How big a solar panel do I need?

Short Answer

For most LoRa mesh nodes: a 5W panel for nRF52840-based nodes, 10-20W for ESP32-based nodes. For Raspberry Pi gateways: 20-40W. These are rule-of-thumb guideline ranges, not sourced specifications - actual requirements depend heavily on your node's duty cycle, display use, and local insolation. They assume worst-month sun and a few days of autonomy; cross-check against Meshtastic's solar-powered node documentation and a solar sizing calculator for your specific site.

The Calculation

Solar system sizing is a four-step calculation. The current-draw figures below are approximate and config-dependent (Wi-Fi/BLE duty cycle and display state move them substantially) - measure your own node where you can rather than trusting these numbers:

1. **Measure your node's current draw** - Use a USB inline power meter. Real measurements beat estimates. Typical (approximate) values: nRF52840 repeater: 8-15 mA average; ESP32 repeater with OLED: 40-70 mA; Pi Zero 2W gateway: 100-150 mA. An nRF52840 repeater can average well below 15 mA, and ESP32 draw varies widely with Wi-Fi.
2. **Calculate daily energy consumption** - Current (mA) × 24 hours = mAh per day. Example: 12 mA × 24 = 288 mAh/day = 0.288 Ah/day.
3. **Find peak sun hours for your location** - This is the key local variable. A panel receives "peak sun hours" as an energy-equivalent of full-rated output. Approximate US annual-average values (source these from NREL PVWatts/NSRDB for your exact location, as they vary by dataset): Miami: 5.5, Denver: 5.3, Seattle: 3.6, Boston: 4.2, Phoenix: 6.1. **Use the worst-month value for sizing, not the annual average.** The worst month is typically December, and December peak sun hours are far lower than the annual figure - e.g. Seattle drops to roughly 1-1.5 PSH in December, not 3.6. Size for that worst month.
4. **Panel size** - A rough starting formula is: Daily consumption (Ah) ÷ worst-month peak sun hours × a combined derate of about 1.5-2x = panel Ah output needed, then convert to Watts at your system voltage. A single 1.25 "efficiency factor" is too optimistic: real-world

losses (charge-controller and battery inefficiency, temperature, soiling/dust, panel aging, off-angle mounting, and only 50-70% of rated panel watts actually harvested in winter) commonly total 1.5-2x or more. The bare arithmetic for an ultra-low-power nRF52840 node yields a tiny number (well under 1 Wh/day), but **do not use that as your panel size** - it ignores those losses and multi-day overcast. After accounting for them, **a 5W panel is the practical minimum even for the smallest nodes** in poor-insolation regions like the Pacific Northwest in winter. Size up further for ESP32 and Pi-class nodes per the table below.

Practical Sizing Recommendations

The current draws and panel sizes below are approximate engineering estimates, not measured specifications. The PNW-winter column assumes you must ride through consecutive overcast days; in the worst sites you may need more than the listed wattage. For solar nodes, disable or duty-cycle the OLED display - leaving it on continuously wastes power for no benefit on an unattended repeater.

Node Type	Average Draw	Panel (temperate US)	Panel (PNW winter)
nRF52840 repeater, no display	10-15 mA	5W	5W (consider 10W for consecutive overcast days)
ESP32 repeater, no display	40-55 mA	10W	20W
ESP32 repeater, OLED on	60-80 mA	15W	30W
Pi Zero 2W + LoRa HAT	120-160 mA	20W	40W (a Pi gateway suits small solar poorly; may need more)

Battery Sizing

Size the battery for 3-5 days of autonomy (no solar input) for ordinary hobby uptime. This covers typical cloudy periods and seasonal weather. **For nodes intended as emergency infrastructure, size for 7-10+ days of autonomy** - the multi-day winter storms, wildfire smoke, and heavy overcast that most demand a working mesh are exactly when solar harvest collapses, and a node sized for only 3-5 days can die mid-incident. Battery (Ah) = Daily consumption (Ah) × autonomy days × a depth-of-discharge multiplier. The right multiplier depends on chemistry: use about 1.25x for LiFePO4 (to stay near 80% usable depth of discharge) and roughly 2x for lead-acid (which wants ~50% depth of discharge for reasonable life). A flat 1.2x is too aggressive for healthy long-term cycling.

Example: nRF52840 at 12 mA × 24h = 0.29 Ah/day × 5 days × 1.25 (LiFePO4) ≈ 1.8 Ah minimum. **For permanent outdoor nodes, use a LiFePO4 pack, not a bare LiPo** - LiPo must not be charged below 0°C, suffers freeze damage, and is a fire risk in an unattended sealed enclosure (see the battery-chemistry guidance). Note that LiFePO4 cells are ~3.2V nominal, not 3.7V like LiPo, so a true "equivalent" differs in voltage and watt-hours; size by capacity (Ah) and chemistry, and pick a pack with comfortable margin (e.g. a few thousand mAh for this example).

Solar & Wiring Safety

For any permanent battery + panel install: **always use a proper charge controller** between the panel and the battery - never wire a solar panel directly to a LiFePO4 (or LiPo) battery, as that risks overcharge, cell damage, and fire. Add an inline fuse at the battery positive terminal sized to your wiring; a shorted lithium pack can dump very high current into thin DIY wiring inside a sealed enclosure. In any climate with freezing winters, use a charge controller or BMS with a low-temperature charge cutoff - lithium chemistries must not be charged below 0°C.

Revision #4
Created 2026-05-03 05:48:18 UTC by Mesh America Admin
Updated 2026-06-08 19:47:29 UTC by Mesh America Admin