Choosing a Solar Panel for LoRa Nodes

Solar panel selection involves matching the panel's output to the node's energy needs while accounting for real-world efficiency losses, geographic location, and physical mounting constraints. This page covers panel technology, rating systems, derating factors, geographic sizing, and wiring configurations.

Panel Technologies

Technology	Efficiency Range	Temperature Coefficient	Low-Light Performance	Physical	Best Use Case
Monocrystalline silicon	17 - 22% typical (up to ~24% for premium cells)	−0.35% / °C above STC	Good	Rigid, glass-covered, aluminum frame	Fixed installations, roof/pole mounts
Polycrystalline silicon	15 - 18%	−0.40% / °C above STC	Good	Rigid, glass-covered, aluminum frame	Budget fixed installations
Amorphous silicon (thin-film)	6 - 8%	−0.20% / °C above STC	Excellent (diffuse light)	Flexible or glass, no frame	Curved surfaces, low-light climates
CIGS thin-film	12 - 14%	−0.32% / °C above STC	Very good	Flexible or rigid	Curved surfaces where efficiency matters

For most LoRa node deployments, monocrystalline panels are the correct choice. Their higher efficiency means a smaller, lighter panel for the same power output - important when mounting on a mast or in a small enclosure. Thin-film flexible panels are useful when the panel must conform to a curved surface (conduit mast, cylindrical enclosure) or when severe vibration makes rigid glass panels impractical.

Understanding Wp (Watt-Peak) Ratings

Panel power is rated in Watts-peak (Wp) at Standard Test Conditions (STC): 1000 W/m² irradiance, 25 °C cell temperature, AM 1.5 spectrum. Real-world conditions deviate from STC in several important ways:

Real-World Adjustment Factors

Most rows below are losses (values below 1.0). One row — spectral mismatch in overcast — can slightly exceed 1.0 for amorphous panels (a small gain, not a loss). Do not blindly multiply every row together as if they were all losses; apply the spectral-mismatch row only to the panel technology it describes.

Adjustment Factor	Typical Value	Explanation
Temperature (hot day)	0.80 - 0.90	Cell temp in direct sun reaches 50 - 75 °C. Monocrystalline loses ~0.35%/°C above 25 °C. At 60 °C: 1 − (35 × 0.0035) = 0.878.
Dirt / dust / pollen	0.90 - 0.97	Uncleaned outdoor panel loses 3 - 10% annually. Clean panels every 6 - 12 months.
Wiring and connection losses	0.97 - 0.99	Resistance in MC4 connectors and cable runs. Use AWG 10 - 12 for runs over 5 m.
Charge controller harvest	0.65 - 0.97	This is the fraction of available panel energy delivered to the battery, not the controller's own conversion efficiency. PWM ties the panel to battery voltage, so a 18 V (12 V-nominal) panel charging a 13 V battery delivers roughly 65 - 75% of its rated energy — the mismatch is the loss, not the controller. MPPT tracks the panel's maximum-power point and delivers ~93 - 97%, recovering more when panel Vmp is well above battery voltage and in cold or low light. See Charge Controllers page.
Partial shading	0.50 - 1.00	Even 5% shadow on a cell in a string can reduce total output by 50%+ (bypass diodes mitigate but don't eliminate).
Spectral mismatch (overcast) — can exceed 1.0	1.0 - 1.05 for amorphous; ~0.95 for mono	A gain, not a loss, for amorphous: amorphous panels outperform mono in overcast because the diffuse-light spectrum favors their bandgap. Apply only to the matching panel technology.

Adjustment Factor	Typical Value	Explanation
Combined typical derating (MPPT, clean, no shade)	**0.70 - 0.80**	Use 0.75 as a conservative planning factor

Peak Sun Hours by US Region

Peak sun hours (PSH) is the equivalent number of hours per day at 1000 W/m² irradiance that delivers the same daily energy as the actual variable irradiance. It is the single most important geographic variable in panel sizing.

Region	Example Cities	Annual Avg PSH	Winter Worst-Month PSH
Southwest Desert	Phoenix, Las Vegas, El Paso	6.0 - 7.0	4.5 - 5.5
Mountain West	Denver, Salt Lake City, Albuquerque	5.5 - 6.5	3.5 - 4.5
Southeast	Miami, Atlanta, Dallas	5.0 - 6.0	4.0 - 5.0
Midwest / Great Plains	Kansas City, Minneapolis, Chicago	4.5 - 5.5	2.5 - 3.5
Mid-Atlantic / Northeast	NYC, Philadelphia, Boston	4.0 - 4.8	2.0 - 3.0
Pacific Northwest	Seattle, Portland, Eugene	3.5 - 4.2	1.5 - 2.5 (Seattle worst-month ~1.5)
Alaska (Anchorage)	Anchorage	3.0 - 4.0	0.5 - 1.5

Always size for the **worst-month PSH**, not the annual average, to ensure year-round operation. Use a single worst-month PSH value per location across the whole book; the values here are representative and should be confirmed against NREL PVWatts for your exact site.

Panel Sizing Calculation

```
Required_Wp = Daily_Wh / (PSH_worst_month × overall_derating)

Example: 5.75 Wh/day node, Seattle (1.5 PSH worst-month winter), MPPT controller (0.95), other c
 Combined derating = 0.95 × 0.85 = 0.808
 Required_Wp = 5.75 / (1.5 × 0.808) = 5.75 / 1.212 = 4.74 Wp → use a 5 Wp panel (sized for the w
```

Panel Sizing by Latitude (Rule of Thumb)

Latitude (°N)	Panel Wp Required per 1 Wh/day node load	Notes
25 - 30° (South Florida, Texas)	0.5 - 0.7 Wp	Year-round high sun
30 - 37° (Southeast, Southwest)	0.6 - 0.9 Wp	Good solar resource
37 - 42° (Mid-Atlantic, Midwest)	0.9 - 1.3 Wp	Moderate winter derating
42 - 48° (New England, Northwest)	1.3 - 2.0 Wp	Poor winter sun
48 - 65° (Northern US, Alaska)	2.0 - 5.0 Wp	Size for worst month or use large battery

Wiring: 5 V USB Charging vs 12 V Systems

5 V USB Charging (small panels, direct LiPo charging)

Panels rated 5 - 6 V open-circuit (e.g., 0.5 - 2 W "USB solar panels") are designed to pair with TP4056 or CN3791 LiPo charger ICs. These work only in full sun - the panel voltage drops below the charger's minimum input at partial cloud cover. Acceptable for *supplemental* trickle charging of small nodes but not reliable primary power. Note neither the TP4056 nor the CN3791 has a low-temperature charge cutoff, so for cold-climate builds add a BMS or charge controller with low-temp protection.

12 V Nominal Systems

Panels rated 18 V open-circuit (12 V nominal, e.g., 10 W, 20 W, 40 W monocrystalline) are the standard for serious solar deployments. These pair with a dedicated charge controller (PWM or MPPT) that regulates voltage down to the battery charge voltage. MC4 connectors are the industry standard for these panels.

Series vs Parallel Configuration

Configuration	Effect on Voltage	Effect on Current	When to Use
Series (panels in series)	Voltages add (2× 18 V = 36 V)	Current stays same	Higher voltage charge controllers; longer cable runs (less current = thinner wire)
Parallel (panels in parallel)	Voltage stays same	Currents add (2× 5 A = 10 A)	Same voltage system but need more current; partial shading (each panel has independent MPPT)

For small LoRa deployments (5 - 40 Wp), a single panel in direct connection to a 12 V charge controller is the simplest and most reliable approach.

Recommended Panels for LoRa Deployments

Prices below are approximate and volatile, as of 2026-06-08; confirm against a current listing before buying.

Panel	Power	Dimensions	Best For	Approximate Cost
Voltaic P110 (monocrystalline)	2 W, 6 V	132 × 91 mm	nRF52840 trickle charge, USB-C output	$25
Newpowa NPA10-12MBK (mono)	10 W, 12 V nominal	340 × 235 mm	ESP32 nodes, primary solar	$20 - 25
Renogy RNG-100D-SS (mono, compact)	100 W, 12 V nominal	~1062 × 531 mm	Pi gateway installations	$85 - 100
Flexible mono ~50 W (verify SKU/datasheet)	~50 W, 12 V nominal	per datasheet	Curved mast mounting, marine	confirm current price
Flexible CIGS ~30 W (verify SKU/datasheet)	~30 W, 12 V nominal	per datasheet	Curved enclosures, portable	confirm current price

---

Revision #3
Created 2026-05-03 05:39:19 UTC by Mesh America Admin
Updated 2026-06-08 22:54:36 UTC by Mesh America Admin