Why does my solar node keep dying at night?

Diagnosing Night Drain

If your solar node runs fine during daylight but goes offline overnight, you have one of three problems: undersized battery, incorrect charge controller settings, or excessive power draw.

Step 1: Verify Actual Battery Capacity

First, measure what you actually have. LiPo and LiFePO4 batteries are frequently sold at optimistic ratings. A "5000 mAh" LiPo from an unknown manufacturer may test at 3000-3500 mAh in practice.

Test: Fully charge the battery, disconnect solar, and measure how long the node runs. Node runtime (hours) × current draw (mA) = actual battery capacity (mAh).

Step 2: Calculate Required Overnight Capacity

In winter at high latitudes, "night" can mean 16+ hours of darkness. Your battery must cover: hours of darkness × node current draw.

Example: 14 hours dark, 12 mA draw = 168 mAh minimum. On paper even a small 1000 mAh battery covers this. But this bare calculation is optimistic: it ignores depth-of-discharge limits (you should not regularly drain a cell to empty), cold-temperature capacity loss (a 1000 mAh cell delivers substantially less at -10°C), and multi-day low-/no-sun events. For emergency-grade reliability, oversize the battery well beyond the textbook minimum and account for cold-weather

derating and several consecutive cloudy days. If your node dies overnight, either the battery is not fully charging during the day or the current draw is much higher than expected.

Step 3: Verify the Battery is Actually Charging

Check the charge controller status LED or voltage output during the day. Common issues:

- **Panel undersized for the season** - A panel just barely adequate in summer may not fully recharge the battery on short winter days. The battery reaches discharge before it can recover overnight.
- **Panel partially shaded** - Even partial shading (one corner of the panel) can sharply reduce output - often on the order of 50-80%, though the exact loss depends heavily on how the cells are wired in series and whether the panel has bypass diodes. Because series-connected cells are limited by the most-shaded cell, shading even a small area can disproportionately cut output. Inspect during the time of day the sun is lowest (winter morning/afternoon).
- **LVD set too high** - If the charge controller's Low Voltage Disconnect threshold is set above the battery's actual minimum, it cuts power while charge still remains. A conservative LVD that protects pack longevity is 3.0V/cell for LiFePO4 (12.0V for 4S) and 3.0-3.2V/cell for LiPo; the absolute safe-discharge floor is lower (~2.5V/cell for LiFePO4, ~2.5-3.0V/cell for LiPo). Always defer to your specific cell/pack datasheet for the recommended cutoff.
- **Charge controller in wrong battery mode** - Lithium chemistries need a matching lithium charge profile. A controller configured for lead acid uses different absorption/float voltages and cutoffs, which can overcharge a LiPo or leave a LiFePO4 pack undercharged. Verify the battery type setting matches your battery chemistry, and check the actual charge voltages against your cell datasheet.

Step 4: Reduce Power Draw

If the battery and panel are correctly sized but the node still dies, attack the power draw. The savings below are approximate and vary with board, configuration, and firmware version; measure your own node where possible:

- Disable OLED display (saves roughly 15-20 mA on a typical small OLED, depending on brightness and how many pixels are lit)
- Disable Bluetooth (saves roughly 5-15 mA on ESP32, depending on advertising interval)
- Switch from ESP32 to nRF52840 board (saves roughly 30-50 mA average, depending heavily on configuration and sleep behavior)

- Reduce TX power to minimum needed. Note: lowering TX power reduces transmit-state energy, but not in a clean "halve the current per 3 dB" relationship - a 3 dB cut halves the radiated RF power, but PA efficiency is non-linear and the supply current does not scale 1:1. For a typical low-duty-cycle mesh node, transmit is only a small fraction of average draw, so the overnight benefit of backing off TX power is usually modest compared with display, Bluetooth, and idle draw.

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