almost 300% Last Year, Utility Dive, 6 January 2026.
8. Federal Energy Regulatory Commission, Show cause orders issued to PJM, MISO, SPP, CAISO, NYISO and ISO-NE, 18 June 2026.
9. U.S. Department of Energy, Report on Evaluating U.S. Grid Reliability and Security, 7 July 2025.
10. Wharton, M., Dominion Load Transfer Event, PJM Operating Committee, 6 August 2026.
11. Watten, A., Bistline, J. and Blanford, G., Have Data Centers Raised Your Electric Bill? Causal Evidence from the United States, 18 June 2026, arXiv:2606.19777.
12. Peak Energy internal analysis, September 2026, based on a 1 GW / 2 GWh system over a 30-year life, against an equivalent LFP BESS. Cell-level round-trip efficiency measured by an independent test laboratory on production cells. Assumptions are available to customers under NDA.
13. Peak Energy internal analysis, 2026.
14. Gao, Y. and Onori, S., Advancing SOC Estimation in LiFePO4 Batteries: Enhanced dQ/dV Curve and Short-Pulse Methods, eTransportation, Vol. 26, Article 100466, 2025.
15. Yang, J., et al., Origin of Iron Dissolution from Industrial LiFePO4@C Cathode, Chemical Engineering Science, Vol. 316, Article 121964, 1 October 2025.
16. Wheeler, W., et al., Postmortem Analysis of 18650 Graphite/LFP Cells in a Long-Term Aging Study for Second-Life Applications, Batteries, Vol. 10, No. 4, Article 119, 2024. https://doi.org/10.3390/batteries10040119
17. Zheng, S., et al., In Situ Stress Monitoring Unravels Particle-Scale Microstructural Evolution in Aging LiFePO4/Graphite Batteries, Journal of Energy Storage, Vol. 147, Article 120247, 2026.
18. Clean Energy Associates (Intertek CEA), Most Common BESS Manufacturing Defects of 2024, 2025.
19. Srinivasan, L., Shaw, S. and Billaut, E., Insights from EPRI's Battery Energy Storage Systems (BESS) Failure Incident Database: Analysis of Failure Root Cause, EPRI, May 2024.
20. Lazard, Levelized Cost of Storage, Version 6.0, 2020.
21. Lazard, Levelized Cost of Energy+, June 2025.

22. Kott, C., Noise, Safety Concerns Raised over 100-Megawatt BESS Project on Tomsons Road in Saugerties, Hudson Valley One, 22 April 2026.
23. Associated Press, Fears of Massive Battery Fires Spark Local Opposition to Energy Storage Projects, 9 October 2025.
24. Peak Energy internal cell testing, September 2026. Thermal runaway onset of NFPP cells.
25. Ouyang, D., et al., An Evaluation on Thermal Runaway Issues of Typical Commercial Large-Format Energy Storage Cells by Accelerating Rate Calorimetry, International Journal of Thermal Sciences, Vol. 228, Article 111054, 2026. https://doi.org/10.1016/j.ijthermalsci.2026.111054
26. Peak Energy internal cell testing, September 2026 (NFPP); Wang, Y., et al., Experimental Research on Thermal-Venting Characteristics of the Failure 280 Ah Battery: Atmospheric Pressure Impacts and Safety Assessment, Batteries, Vol. 10, No. 8, Article 270, 2024. https://doi.org/10.3390/batteries10080270 (LFP).
27. Paoli, L., Fernandez Pales, A. and Gül, T., Global Battery Markets Are Growing Strongly, and So Are the Supply Risks, International Energy Agency (IEA), 13 February 2026.
28. International Energy Agency (IEA), Global Critical Minerals Outlook 2025, 2025.
29. U.S. Geological Survey, Mineral Commodity Summaries 2025, January 2025.
30. Kelty, K., Why Sodium-Ion Batteries Will Reshape Grid-Scale Energy Storage, GM News, 9 June 2026.