Lithium-Ion UPS Batteries:
A Complete Guide to TCO, Safety, and
Making the Right Choice for Your Infrastructure

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Executive Summary

Lithium-ion batteries have become the preferred alternative to valve-regulated lead-acid (VRLA) batteries across Schneider Electric's UPS portfolio — and for good reason. Over a standard 10-year UPS lifecycle, Li-Ion typically delivers lower total cost of ownership, meaningfully better operational visibility into battery health, and a footprint that can change how a data center or server room is planned.

The safety concerns that have kept some organizations on VRLA are understandable but, in most cases, based on the wrong chemistry comparison. Schneider Electric UPS systems use lithium iron phosphate (LFP) — a fundamentally more stable chemistry than the lithium formulations behind high-profile battery incidents in consumer electronics. Combined with a multi-layered battery management system (BMS) and compliance with established safety standards, the risk profile is well-documented and well-managed.

This white paper covers the full decision: TCO analysis across replacement cycles, third-party battery monitoring for VRLA, floor space, and maintenance; runtime requirements and when the TCO calculus changes; the safety facts and chemistry distinctions that matter; retrofitting considerations for existing VRLA installations; sustainability factors; and a brief assessment of nickel-zinc as an alternative chemistry. The goal is to give IT directors, facilities managers, and procurement teams the information needed to make a well-grounded battery technology decision — including an honest acknowledgment of the applications where VRLA remains competitive.

PART 1: Total Cost of Ownership

Starting with the Right Comparison

The upfront cost of Li-Ion batteries is higher than VRLA. That is the starting point of the analysis, not the conclusion. Total cost of ownership over the service life of the UPS — typically 10 to 15 years — tells a different story, and for most mid-market organizations evaluating a battery technology decision over that horizon, the full picture favors Li-Ion. The qualification 'most' is deliberate: there are applications, particularly those requiring extended runtime, where that conclusion does not hold. Those are addressed separately below.

Battery Replacement Cycles: The Largest Single TCO Driver

VRLA batteries have a rated service life of 3–5 years under normal operating conditions. In practice, real-world conditions — ambient temperature variation, inconsistent load levels, uneven cell aging — frequently compress that service life. Most organizations running a UPS system for 10 years will replace VRLA batteries two to three times. Each replacement involves the battery string cost, a service provider visit for installation and commissioning, and the operational risk that comes with any maintenance event on live critical power infrastructure.

Li-Ion batteries have a service life of 10 years. Over a 10-year UPS lifecycle, a Li-Ion installation typically requires no mid-cycle battery replacement at all. That avoided event — or two — is the single largest driver of Li-Ion's TCO advantage, and it compounds: fewer replacement events mean fewer service visits, fewer maintenance windows, and fewer opportunities for something to go wrong during an installation on live equipment.

Floor Space: An Opportunity Cost Frequently Overlooked

Li-Ion battery cabinets run approximately 50% smaller and lighter than equivalent VRLA configurations. At the scale of a Galaxy VL or VX installation, this is an economic factor, not just a physical convenience. In co-location environments where floor space is priced per cabinet or per kW, battery room square footage has a direct dollar value — space occupied by VRLA battery cabinets is space that cannot be allocated to revenue-generating compute, storage, or networking equipment. In enterprise data centers, reclaimed space defers expansion costs and accommodates IT growth that might otherwise require a build-out.

Maintenance and Battery Monitoring: Knowing What You Actually Have

VRLA batteries degrade gradually and invisibly. A voltage check does not reveal capacity loss — a string that passes can still have lost 30–40% of its rated runtime. The only reliable verification method is a full discharge test under load, which costs significantly more than a standard battery PM and is rarely performed as a result. A standard PM — visual inspection, connection checks, voltage readings, thermal imaging — catches real problems but does not measure actual available runtime.

Most UPS models display a runtime estimate in the front-panel menu. That estimate factors in current load and battery age, but it can overestimate available runtime because it does not fully account for operating temperature history or the cumulative effect of prior discharge events. It is an estimate, not a measurement.

Third-party battery monitoring systems for VRLA can meaningfully improve this picture, providing continuous voltage, temperature, and impedance readings at the cell or string level — giving facilities teams earlier warning of degrading cells than routine PMs alone. The trade-off is cost: monitoring infrastructure, installation, software licensing, and — critically — the labor to remove and reinstall the hardware at every battery replacement cycle. Over two to three replacement events in a 10-year UPS lifecycle, that incremental cost accumulates.

Power Solutions Li-ion TCO Analysis

For a detailed cost model specific to your installation, see the Li-Ion TCO Whitepaper.

Power Solutions also provides customized TCO analysis as part of the battery assessment process.

Li-Ion's integrated BMS sidesteps all of this. Cell-level monitoring is built into the battery system and reported through EcoStruxure IT in real time — no additional infrastructure, no removal and reinstall at replacement, and because Li-Ion typically eliminates the mid-cycle replacement events VRLA requires, the associated labor and logistics costs don't arise in the first place.

Recharge Time

Li-Ion batteries recharge to 90% capacity in 2–4 hours following a discharge event. VRLA requires 8–12 hours for equivalent recovery. In facilities subject to recurring utility disturbances, or those that have experienced multiple events within a short window, the difference in recovery time affects how long the protected load is exposed between events.

VRLA and Lithium-Ion UPS Batteries – A Side-by-Side Comparison

Factor	VRLA	Li-Ion
Battery service life	3–5 years	10 years
Replacement cycles (10-yr horizon)	2–3 battery replacements	No battery replacements
Third-party BMS availability	Available — additional capital and installation cost	Integrated — included in system cost
BMS removal/reinstall at replacement	Additional labor cost each replacement cycle	N/A — BMS is integral to the battery
Capacity monitoring method	Periodic discharge test (or third-party BMS where installed)	Continuous — real time via integrated BMS
Footprint vs. equivalent VRLA	Baseline	~50% smaller and lighter
Recharge time to 90%	8–12 hours	2–4 hours
Maintenance overhead	Higher — testing, coordination, BMS costs where applicable	Lower — BMS automates monitoring
Upfront cost	Lower	Higher
10-year TCO — standard runtime of a few minutes	Higher when full costs included	Lower when full costs included
10-year TCO — extended runtime of 20 minutes or more	May be competitive or favorable	Upfront premium may not be recovered — site-specific analysis required

PART 2: When Runtime Requirement Change the TCO Calculus

The TCO case for Li-Ion described above applies to most commercial UPS applications — environments where the UPS is sized to provide a few minutes of runtime, sufficient to bridge to generator start or ride through brief utility disturbances. This is the design target for most UPS deployments, and it is the application where Li-Ion's cost, footprint, and monitoring advantages are most clearly expressed.

For sites with extended runtime requirements, the analysis changes, and Li-Ion does not always win.

Why Runtime Requirements Affect the Li-ion TCO Case

Li-Ion UPS batteries are engineered for short-duration, high-rate discharge — the kind of event that most UPS systems are called on to handle. The energy density advantage Li-Ion offers over VRLA is most significant at these shorter discharge durations. As runtime requirements increase, the battery string must grow proportionally to store more total energy, and the cost-per-kWh of Li-Ion capacity remains higher than VRLA. At extended runtimes, the incremental cost of Li-Ion battery capacity widens substantially.

The practical consequence: for sites that require extended runtime — long enough that the battery string must be significantly larger than a standard short-duration configuration — the upfront cost premium of Li-Ion may not be recovered through avoided replacement cycles and reduced maintenance over the service life of the UPS. The longer the runtime requirement, the larger the battery string, and the larger the upfront cost gap that Li-Ion must overcome through TCO savings.

What This Means in Practice

Organizations with extended runtime requirements should not assume Li-Ion automatically wins the TCO analysis — but they also should not assume VRLA automatically wins. The crossover point depends on the specific runtime requirement, the load profile, current Li-Ion pricing, and the number of replacement cycles VRLA would require over the UPS service life. A site-specific TCO analysis is the appropriate tool for this decision.

It is also worth noting that some applications with extended runtime requirements are better served by alternative runtime strategies — dedicated battery rooms sized for VRLA at the required runtime, generator integration that reduces the UPS runtime requirement, or flywheel-based ride-through for short bridge periods. In some cases, reducing the runtime requirement through generator or alternative power strategy is a more cost-effective path than specifying a large battery string of either chemistry.

Runtime and Battery Decision Challenges

For sites with extended runtime requirements, Power Solutions recommends a site-specific TCO analysis before making a battery chemistry decision. The analysis should account for actual runtime requirement, load profile, current battery pricing, and replacement cycle projections over the UPS service life of 10–15 years. Contact your Power Solutions representative to discuss your runtime requirements and request a customized analysis.

PART 3: Safety – The Facts Behind the Concerns

The safety concerns about Li-Ion batteries are legitimate questions that deserve accurate answers. In practice, most concern is rooted in a chemistry mismatch: the lithium formulations used in consumer electronics — where thermal incidents have occurred and received significant media coverage — are being associated with UPS battery technology, which uses a fundamentally different chemistry in a fundamentally different system. Understanding that distinction is where an accurate safety evaluation must begin.

The Chemistry Difference

Most high-profile lithium battery incidents involve lithium cobalt oxide (LCO) or lithium nickel manganese cobalt (NMC) chemistries — the formulations used in laptops, smartphones, and some electric vehicle applications where maximizing energy density is the primary engineering priority. These chemistries are more reactive at the electrochemical level. Under conditions of overcharge, physical damage, or thermal stress, they can enter a self-sustaining exothermic reaction — thermal runaway — that releases significant heat and, in some cases, produces smoke or flame.

Schneider Electric UPS systems use lithium iron phosphate (LFP) chemistry. LFP has a fundamentally different electrochemical structure. The phosphate bond in LFP is significantly stronger than the oxide bonds in LCO and NMC, which means LFP does not release oxygen under thermal stress the way those chemistries do. Without the combination of heat, fuel, and oxygen that thermal runaway requires, the reaction that drives high-profile lithium battery incidents simply cannot occur in the same way with LFP. The thermal stability of LFP under overcharge, physical damage, and short-circuit conditions is substantially better than LCO or NMC — and the worst-case scenarios that most safety concerns are based on are drawn from the wrong chemistry.

The Battery Management System

Beyond chemistry, Schneider Electric's battery management system provides multi-layered active protection that operates independently of and in addition to LFP's inherent chemical stability.

- Cell-level monitoring: The BMS monitors each individual cell continuously for voltage deviation, temperature anomaly, and state of health. Degrading cells are identified in real time — not at the next scheduled discharge test.
- Charge and discharge rate management: The BMS actively manages charge and discharge rates to stay within parameters that prevent the conditions — overcharge, deep discharge, thermal stress — that accelerate degradation and create safety risk.
- Automatic disconnection: If any cell falls outside safe operating parameters, the BMS includes automatic disconnection circuits that isolate the battery pack. This protection operates faster than any manual intervention could.
- EcoStruxure IT integration: All BMS data — cell health, state of charge, temperature, event history — is reported through EcoStruxure IT in real time. Facilities teams and IT directors can see developing issues before they become failures, from any connected device.

The BMS is both the mechanism that makes continuous capacity monitoring possible and the primary active safety control that distinguishes a purpose-designed UPS battery system from the consumer battery technologies that most safety concerns originate from.

Code Compliance and Documentation

Li-Ion UPS batteries fall under NFPA 855 (Standard for the Installation of Stationary Energy Storage Systems) and UL 9540 (Standard for Energy Storage Systems and Equipment). Schneider Electric systems comply with UL 1973 (Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail Applications). These are well-established standards with documented installation precedent across healthcare, government, education, and commercial buildings.

Bottom Line on Safety Code

The safety question about Li-Ion UPS batteries has a clear answer once the right chemistry is the basis for the comparison. LFP in a purpose-designed UPS system with a multi-layered BMS is not the same as the lithium batteries behind the incidents in the news. The risks are different in kind, not just in degree. Organizations that have stayed with VRLA because of safety concerns are making that decision based on the wrong reference point.

PART 4: Retrofitting – Relacing VRLA With Li-ion in Existing Installations

For organizations with existing UPS infrastructure, the battery technology decision is not limited to new installations. Retrofitting an existing VRLA system with Li-Ion batteries is possible in several configurations — and for systems where the UPS itself still has significant service life remaining, retrofit is often the most cost-effective path to the operational and TCO benefits Li-Ion provides.

What's Possible – And What Isn't

Li-Ion retrofit compatibility depends on the UPS platform. Not all UPS systems support Li-Ion battery configurations, and compatibility is determined by the UPS firmware, power electronics, and battery management interface — not just physical form factor. Schneider Electric has Li-Ion battery options available for several of their current and recent UPS platforms, but retrofit eligibility must be confirmed against the specific model and firmware version before planning.

For Schneider Electric UPS systems that support Li-Ion retrofit, the process typically involves replacing the battery string and, in some cases, updating UPS firmware to support the different charge profile that Li-Ion requires. LFP charges at different voltage thresholds and with different termination characteristics than VRLA — the UPS charger must be configured appropriately for Li-Ion to achieve its rated service life and performance.

Power Solutions can confirm retrofit compatibility for specific UPS models and configurations, provide the firmware and configuration support required, and handle installation and commissioning. The assessment process includes a review of the UPS model, current firmware version, and remaining service life to determine whether retrofit or full system replacement is the better path.

When Retrofit Makes Sense

The UPS platform supports Li-Ion battery configuration and the UPS itself has significant remaining service life — typically 5 or more years.

- The primary driver is operational improvement — better battery health visibility, elimination of discharge testing overhead, longer battery service life — rather than UPS capacity expansion.

- The installation is in a space-constrained environment where Li-Ion's smaller battery footprint provides a meaningful practical benefit.
- Budget constraints make a full UPS replacement difficult to justify in the near term, but battery replacement is already due or approaching.

When Full Replacement is the Better Answer

The UPS platform does not support Li-Ion battery configuration — attempting to force an incompatible configuration voids the warranty and creates operational risk.

- The UPS itself is approaching end of service life or is already beyond manufacturer support — retrofitting batteries into an unsupported platform defers a necessary capital decision without resolving the underlying infrastructure risk.
- The installation requires capacity expansion that the existing UPS cannot support — battery retrofit addresses chemistry, not power capacity.
- The organization is moving from single-phase to three-phase protection or upgrading to a platform with significantly better monitoring and redundancy capabilities — a full system change is the appropriate path.

Planning Considerations for Retrofit Projects

- Firmware review: Confirm current UPS firmware version and identify whether a firmware update is required to support Li-Ion charge profiles before battery procurement.
- Battery room sizing: Li-Ion battery cabinets are smaller and lighter than VRLA equivalents. For installations where the battery room was sized around VRLA cabinet dimensions, retrofit may free meaningful floor space.
- Load bank testing before retrofit: If the current VRLA battery condition is unknown, a discharge test before retrofit establishes a baseline and may reveal that the existing batteries have more remaining life than a standard PM would indicate — affecting the timing and urgency of the project.

Power Solutions Retrofit Assessment

Power Solutions provides retrofit compatibility assessments for existing Schneider Electric UPS installations — confirming platform eligibility, firmware requirements, and the relative economics of retrofit versus full system replacement. Contact your Power Solutions representative to schedule an assessment.

- Third-party VRLA monitoring decommissioning: For sites that have deployed third-party battery monitoring on existing VRLA strings, that infrastructure will need to be removed and decommissioned as part of the retrofit. Factor this into project labor planning.
- Commissioning and monitoring setup: EcoStruxure IT monitoring should be configured as part of the retrofit commissioning process so the BMS reporting capability is active from day one.

PART 5: Sustainability Considerations

For organizations with documented sustainability commitments — carbon reduction targets, ESG reporting requirements, or board-level environmental mandates — the battery technology decision has dimensions beyond TCO and operational performance. Li-Ion compares favorably to VRLA on most sustainability metrics, though the picture is more nuanced than a simple characterization.

Fewer Replacement Cycles, Less Material Throughput

The most straightforward sustainability argument for Li-Ion is the replacement cycle reduction. VRLA batteries replaced two to three times over a 10-year UPS lifecycle represent two to three times the raw material extraction, manufacturing energy, logistics, and end-of-life processing of a single Li-Ion installation covering the same period. Fewer physical battery replacements mean less total material throughput over the infrastructure lifecycle — a benefit that compounds across a large installed base.

Lead vs. Lithium: The Materials Comparison

VRLA batteries contain lead — a toxic heavy metal with significant environmental implications at extraction, processing, and end-of-life stages. Lead-acid recycling infrastructure is mature and widely available, and the majority of VRLA batteries are recycled. However, the lead-acid recycling process itself is energy-intensive and produces byproducts that require careful management.

LFP chemistry uses lithium, iron, and phosphate — none of which carry the toxicity profile of lead. LFP contains no cobalt, which is the material most associated with environmental and supply chain concerns in lithium battery manufacturing. The lithium iron phosphate formulation is among the most environmentally benign of the commercially deployed lithium battery chemistries. Li-Ion recycling infrastructure for UPS applications is less mature than lead-acid recycling, but Schneider Electric has established battery recycling programs, and the overall environmental burden of LFP over its lifecycle compares favorably to lead-acid.

Energy Efficiency

Li-Ion batteries have higher round-trip energy efficiency than VRLA — a smaller percentage of the energy put into the battery is lost as heat during charge and discharge cycles. For large UPS installations operating continuously, the efficiency difference contributes to reduced energy consumption and lower heat load in the data center environment, which in turn reduces cooling demand. The improvement is incremental rather than transformative, but for organizations calculating PUE and energy costs at scale, it is a real contributor.

Sustainability Reporting

For organizations with formal ESG reporting requirements or sustainability commitments, the battery technology decision can be documented as a measurable contribution: reduced material throughput from fewer replacement cycles, elimination of lead from the battery inventory, and efficiency improvements from Li-Ion's higher round-trip efficiency. Power Solutions can provide lifecycle documentation to support sustainability reporting for UPS battery decisions.

PART 6: A Note on Nickel-Zinc Battery Alternatives

Nickel-zinc (NiZn) batteries have emerged as a UPS battery option in recent years, with NiZn vendors positioning them as a safer or more sustainable alternative to lithium-ion. The chemistry is worth understanding accurately, because the comparison involves real differences — and one significant practical barrier for organizations running Schneider Electric equipment.

What NiZn Gets Right

Nickel-zinc batteries offer a legitimate set of advantages. The chemistry contains no lithium, which addresses procurement concerns in organizations where lithium chemistry perception — regardless of the technical facts — is a meaningful barrier. The materials are widely recyclable: both zinc and nickel have well-established recycling infrastructure. And NiZn's thermal stability profile is favorable — the chemistry does not carry the perceived thermal runaway risk associated with high-energy-density lithium formulations.

Where NiZn Falls Short for Most UPS Applications

- Cycle life: NiZn has a shorter demonstrated cycle life than LFP in UPS applications, which affects the replacement cycle economics that are central to the Li-Ion TCO case.
- BMS and monitoring integration: NiZn systems currently available for UPS applications offer more limited battery management system integration and monitoring capability compared to the EcoStruxure IT-connected BMS in Schneider Electric's LFP portfolio. For organizations where continuous battery health visibility is an operational priority, this is a significant gap.
- Track record at scale: LFP has an extensive deployment history across healthcare, financial services, government, and enterprise data center environments. NiZn's installed base in UPS applications is considerably smaller, and the long-term field performance data that informs replacement cycle planning is less available.

The Authorization Issue

Schneider Electric has not authorized the use of nickel-zinc batteries with their UPS platforms. This matters beyond the warranty question.

An unauthorized battery pairing affects service agreement eligibility and creates liability ambiguity for both the organization and its service provider. It affects EcoStruxure IT integration support — the monitoring and reporting capability that Li-Ion's primary operational advantages depends on. And in regulated environments — healthcare, government, financial services — an unauthorized battery configuration creates a documentation gap that is difficult to resolve in a compliance review.

Before evaluating any third-party battery technology for use with a Schneider Electric UPS, manufacturer authorization status should be the first question asked. For NiZn and Schneider Electric equipment, as of this writing, the answer is no.

SCHNEIDER ELECTRIC LI-ION UPS PORTFOLIO

Li-Ion battery options are available across Schneider Electric's full UPS lineup — from compact single-phase units for smaller server rooms and edge locations to large three-phase systems for enterprise data centers. All platforms integrate with EcoStruxure IT for continuous BMS monitoring and reporting.

Single-Phase Platforms

- Smart-UPS Ultra — Compact rack and tower single-phase UPS for smaller server rooms, IDF closets, and edge locations. Li-Ion is available across the product family. The right specification for distributed IT environments where load does not justify a modular platform.
- Smart-UPS Modular Ultra (5–20 kW, 208V single-phase) — Hot-swap modular architecture with N+1 redundancy; no maintenance bypass panel required for module service. Li-Ion is the native battery configuration. Designed for distributed IT rooms and edge locations where both redundancy and monitoring capability are required.

Three-Phase Platforms

- Galaxy VS (10–150 kVA, three-phase, 208V or 480V) — Modular hot-swap three-phase UPS for medium-density data centers and critical facilities. Internal N+1 redundancy without parallel frames. Available in both 208V and 480V — a practical distinction for facilities with mixed distribution voltage.
- Galaxy VL (200–500 kVA, three-phase) — Frame-level scalable architecture for large data centers. Parallel frame configurations for Tier III equivalent redundancy. Li-Ion's footprint reduction has the most significant floor planning impact at this scale.
- Galaxy VX (500–1,500 kVA, three-phase) — Enterprise and hyperscale data centers. ECOnversion mode reaches up to 99% efficiency while keeping the inverter active — not standard bypass. For large facilities where battery room floor space has a direct dollar value, Li-Ion at VX scale changes the floor planning equation.

All three Galaxy platforms operate in double-conversion (VFI) mode. Transfer time is zero because the load is always running on inverter-derived power — the battery is already in the active power path when a utility event occurs.

CONCLUSION: Making The Decision

The battery technology decision — VRLA or Li-Ion — is one that most organizations will face at least once during the service life of their UPS infrastructure. For new installations and infrastructure refresh projects with standard runtime requirements, Li-Ion is the right starting point for most mid-market environments: the TCO case is well-established, the safety profile is well-documented, and the operational visibility the BMS provides addresses a real and common gap in how organizations understand their battery infrastructure.

The decision is more nuanced for two categories of installation: sites with extended runtime requirements, where the upfront cost premium of Li-Ion may not be recovered through avoided replacement cycles; and existing VRLA installations, where retrofit compatibility, remaining UPS service life, current battery condition, and budget timing all factor into whether Li-Ion retrofit, full system replacement, or continued VRLA operation is the right near-term path.

What should not drive the decision: assumptions about Li-Ion safety based on the wrong chemistry comparison, or a TCO analysis that stops at the upfront price without accounting for replacement cycles, third-party monitoring costs, maintenance overhead, and floor space. The full picture is more favorable to Li-Ion than a first glance at the battery quote suggests — for the applications it is designed for.

Talk to Power Solutions About Your Battery Options

Power Solutions provides battery health assessments, Li-Ion TCO analysis, retrofit compatibility reviews, compliance documentation support, and replacement planning for the full Schneider Electric UPS portfolio. Call 800-876-9373 or email sales@power-solutions.com to discuss your environment and determine which battery chemistry is the right fit for your application.

For more information about the Li-ion Battery TCO, visit our website or contact us sales@power-solutions.com or 800-876-9373.

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