Battery and Power

Answers to common questions about battery life, power management, battery chemistry, solar sizing, and long-term deployments.

How long does the battery last?

Battery life varies significantly by device type, display type, messaging activity, and whether the device is acting as a relay. The figures below are approximate community estimates - actual runtime varies widely with screen use, GPS, and transmit duty cycle:

Device Type	Typical Battery Life	Notes
ESP32 client node (e.g., Heltec V3, T-Beam)	~1 - 3 days (approx.)	3000 mAh battery, moderate messaging. ESP32 nodes are power-hungry; T-Beam with GPS active is toward the shorter end.
nRF52 client node (e.g., T114, RAK4631)	~3 - 7 days (approx.)	Lower power than ESP32 (efficient MCU, no Wi-Fi radio)
E-ink display device (T-Echo, Wireless Paper)	~7 - 14 days (approx.)	E-ink uses power only when updating; excellent for always-on carry
Repeater node (always receiving)	Varies by MCU: ESP32 ~1 - 2 days on 3000 mAh; nRF52 several days	The always-on radio is the main draw. An nRF52 repeater (~10 - 15 mA) lasts far longer than an ESP32 one; for permanent sites plan for continuous/solar power rather than battery-only.

Power-saving tips: reduce TX power to the minimum needed for your use case; increase the sleep interval between beacon transmissions; disable GPS if not needed; use an e-ink device for always-on carry.

What battery chemistry should I use for outdoor deployments?

LiFePO4 (Lithium Iron Phosphate) is strongly preferred for any outdoor, unattended, or cold-weather deployment.

Why LiFePO4 over LiPo:

- **Temperature performance:** LiFePO4 operates reliably from about - 4°F (- 20°C) to 140°F (60°C), while LiPo degrades significantly below 32°F (0°C) and risks damage below - 4°F. Note: this is the *discharge* range - see the cold-weather note below for the separate, stricter charging limit.
- **Safety:** LiFePO4 is far more resistant to thermal runaway than LiPo, with a much higher onset temperature (~270°C vs ~150-210°C for LiPo/NMC), so it is much less likely to ignite under abuse. It is **not** completely immune, however - under severe abuse (puncture, dead short, gross overcharge, or charging a frozen cell) any lithium cell can vent flammable gas, overheat, and in extreme cases ignite. Still use a proper BMS and fusing, and avoid puncture or overcharge. LiPo combusts far more readily under these conditions.
- **Cycle life:** LiFePO4 typically lasts 2,000 - 5,000+ charge cycles. LiPo lasts roughly 300 - 1,000 cycles. For a permanently deployed solar-charged node, LiFePO4 can last a decade; LiPo may degrade in 1 - 3 years.
- **Voltage characteristics:** LiFePO4 has a flatter discharge curve (steady ~3.2V per cell vs. LiPo's declining curve), which means more consistent performance through the discharge cycle.

Critical cold-weather note: Do **not charge** any lithium chemistry, including LiFePO4, below 0°C (32°F) - sub-freezing charging causes lithium plating, which permanently damages the cell and can create internal shorts (a fire hazard on later cycles). For winter solar deployments, use a BMS or charge controller with low-temperature charge cutoff, or a self-heating/insulated battery. Separately, LiFePO4 also loses a large fraction of its usable capacity in extreme cold (roughly half by around - 40°F / - 40°C, as a rough estimate) - and note that many LiFePO4 cells are only rated for discharge down to about - 20°C, not - 40°C. If deploying in Minnesota, the Dakotas, Canada, or similar climates, check your cell's datasheet and size your battery bank for worst-case winter temperatures, not just rated capacity.

Are cheap 18650 batteries from Amazon OK?

Be very careful. First, for reference: a real 18650 cell holds roughly 2,500 - 3,500 mAh. Treat any listing above about 3,600 mAh as false advertising, regardless of price. The 18650 market on Amazon is saturated with counterfeit and overstated-capacity cells - a cell listed as "9800 mAh" for a few dollars is physically impossible.

Counterfeit cells often have:

- Actual capacity 20 - 50% of stated capacity
- Poor protection circuitry or none at all. (Note: many legitimate 18650 cells are intentionally sold "unprotected" - bare cells without a built-in protection PCB - which is normal and expected when they are used inside a pack that has its own BMS. The concern with counterfeits is the absence of *any* protection in a context that needs it, plus generally poor quality control.)
- Higher internal resistance = poor performance under load
- Increased fire/damage risk

Buy 18650 cells from reputable sources:

- **18650batterystore.com** - US-based, genuine cells, good selection
- **illumn.com** - US-based specialty battery retailer
- **Brand-name cells:** Samsung 30Q, Samsung 40T, Molicel P26A, Molicel P42A, Panasonic NCR18650B, LG MJ1

For outdoor deployments where capacity and reliability matter, buying genuine cells from a reputable source is worth the modest price premium over Amazon mystery cells.

How big a solar panel do I need for a repeater node?

A typical LoRa repeater node in the continental United States requires a surprisingly modest solar setup. Rules of thumb:

- **Panel:** 5 - 10 W is adequate for most locations during summer. A 10 W panel provides comfortable margin for cloudy days.
- **Battery:** Size for 3 - 5 days of runtime without any solar input. Worked example for a node drawing an assumed ~150 mA average (your node's actual average draw varies by role and TX duty - measure it if you can): 150 mA × 24 h × 3 days = 10,800 mAh = 10.8 Ah minimum. A 20 Ah LiFePO4 battery provides good margin.

Safety: fuse the battery. Install an appropriately-rated fuse between the battery and the charge controller/load. An unfused lithium bank (especially a 20 - 40 Ah LiFePO4 pack) can deliver very high fault current into a wiring fault or a shorted controller and start a fire; a fuse is standard practice and is not optional.

Regional considerations:

- **Southern US (Texas, Arizona, California):** Ample sun year-round; 5 - 7 W panel is usually sufficient.
- **Northern US (Minnesota, North Dakota, Montana):** December peak sun hours typically drop to about **2.5 - 3.5 hours/day** (e.g. Minnesota winter is roughly 3 - 5 h/day) - significantly less than the 4 - 6 hours/day you get in summer. A 10 W panel and a larger battery bank (30 - 40 Ah) is recommended for year-round operation without manual intervention.
- **Pacific Northwest:** Low winter sun and frequent overcast push peak sun hours down toward ~2.5 h/day or less in deep winter; plan for 2 - 3 hours/day. Size accordingly or accept that the node may need occasional charging in deep winter.

Practical formula: Daily energy consumption (Wh) ÷ peak sun hours ÷ panel efficiency (typically 80% for a real system) = panel wattage needed. Always add 50 - 100% margin for real-world inefficiency, dirty panels, and suboptimal panel angle.

Can I charge LiFePO4 batteries with a standard LiPo charger?

No - use only a charger designed for LiFePO4. LiFePO4 cells have a different charge voltage profile than LiPo cells (3.65V/cell max for LiFePO4 vs. 4.2V/cell for LiPo). Charging LiFePO4 with a LiPo charger will overcharge the cells, reducing their life and potentially causing damage.

Purpose-built LiFePO4 solar charge controllers and battery management systems (BMS) are widely available and not expensive. Many solar charge controllers include a LiFePO4 mode.

Should I run my node from a USB power bank?

USB power banks work well for **portable and temporary deployments**. They are convenient, inexpensive, and widely available.

Limitations for permanent deployment:

- Most USB power banks shut off when they detect a low-current draw (like a standby LoRa node). This is called "low-current cutoff." The node will stop running after a short time even if the power bank is not depleted.

- Power banks are not designed for continuous solar charging - charging and discharging simultaneously (known as "pass-through") degrades many power banks quickly.

For permanent outdoor deployment, use a dedicated LiFePO4 battery with a proper solar charge controller rather than a consumer power bank.

My device gets warm during operation. Is this normal?

Mild warmth is normal, particularly during active transmission or when running at high TX power. Most ESP32 LoRa boards (e.g. Heltec V3, which use the SX1262) transmit at up to about 22 dBm conducted and run slightly warm at that level - this is not a concern at normal operating temperatures. Higher outputs (27 dBm and above, i.e. 0.5 W) are beyond the SX1262's native ~22 dBm capability and require an external power-amplifier module; a bare Heltec cannot reach them.

Concerns to watch for:

- Excessive heat from the battery area may indicate a failing or improperly charged lithium battery. If a cell is hot to the touch or swelling, **stop charging and disconnect it immediately**. Do not puncture, crush, or continue to use a swollen cell - it is a fire and venting hazard. Move it to a non-combustible surface away from flammable material, let it cool, and dispose of it at a battery-recycling or hazardous-waste facility - never in the household trash.
- Sustained high temperature inside a sealed enclosure can shorten component life. A weatherproof box is by definition sealed, so don't drill open holes (that defeats the weatherproofing) - instead use vapor-permeable vents (e.g. Gore vents) or a sun shield, and keep the enclosure out of direct sun where practical.

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