Cold Weather & Winter Operation

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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	**Strongly preferred for outdoor cold-climate deployments**

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 × 2.5h × 0.70 = 10.5 Wh/day
Margin over consumption	4.7× - adequate even accounting for snow shading
Battery for 3-day reserve (LiFePO4, 50% derate)	2.22 × 3 ÷ 0.5 = 13.3 Wh minimum → 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.

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