

# Solar Repeater Build

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# Parts List & Overview

## Parts List & Overview

A DIY solar repeater can be built for \$80 - \$130 using commodity parts. This build creates a weatherproof, autonomous LoRa mesh repeater powered entirely by solar with enough battery reserve to ride through multiple cloudy days.

## Full Parts List

Component	Recommended Option	Cost	Notes
LoRa node	Heltec V3 or Heltec V4	\$20 - \$35	V4 preferred for solar builds (built-in solar input); V3 works with external charge controller
Alternative node	RAK WisBlock (RAK4631 + RAK19007)	~\$35	Lower power draw; more expensive but nRF52840 runs cooler
Antenna	5 dBi fiberglass omni	\$12 - \$20	RAK 5.8 dBi fiberglass is a community favourite at \$30 - \$40
Coax pigtail	SMA pigtail, 15 - 30cm	\$3 - \$5	Match connector type to your node (SMA or RP-SMA)
Solar panel	6W 6V monocrystalline	\$15 - \$20	6V panel works directly with TP4056 or CN3791
Battery	Samsung 35E 18650, 3500mAh	\$10	Buy from reputable source - most Amazon 18650s are counterfeit
Charge controller	CN3791 MPPT module	\$3 - \$5	More efficient than TP4056; better for variable solar; supports 6V input
Enclosure	Zulkit IP65 150×100×70mm	\$12	Hinged lid; 2 cable glands included
Cable glands	PG7 (thin cables) or PG9 (coax)	\$3 - \$5	For antenna pigtail and solar wires entering enclosure
Mounting hardware	U-bolt + hose clamps or pole mount	\$5 - \$8	Stainless steel preferred for outdoor longevity

Component	Recommended Option	Cost	Notes
Desiccant	Silica gel packs 5g	\$2	Place inside enclosure; replace annually
Sealant & misc	Silicone sealant, zip ties, heat shrink	\$5	Seal cable glands and any penetrations

**Total estimated cost: \$80 - \$130** depending on component choices.

## Power Budget

Before building, verify the solar panel and battery are adequately sized for your location and expected traffic.

Parameter	Value	Notes
Average current draw	20 - 40 mA	Typical repeater with moderate traffic
Daily energy use	~2.22 Wh/day	25mA × 3.7V × 24h
6W panel, 2.5 peak sun hours, 70% efficiency	10.5 Wh/day	4.7× margin over consumption - adequate for year-round North Dakota
Single 3500mAh 18650 capacity	12.95 Wh	3500mAh × 3.7V; covers ~5.8 days with no solar

## Build Overview

The build has four main stages:

1. **Flash firmware** - flash MeshCore Repeater variant onto the node before sealing it in the enclosure
2. **Wire the power system** - solar panel → charge controller → battery → node
3. **Weatherproof the enclosure** - cable glands, sealant, desiccant
4. **Mount and aim** - antenna orientation, solar panel angle

See the [Assembly Guide](#) page for step-by-step wiring and mounting details.

# Assembly Guide

## Assembly Guide

This guide assumes you have all parts from the Parts List & Overview page and have already flashed MeshCore Repeater firmware onto the node.

### Step 1: Test Before Sealing

Before putting anything in the enclosure, bench-test the complete power chain:

1. Connect the charge controller to a bench power supply set to 6V (simulating the solar panel).
2. Connect a battery to the charge controller output.
3. Power the node from the battery via the appropriate connector (JST or 18650 contacts).
4. Verify the node boots, joins the mesh, and can be configured. Fix any issues now before sealing.

### Step 2: Prepare the Enclosure

1. Drill or punch holes for cable glands. Typical layout: one PG9 gland for the antenna pigtail, one PG7 gland for the solar wires. Place glands on the bottom or sides of the enclosure - never on top where water can pool.
2. Thread cable glands into holes. Tighten finger-tight plus a quarter turn with a wrench. Do not overtighten or you will crack the enclosure.
3. Route the antenna coax pigtail through a PG9 gland. Leave enough slack inside to connect to the node. Tighten the gland around the cable until it grips firmly.
4. Route solar panel wires through a PG7 gland.

### Step 3: Wire the Power System

Wiring order: Solar panel → Charge controller input → Charge controller battery output → Battery → Charge controller load output → Node.

1. Connect the solar panel positive and negative wires to the IN+ and IN - terminals of the CN3791 or TP4056 charge controller.
2. Connect the battery to the BAT+ and BAT - terminals.
3. The node is powered from the charge controller load output (OUT+ / OUT - ). If using the Heltec V4 with its built-in solar input, connect the solar panel directly to the solar input

and skip the external charge controller - the V4 handles charging internally.

4. Use appropriately rated wire. 24 AWG is adequate for the current levels involved (under 500mA).
5. Insulate all connections with heat shrink. Exposed connections inside an enclosure can still short against the metal walls of a die-cast box.

## Step 4: Mount Components Inside the Enclosure

1. Use double-sided foam tape or small cable ties through holes in the enclosure wall to secure the charge controller and node. Hot glue is acceptable but makes future servicing harder.
2. Place the desiccant pack in a corner of the enclosure where it will not interfere with components or lid closure.
3. Ensure the node's USB port is accessible from the enclosure lid or a gland - you may need to access it for firmware updates.

## Step 5: Seal and Close

1. Apply a thin bead of silicone sealant around the inside edge of each cable gland nut where the cable exits. This is belt-and-suspenders weatherproofing on top of the gland's O-ring.
2. Verify the enclosure lid gasket is seated properly. Close and latch the lid.
3. Check that no wires are pinched by the lid.

## Step 6: Mount the Enclosure

1. Mount at the highest practical point with clear line of sight to the mesh coverage area. For most community nodes: rooftop, eave, fence post, or tree mount.
2. Orient the antenna vertically. A vertical antenna radiates horizontally in all directions; tilting it reduces coverage.
3. Mount the solar panel facing south (northern hemisphere) at an angle of 55 - 60° from horizontal for year-round performance in northern US/Canada. A shallower angle (30 - 45°) favours summer production; steeper favours winter.
4. Route solar panel wires so water cannot follow them into the enclosure. A drip loop - a downward U in the wire before it enters the gland - prevents capillary wicking.

## Step 7: Verify Operation

1. In the MeshCore app, confirm the repeater appears in the node list and is relaying messages.
2. Check battery voltage via the app or CLI. A full 18650 reads ~4.2V; the CN3791/TP4056 will stop charging at 4.2V.
3. During daylight, verify solar charging is active (charge controller LED or app telemetry).

# Cold Weather & Winter Operation

## Cold Weather & Winter Operation

LoRa mesh nodes can operate year-round in cold climates, but cold weather affects battery chemistry, solar production, and hardware longevity. Plan for these factors before deployment.

### Battery Chemistry in Cold

Chemistry	Cold Performance	Recommendation
LiPo (Li-ion polymer)	Significant capacity loss below 0°C; can be damaged by charging below 0°C	Avoid for unheated outdoor enclosures in cold climates
Li-ion 18650 (standard)	30 - 40% capacity loss at - 20°C; charging below 0°C degrades cells	Acceptable with a charge controller that limits charge at low temps
LiFePO4	~50% capacity loss at - 40°F ( - 40°C), but tolerates the temperature without damage; can be charged down to - 20°C	<b>Strongly preferred for outdoor cold-climate deployments</b>

Plan for LiFePO4 batteries to deliver only 50% of their rated capacity during extreme cold snaps. Size your battery bank accordingly - if you need 3 days of reserve at typical temperatures, plan for 6 days of capacity with LiFePO4 in a cold-climate installation.

### Solar Production in Winter

Winter solar production drops for two reasons: shorter days and lower sun angle. In North Dakota, December peak sun hours drop to approximately 2.5 hours/day (vs. 5 - 6 hours in summer). Counterintuitively, cold temperatures slightly *increase* solar panel efficiency compared to hot summer operation.

**Panel angle for northern US/Canada:** Tilt to 55 - 60° from horizontal for year-round optimisation. This sacrifices some summer production to improve winter output when it matters most.

**Snow accumulation:** A steep panel angle (55 - 60°) helps snow slide off naturally. If the panel will be frequently snow-covered, size your battery reserve for 5 - 7 days of zero-solar operation rather

than 3 days.

## Condensation and Moisture

Temperature swings cause moisture to condense inside enclosures even when sealed. Desiccant packs absorb this moisture but become saturated over time. Replace desiccant annually, or use indicating silica gel that changes colour when saturated.

Rechargeable desiccant canisters (such as Eva-Dry E-333) can be recharged by heating in an oven, making annual maintenance easier.

## Enclosure Selection for Cold

- Avoid enclosures with rubber gaskets that harden and crack at - 40°C. EPDM gaskets remain flexible in cold; standard neoprene does not.
- Junction boxes rated IP67 or IP68 provide better moisture sealing than IP65 when subjected to repeated freeze-thaw cycles.
- Ammo cans with EPDM gasket replacements are a community favourite for cold climates - cheap, robust, and easy to seal.

## Sizing Example: North Dakota December

Parameter	Value
Daily energy consumption	2.22 Wh/day (typical repeater)
Solar panel	6W monocrystalline
Peak sun hours (December, ND)	2.5 hours/day
Panel efficiency factor	0.70
Daily solar harvest	$6W \times 2.5h \times 0.70 = 10.5 \text{ Wh/day}$
Margin over consumption	4.7× - adequate even accounting for snow shading
Battery for 3-day reserve (LiFePO4, 50% derate)	$2.22 \times 3 \div 0.5 = 13.3 \text{ Wh minimum} \rightarrow$ single 3500mAh 18650 (12.95 Wh) marginal; two cells strongly recommended

## Operational Tips

- Check battery voltage remotely via the MeshCore app before and after cold snaps.
- If the node goes offline in winter, low battery from insufficient solar or cold-degraded capacity is the most common cause - not hardware failure.
- Black or dark-coloured enclosures absorb solar heat and can keep the interior a few degrees warmer than ambient - useful in extreme cold.

- Do not use standard lithium batteries that are not rated for low-temperature charging in unheated enclosures. Charging a lithium cell below 0°C causes permanent capacity loss from lithium plating.