

LiFePO4 vs LiPo vs Lead Acid for LoRa Deployments

Choosing the right battery chemistry for a LoRa mesh node is one of the most consequential hardware decisions you will make. The chemistry determines cycle life, safe operating temperature, charging behaviour, physical size, and total cost of ownership. This page provides a deep technical comparison of the three chemistries most commonly encountered in field deployments: Lithium Iron Phosphate (LiFePO4), Lithium Polymer (LiPo), and valve-regulated lead acid (VRLA/AGM).

Chemistry Overview

Property	LiFePO4	LiPo (LiCoO ₂ /NMC)	Lead Acid (AGM/VRLA)
Nominal cell voltage	3.2 V	3.7 V	2.0 V per cell (12 V = 6 cells)
Fully charged voltage	3.65 V	4.2 V	12.7 - 12.8 V (12 V battery)
Fully discharged cutoff	2.5 V (3.0 V recommended)	3.0 V (3.2 V recommended)	10.5 V (50% DoD recommended)
Usable energy density (Wh/kg)	90 - 120 Wh/kg	150 - 200 Wh/kg	30 - 40 Wh/kg
Cycle life (to 80% capacity)	2,000 - 4,000 cycles	300 - 500 cycles	200 - 500 cycles (50% DoD)
Self-discharge per month	1 - 3%	2 - 5%	3 - 5%
Thermal runaway risk	Very low; cell-to-cell propagation is unlikely but not impossible under severe abuse in tightly packed packs	High - flammable electrolyte	Low - explosive H ₂ gas if overcharged
Operating temperature (discharge)	-20 °C to +60 °C	-10 °C to +45 °C	-15 °C to +50 °C (capacity drops >30% at 0 °C)
Charging temperature minimum	0 °C (lithium plating below)	0 °C	≈-20 °C at reduced rate, only if not frozen (never charge a frozen lead acid battery — it can rupture)

Property	LiFePO4	LiPo (LiCoO ₂ /NMC)	Lead Acid (AGM/VRLA)
Typical cost (USD, approximate, as of 2024)	\$0.25 - \$0.50 / Wh (cells); \$0.60 - \$1.20 / Wh (pack)	\$0.15 - \$0.30 / Wh (pouch)	\$0.10 - \$0.20 / Wh
Cost per cycle (at rated life)	\$0.0002 - \$0.0006 / Wh / cycle	\$0.0006 - \$0.0010 / Wh / cycle	\$0.0008 - \$0.0020 / Wh / cycle

Cycle Life in Depth

LiFePO4 is the standout performer for longevity. A quality cell from EVE, CALB, or Headway will reliably deliver 2,000 cycles at 100% depth of discharge (DoD) and can exceed 4,000 cycles at 80% DoD per the manufacturers’ published cycle-life-vs-DoD curves (e.g. the EVE LF280K datasheet). At a 1-cycle-per-day charge rate typical of solar nodes, this translates to 5 - 11 years of service life.

LiPo cells (using LiCoO₂ or NMC cathodes as found in hobby packs and phone batteries) are rated for 300 - 500 full cycles. With daily cycling on a solar node, these cells will reach end-of-life in under 18 months. Permanent deployments in LiPo are therefore not economical.

Lead acid (AGM) ratings of 200 - 500 cycles assume 50% DoD. Discharging deeper (toward 80% DoD) shortens cycle life substantially; the cycle-life-vs-DoD relationship is nonlinear and varies by battery, so consult the manufacturer’s cycle-vs-DoD curve. Because solar systems routinely deep-discharge during extended cloudy periods, real-world lead acid life in solar applications is often only 2 - 3 years.

Temperature Performance

This is where LiFePO4 dominates cold climates. At –20 °C, LiFePO4 retains approximately 70 - 80% of rated capacity on discharge - usable, though not ideal. LiPo cells at –10 °C typically retain only 50 - 60% of rated capacity and internal resistance rises sharply, causing voltage sag under load. At –20 °C many LiPo cells effectively stop functioning. Lead acid loses approximately 30 - 40% of rated capacity at 0 °C, and at –20 °C a fully charged lead acid battery delivers only 40 - 50% of its 25 °C rating.

Critical charging constraint: Both LiFePO4 and LiPo must not be charged below 0 °C. Charging lithium cells in freezing temperatures causes metallic lithium plating on the anode, permanently reducing capacity and creating an internal short-circuit hazard. Solar systems in freezing climates must incorporate a low-temperature charge cutoff. Many commercial LiFePO4 BMS modules include this feature.

Safety

LiFePO4 uses an olivine phosphate cathode that is inherently stable. Even in nail-penetration and overcharge abuse tests, LiFePO4 cells typically vent mildly without fire or explosion. LiFePO4 is far more resistant to thermal runaway than LiPo/NMC, but it is not immune — still use a BMS and proper fusing. Its stability makes it much safer than LiPo for enclosed installs, but you must still observe ambient temperature limits (charge only between 0 °C and 45 °C — attics can exceed charge-temperature limits and cold walls can fall below the 0 °C charge floor), provide thermal management, and follow local fire/building codes.

LiPo cells with NMC or LiCoO2 cathodes store significantly more energy per unit mass and release it rapidly in fault conditions. Thermal runaway in a LiPo pack can reach temperatures of several hundred °C and produces toxic hydrogen fluoride (HF) gas. Never install LiPo packs in sealed enclosures without adequate ventilation or thermal fusing. For unattended LoRa repeater deployments in public locations, LiPo represents a meaningful liability.

Lead acid produces hydrogen gas during overcharge. In sealed VRLA/AGM formats the recombination rate is high, but a faulty charge controller can still cause pressure build-up and case rupture. AGM batteries should not be enclosed in airtight boxes.

Voltage Curves and State-of-Charge Estimation

LiFePO4 has an extremely flat discharge curve - the cell voltage sits near 3.2 - 3.3 V for the majority of its capacity range, dropping steeply only in the last 10 - 15% of charge. This makes voltage-based SoC estimation imprecise in the mid-range, but the flat curve is beneficial because the node's voltage regulator sees a near-constant input for most of the discharge cycle.

SoC (%)	LiFePO4 OCV (V/cell)	LiPo OCV (V/cell)	12 V Lead Acid OCV (V)
100 (resting)	3.35 - 3.45	4.18 - 4.20	12.70 - 12.80
90	3.35 - 3.38	4.07 - 4.10	12.50 - 12.60
80	3.32 - 3.34	3.98 - 4.02	12.40 - 12.50
70	3.30 - 3.33	3.88 - 3.92	12.30 - 12.40
50	3.27 - 3.30	3.73 - 3.77	12.10 - 12.20
30	3.22 - 3.25	3.60 - 3.65	11.90 - 12.00
20	3.18 - 3.22	3.55 - 3.60	11.75 - 11.90
10	3.10 - 3.18	3.45 - 3.55	11.50 - 11.75

SoC (%)	LiFePO4 OCV (V/cell)	LiPo OCV (V/cell)	12 V Lead Acid OCV (V)
0 (cutoff)	2.5 - 3.0	3.0 - 3.2	10.5 - 11.2

All OCV values are resting (settled) open-circuit voltage with no load applied for at least 30 minutes. These are rest voltages, not charge/absorption voltages — a freshly-charged LiFePO4 cell sits near 3.6 V while charging but settles to roughly 3.35 - 3.45 V at rest. Under load, voltages will be lower due to internal resistance. Note that voltage-based SoC estimation is especially unreliable across the LiFePO4 mid-range because of the cell's flat 3.25 - 3.30 V plateau, where small voltage changes span a large capacity range. For LiFePO4, Meshtastic firmware reports battery percentage based on voltage thresholds; refer to the telemetry page in this book for specific ADC configuration.

Specific Product Recommendations

LiFePO4 - Recommended Products

- **EVE LF50K (50 Ah, 3.2 V prismatic):** Cells widely used in DIY packs. ~\$15 - 20 USD per cell from Chinese suppliers (volatile, as of 2026-06-08). Per the EVE datasheet these cells are rated on the order of 4,000+ cycles at a specified DoD and low charge rate ("Grade A" is a market term, not a quality guarantee). Excellent for 12 V 4S packs powering Pi gateways.
- **Headway 38120S (10 Ah, 3.2 V cylindrical):** Threadable terminals, very robust, 2,000+ cycle rating. Good for vibration-prone installations.
- **Bioenno Power BLF-1206A (6 Ah, 12.8 V):** Complete sealed pack with integrated BMS, ~\$80 (MSRP, as of 2026-06-08). Designed for portable amateur radio use. Plug-and-play for most repeater boxes.
- **Dakota Lithium 12V 7Ah:** Includes BMS, marketed as rugged/waterproof for marine and ice-fishing use (verify the exact ingress rating against Dakota Lithium's spec sheet before relying on it). Price varies — check current pricing (as of 2026-06-08). Good for outdoor enclosures.

LiPo - Acceptable for Short-Deployment or Prototype Use

- **EEMB LP805060 (3.7 V, 3000 mAh):** Popular single-cell pouch for T-Beam style boards, includes built-in PCM protection board.
- **Adafruit 328 (3.7 V, 2500 mAh):** JST PH 2.0mm connector, compatible with most Adafruit LoRa boards out of the box. (If you specifically need the 2000 mAh cell, that is Adafruit #2011.)

- **Tenergy LP 103450 (3.7 V, 1800 mAh):** Flat pouch, low profile for tight enclosures.

Lead Acid - Only Where Weight/Cost Dominates

- **Mighty Max ML7-12 (12 V, 7 Ah AGM):** ~\$20, widely available. Suitable for short-duration backup where replacement is routine.
- **Universal Power Group UB1270 (12 V, 7 Ah):** UL-listed, common in security system applications, drop-in for 12 V enclosures.

Summary Recommendation

For any unattended LoRa repeater or mesh node intended for permanent or semi-permanent deployment, **LiFePO4 is the correct choice**. The superior cycle life, wide temperature tolerance, and thermal safety profile outweigh its higher per-Wh cost compared to LiPo. Lead acid remains viable only when cost is the dominant constraint and the installation allows for routine (annual) battery replacement. LiPo is acceptable for short-term field deployments, handheld nodes, and prototyping, but should not be used in sealed enclosures or unattended permanent installations.

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