Sizing Your Solar System

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Proper solar sizing means the system produces enough energy to run indefinitely through your worst-case season while maintaining enough battery reserve to survive multiple consecutive cloudy days.

Step-by-Step Sizing Process

Step 1: Determine Daily Energy Consumption

From the Current Draw page: a typical LoRa repeater consumes approximately 2.22 Wh/day (25 mA average at 3.7V over 24 hours). Use your actual measured value if available.

Step 2: Find Worst-Case Peak Sun Hours

Peak sun hours (PSH) vary by location and season. Use the December value for year-round reliability in the northern hemisphere. Look up your location on the NREL PVWatts calculator or use these reference values:

Location	December PSH	Annual Average PSH
North Dakota (46°N)	2.5 h/day	4.5 h/day
Minnesota (45°N)	2.8 h/day	4.6 h/day
Texas (30°N)	4.5 h/day	5.8 h/day
Pacific Northwest (47°N)	1.5 h/day	4.2 h/day
Florida (28°N)	4.8 h/day	5.5 h/day

Step 3: Calculate Required Panel Size

Panel size (W) = Daily energy (Wh) ÷ (PSH × efficiency factor)

Use efficiency factor 0.70 to account for panel temperature, wiring losses, and charge controller losses.

Example (North Dakota repeater):
Panel = 2.22 Wh ÷ (2.5h × 0.70) = 2.22 ÷ 1.75 = **1.27W minimum**

A 6W panel provides 4.7× the minimum required - a comfortable margin that accounts for snow shading, panel degradation, and future firmware changes that may increase power use.

Step 4: Calculate Battery Reserve

Battery capacity (Wh) = Daily energy × Reserve days ÷ Usable fraction

- Reserve days: 3 days for most locations; 5 - 7 days for high-latitude winter deployments
- Usable fraction: 0.80 for Li-ion (discharge to 20% to preserve cell life); 0.90 for LiFePO4

Example (3-day reserve, Li-ion):
Battery = 2.22 × 3 ÷ 0.80 = **8.33 Wh minimum**

A single 3500mAh 18650 cell = 3.5Ah × 3.7V = 12.95 Wh. This provides the required 3-day reserve with margin.

For 5-day reserve in cold climate with 50% cold-weather derate:
Battery = 2.22 × 5 ÷ 0.80 ÷ 0.50 = **27.75 Wh minimum**
→ Two 3500mAh 18650 cells in parallel = 25.9 Wh (marginally adequate); three cells = 38.85 Wh (comfortable)

Complete Sizing Example: North Dakota Year-Round Repeater

Parameter	Value
Node	Heltec V3, MeshCore Repeater
Average current draw	25 mA
Daily energy	2.22 Wh/day
Location	Fargo, ND (46.9°N)
December PSH	2.5 h/day
Panel required (minimum)	1.27W
Panel selected	6W 6V monocrystalline
Panel margin	4.7×
Battery reserve target	5 days (cold derate applied)
Battery required	27.75 Wh
Battery selected	2× Samsung 35E 18650 in parallel = 25.9 Wh (use 3 cells for full margin)
Charge controller	CN3791 MPPT
Total build cost	~$85 - $100

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