

# Power Fundamentals

- [Current Draw & Power Budgets](#)
- [Battery Chemistry Guide](#)

# Current Draw & Power Budgets

## Current Draw & Power Budgets

Understanding how much power your node consumes is the starting point for sizing batteries and solar panels. LoRa mesh nodes have variable current draw depending on what they are doing at any given moment.

### Typical Current Draw by State

State	Current Draw	Notes
Deep sleep (nRF52)	2 - 20 $\mu$ A	Heltec Wireless Paper: $\sim$ 20 $\mu$ A; T-Echo: $\sim$ 2 - 5 $\mu$ A
Deep sleep (ESP32)	10 - 100 $\mu$ A	ESP32 deep sleep varies widely by implementation
Idle / listening	15 - 30 mA	Radio on, waiting for packets; display off
Active with display	30 - 60 mA	OLED adds $\sim$ 10 - 20 mA; e-ink adds $\sim$ 0 mA between refreshes
Transmitting	50 - 120 mA	Depends on TX power setting; 22 dBm $\approx$ 80 mA typical
Transmitting (Station G2, 36.5 dBm)	800 - 1200 mA	Requires 15V PD supply capable of delivering this current

### Average Current for a Repeater Node

A repeater node running MeshCore is mostly in idle/listening mode, with brief transmit bursts when relaying traffic. Typical average:

- **Idle listening:**  $\sim$ 25 mA most of the time
- **Transmit duty cycle:** Low (a few percent in typical mesh traffic)
- **Average current:**  $\sim$ 20 - 40 mA total, typically  $\sim$ 25 mA for a lightly-loaded repeater

### Calculating Daily Energy Use

Daily energy (Wh/day) = Average current (A)  $\times$  Voltage (V)  $\times$  24 hours

Example for a Heltec V3 repeater:

- Average current: 25 mA = 0.025 A
- Battery voltage: 3.7V (nominal LiPo/Li-ion)
- Daily energy:  $0.025 \times 3.7 \times 24 = \mathbf{2.22 \text{ Wh/day}}$

This is the baseline figure used in solar sizing calculations. A Room Server running with active connections may draw more - budget 3 - 4 Wh/day for a heavily used Room Server node.

## Power Budget Worksheet

Parameter	Your Value	Notes
Average current draw (mA)	—	Measure with a USB power meter or estimate from table above
Supply voltage (V)	3.7	Standard LiPo/Li-ion nominal voltage
Daily energy (Wh/day)	—	= current(A) $\times$ 3.7 $\times$ 24
Days of battery reserve needed	—	3 - 7 days recommended for outdoor solar nodes
Battery capacity needed (Wh)	—	= daily energy $\times$ reserve days $\div$ 0.8 (usable fraction)
Worst-case peak sun hours	—	Look up your location; use December value for year-round reliability
Solar panel needed (W)	—	= daily energy $\div$ (peak sun hours $\times$ 0.70)

## Measuring Real Current Draw

For accurate power budgeting, measure actual current with a USB power meter (for 5V USB-powered nodes) or a multimeter in series with the battery lead. A USB meter like the UM25C gives real-time current and accumulates energy over time. Log over a 24-hour period under typical traffic conditions for the most accurate average.

## Reducing Power Consumption

- Disable unused peripherals (OLED display off when not needed)
- Use nRF52-based boards (T-Echo, T114, RAK4631, Wio series) instead of ESP32 for lower idle current
- Reduce TX power if the node is within range with lower power - every 3 dB reduction halves transmit current
- Enable deep sleep between transmit windows for infrequent sensor nodes

# Battery Chemistry Guide

## Battery Chemistry Guide

Choosing the right battery chemistry for your deployment is critical. The wrong choice leads to shortened battery life, safety hazards, or a node that fails in cold weather.

### Li-ion 18650 Cells

The 18650 is the workhorse battery for DIY LoRa nodes. Named for its dimensions (18mm × 65mm), it is widely available, well-understood, and supported by most mid-range device designs with a holder.

**Warning:** Most 18650 cells sold on Amazon are counterfeit. A cell labelled 6000mAh from an unknown brand is physically impossible - the best genuine 18650 cells reach ~3500mAh. Buy from reputable electronics retailers only.

### Recommended 18650 Cells

Cell	Price	Capacity	Max Continuous	Notes
Samsung 35E Protected	\$10	3500mAh	8A	Good all-around; protected circuit prevents overdischarge
Molicel M35A Protected	\$12	3500mAh	10A	Slightly higher max current than Samsung 35E
Panasonic NCR18650GA	\$14	3450mAh	10A	Excellent quality; established brand

All three options are equivalent for LoRa node use. The 8 - 10A max current is far above the <200 mA draw of typical nodes, so any of these cells will work well. Buy protected cells - the protection circuit prevents over-discharge which can damage the cell.

### 21700 Cells

21700 cells are slightly larger (21mm × 70mm) and offer higher capacity. Fewer devices have 21700 holders but they can be used in custom builds or with adapter sleeves.

Cell	Price	Capacity	Max Continuous
------	-------	----------	----------------

Samsung 50S	\$8	5000mAh	25A
MoliceI P50B	\$11	5000mAh	50A

## LiPo Packs

Lithium polymer packs in various capacities with JST connectors are the standard battery choice for devices without 18650 holders (Heltec V3, many LilyGo boards). Match the connector type carefully.

Pack	Price	Capacity	Connector	Fits
3000mAh JST PH 2.0	\$11	3000mAh	JST PH 2.0mm	Heltec V3, V4, LilyGo boards
3200mAh 3-Pin JST	\$15	3200mAh	3-pin JST	RAK19026
Rokland LiPo Packs	\$10 - \$20	Multiple sizes	Micro JST 1.25	Various; check listing for exact connector

**LiPo caution:** LiPo cells can swell, catch fire, or vent if overcharged, over-discharged, punctured, or charged at low temperatures. Use only with a proper charge controller. Never charge below 0°C. For unattended outdoor deployments in cold climates, prefer Li-ion 18650 or LiFePO4 over LiPo.

## LiFePO4 (Lithium Iron Phosphate)

LiFePO4 is strongly preferred for outdoor and cold-weather deployments. Key advantages over Li-ion/LiPo:

- **Temperature tolerance:** Operates and can be charged at much lower temperatures ( - 20°C for charging, - 40°C for discharge)
- **Safety:** Much less prone to thermal runaway; does not catch fire when punctured or overcharged
- **Cycle life:** 2000 - 3000 cycles vs. 300 - 500 for standard Li-ion
- **Discharge curve:** Flat 3.2V nominal vs. 3.7V for Li-ion - verify your device supports 3.2V operation

**Trade-off:** Lower energy density than Li-ion. A LiFePO4 pack of the same physical size will have less capacity than a Li-ion pack. Plan for ~50% capacity loss at - 40°F even with LiFePO4, and size accordingly.

## Battery Chemistry Comparison

Chemistry	Nominal Voltage	Cold Weather	Safety	Cycle Life	Best For
-----------	-----------------	--------------	--------	------------	----------

LiPo	3.7V	Poor	Moderate	300 - 500	Indoor, portable, attended deployments
Li-ion 18650	3.7V	Moderate	Good (protected)	500 - 800	General purpose; most DIY builds
LiFePO4	3.2V	Excellent	Excellent	2000+	Outdoor permanent, cold climate, unattended