Solar Sizing Guide

A correctly sized solar system can keep your repeater running for years with minimal maintenance - an undersized system fails within days during cloudy weather. Note that batteries are a wear item: they degrade over time and need periodic replacement, connectors corrode, panels soil, and a long enough run of overcast can exceed any finite battery reserve, so plan for periodic inspection (see the cold-weather page for a seasonal maintenance schedule).

The two goals of solar sizing

1. **Enough panel** to fully recharge the battery on a typical sunny day
2. **Enough battery** to run through several consecutive cloudy days (autonomy period)

Step 1: Calculate daily energy consumption

Use the power consumption tables on the previous page. The official Meshtastic power figures are use-case and duty-cycle dependent, so treat the numbers below as *representative examples — measure your own node*. For a typical optimized nRF52 (RAK4631 / T-Echo) repeater, a representative average is ~10 - 15 mA; we use 12 mA here:

```
Daily consumption = 12 mA × 24 h = 288 mAh = 0.288 Ah
At 3.7V: 0.288 Ah × 3.7 V = 1.07 Wh/day
```

For an ESP32 (Heltec LoRa 32 V3) repeater, a representative always-on average is ~40 - 80 mA (higher with Wi-Fi/MQTT). Using 40 mA: `40 × 24 = 960 mAh = 3.55 Wh/day`. A stripped, Wi-Fi-off ESP32 can be ~25 - 30 mA; a full-featured one is higher.

Step 2: Size the battery

Rule of thumb: **target 5 days of autonomy** (no sun) for a general node, and **5 - 7+ days for an emergency-comms node** (panels don't help during multi-day overcast). Use 80% usable depth-of-discharge for LiFePO4:

```
Battery (Ah) = (daily consumption × 5 days) / 0.8

nRF52 example: (0.288 Ah × 5) / 0.8 = 1.8 Ah minimum → use 5 - 10 Ah for margin
ESP32 example: (0.96 Ah × 5) / 0.8 = 6.0 Ah minimum → use 10 - 20 Ah
```

Step 3: Size the solar panel

Do **not** assume 4 peak sun hours per day — that is *not* conservative year-round. Look up your location's worst-month (December) peak sun hours (PSH) on NREL PVWatts: winter PSH can be as low as ~1.5 in the Pacific Northwest (Seattle/Portland), ~2.5 in the Midwest (Chicago), and ~0.5 in Alaska (Anchorage). Size the panel against that winter minimum, not a year-round average. Divide by an overall system derate factor of 0.75 (covering charge-controller inefficiency, wiring, temperature, soiling, and panel degradation):

```
Panel (W) = (daily Wh / winter PSH) / 0.75

nRF52 example at 1.5 PSH (PNW winter): (1.07 / 1.5) / 0.75 = 0.95W minimum → a 5W panel is the safer floor for any northern deployment
ESP32 example at 1.5 PSH (PNW winter): (3.55 / 1.5) / 0.75 = 3.16W minimum → 10W panel recommended
```

Re-run this calculation with **your** winter PSH before trusting a small panel. At a year-round-average 4 PSH the nRF52 minimum would be only ~0.36W, but at a real PNW winter 1.5 PSH it is ~0.95W, and once cold derate and snow-cover risk are added a 1 - 3W panel is marginal — a 5W panel is the safer floor for northern winters.

Typical community build: $108 - $290 *(prices as of 2026-06-08, volatile)*

This is a generic example build for a small solar-powered LoRa mesh node. Match the battery voltage to your node's input requirement and confirm current vendor listings before purchasing:

Component	Spec	Cost

Solar panel	5W, south-facing, 30 - 40° tilt (match your latitude)	$15 - 25
Charge controller	MPPT — e.g. Victron SmartSolar MPPT 75/10 (Victron's smallest model; ~$50 - 65, a 12V-system controller) or a generic CN3791 board (a single-cell ~6V LiPo solar charger IC — **not interchangeable**; match it to your battery voltage)	$15 - 65
Battery	LiFePO4 10 Ah — either a 4S 12.8V pack (~128 Wh) **or** a single 3.2V cell (~32 Wh). These are **not** equivalent: at the same Ah the 12.8V pack stores ~4× the energy, and a single 3.2V cell won't power a board needing 3.3V+. Match the battery voltage to your node.	$25 - 60
Radio board	RAK4631 or Heltec LoRa 32 V3 or T-Echo	$18 - 75
Enclosure	IP65 ABS junction box, 200×120×75mm	$10 - 20
Antenna	5 dBi fiberglass, N-female mount	$15 - 25
Misc	Cable glands, silicone, wiring, and a fuse on the battery-positive lead within a few inches of the terminal (see the Wiring page)	$10 - 20
Total		**$108 - $290**

Cold-climate note: LiFePO4 must **never** be charged below 0 °C (32 °F) — sub-freezing charging causes lithium plating and permanent damage. The CN3791 has no low-temperature charge cutoff, so for cold/winter builds use a BMS with low-temp protection, or a charge controller with a battery temperature sensor.

Panel mounting orientation

- **Azimuth:** Face south (in North America). A deviation of up to 30° east or west reduces output by only ~5%.
- **Tilt angle:** Set to your latitude for best year-round average. Steeper tilt (latitude + 15°) optimizes for winter; shallower (latitude − 15°) for summer.
- **Avoid shading:** Even partial shading of one cell can reduce output of the entire panel significantly. Use terrain and shadow analysis before finalizing mount position.

Charge controller: MPPT vs PWM

Strongly prefer MPPT for solar-powered mesh nodes:

- MPPT controllers extract more power from the panel when the panel's Vmp is well above the battery voltage (and in cold or low-light conditions)
- On small systems (3 - 10W panels), this can be the difference between running through winter and falling into deficit
- PWM is acceptable when the panel's Vmp closely matches the battery voltage (e.g. a nominal-12V panel on a 12V battery); for higher-voltage panels, MPPT is needed. On very-low-power nodes, also weigh the controller's own quiescent (idle) current draw — a tiny panel paired with a hungry MPPT can lose more than it gains.

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