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 µA	Heltec Wireless Paper: ~20 µA; T-Echo: ~2 - 5 µA
Deep sleep (ESP32)	10 - 100 µA (bare MCU); often hundreds of µA to a few mA at board level	Bare-module figures; real ESP32 Meshtastic boards draw far more (community measurements show up to ~2.7 mA) due to regulators/peripherals
Idle / listening	nRF52: ~10 - 30 mA; ESP32: ~40 - 80 mA	Radio on, waiting for packets; display off. ESP32-based boards (e.g. Heltec V3) draw considerably more than nRF52 boards (e.g. RAK4631, T-Echo)
Active with display	30 - 60 mA	OLED adds ~10 - 20 mA; e-ink adds ~0 mA between refreshes
Transmitting	Radio/PA ~50 - 120 mA; whole device commonly 150 - 330 mA at 22 dBm	The ~80 mA figure is radio-only on efficient boards (RAK nRF52840 ≈ 88 mA); full-board TX current at 22 dBm reaches ~163 - 332 mA depending on board (MCU + PA + regulator). Representative — measure your own

State	Current Draw	Notes
Transmitting (Station G2, 36.5 dBm)	~800 - 1200 mA (estimate)	36.5 dBm (≈4.46 W) RF output is the manufacturer spec; the current draw is an estimate (the vendor notes consumption does not scale strongly with PA output). Requires a 15 V PD supply (≥20 W). Note: 4.46 W EIRP/conducted may exceed license-free power limits in your band/jurisdiction — verify the legal limit before transmitting at full power

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:** ~10 - 15 mA most of the time for an nRF52-class board (e.g. RAK4631); ESP32 repeaters idle considerably higher (~40 - 80 mA). Representative values — measure your own
- **Transmit duty cycle:** Low (a few percent in typical mesh traffic)
- **Average current:** ~10 - 15 mA for a lightly-loaded nRF52 repeater; an ESP32 repeater (Heltec V3) averages ~40 - 80 mA. These are representative figures from community measurements — measure your own board

Calculating Daily Energy Use

Daily energy (Wh/day) = Average current (A) × Voltage (V) × 24 hours. Equivalently, Wh/day = average current (mA) × 24 h × system voltage (V) ÷ 1000. (Current in mA × hours gives mAh/Ah; you must multiply by voltage to get watt-hours.)

Example for an nRF52 (RAK4631) repeater:

- Average current: 12 mA = 0.012 A (representative nRF52 figure — measure your own)
- Battery voltage: 3.7V (nominal LiPo/Li-ion)
- Daily energy: 0.012 × 3.7 × 24 = **~1.07 Wh/day**

An always-on ESP32 board (e.g. Heltec V3) averaging ~50 mA would instead consume 0.050 × 3.7 × 24 ≈ **4.4 Wh/day** — roughly four times as much. Always size to your specific board.

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) × 3.7 × 24
Days of battery reserve needed	___	General outdoor solar nodes: 3 - 5 days. Emergency-comms nodes: 5 - 7+ days (panels do not help during multi-day overcast)
Battery capacity needed (Wh)	___	= daily energy × reserve days ÷ (usable fraction × cold derate × end-of-life derate) × 1.2 safety margin. For a warm-climate LiFePO4 node the usable fraction alone is ~0.80; for a cold-climate node the *combined* derate is roughly 0.58, so the battery must be substantially larger. Do NOT size on 0.80 alone in freezing climates — see the Battery Sizing page for the full method (this worksheet's simple 0.80 divisor undersizes a winter node by ~40%)
Worst-case peak sun hours	___	Look up your location's worst-month (December) value from NREL PVWatts — do not assume a flat 4 PSH year-round. Northern-US winter is ~1 - 2.5 PSH (e.g. Seattle/Portland ~1.5, Chicago ~2.5)
Solar panel needed (W)	___	= daily energy ÷ (peak sun hours × 0.75). The 0.75 overall system derate covers controller, wiring, temperature and soiling losses. Use your location's worst-month (winter) peak sun hours from NREL PVWatts — northern-US winter is ~1 - 2.5 PSH, not a flat 4

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

---

Revision #3
Created 2026-05-03 03:13:07 UTC by Mesh America Admin
Updated 2026-06-08 22:49:24 UTC by Mesh America Admin