Solar Panel Mounting and Orientation

The mechanical installation of a solar panel is as important as the panel selection itself. A correctly sized panel pointed in the wrong direction, partially shaded, or insufficiently secured will fail to meet its energy budget. This page covers orientation rules, mounting hardware options, shading avoidance, and special-purpose installations.

South-Facing Tilt: The Fundamental Rule

In the Northern Hemisphere, solar panels produce maximum annual energy when facing **true south** (azimuth 180°) and tilted at an angle approximately equal to the installation latitude. This is not magnetic south - use a compass corrected for magnetic declination or use a sun-path tool (NREL's PVWatts, Solargis) to confirm true south orientation at your specific location. **This page is the canonical reference for panel tilt and orientation in this book.** The single rule of thumb used throughout: **optimal fixed tilt = latitude; winter-optimized tilt = latitude + 15°.** The example tilt values in the table below are approximate and should be confirmed against NREL PVWatts output for your specific site.

Latitude (°N)	Optimal Fixed Tilt	Winter-Optimized Tilt	Example Locations
25°	25°	~40°	Miami FL, Key West FL
30°	30°	~45°	Houston TX, Jacksonville FL
35°	35°	~50°	Los Angeles CA, Memphis TN
40°	40°	~55°	Denver CO, Columbus OH, NYC
45°	45°	~60°	Minneapolis MN, Portland OR
47°	47°	~62°	Seattle WA
61°	~58°	~73°	Anchorage AK

Values are approximate (fixed ≈ latitude, winter ≈ latitude + 15°) and should be confirmed against NREL PVWatts for the exact location. Above roughly 55°N the annual optimum is typically a few degrees *below* latitude, which is why Anchorage's fixed value is shown slightly under its latitude.

For fixed-tilt installations in climates with significant winter operation (Pacific NW, New England, Mountain states), set the panel at approximately latitude + 15° to capture more low winter sun. This sacrifices some summer production but improves the worst-month (winter) performance critical for battery sizing.

A ±15° deviation from true south reduces annual yield by only 2 - 3%. A ±30° deviation reduces it by about 7 - 8%. East or west orientations (90° from south) reduce yield by approximately 20%.

Fixed Tilt vs Seasonal Adjustment

Single-axis seasonal adjustment (adjusting tilt twice a year - summer and winter) improves annual yield by 5 - 10% compared to a fixed optimal tilt. For most unattended LoRa deployments, this tradeoff is not worth the maintenance visit. The exception is a high-latitude deployment (above 45°N) where winter sun angles are very low and a steep winter tilt meaningfully improves worst-month performance.

Mounting Hardware Options

Pole and Mast Mounts

Mast mounting is ideal for LoRa repeaters that are already on a mast or tripod. The same structure that supports the LoRa antenna can support the solar panel, reducing site footprint. Two common approaches:

- **Side-of-pole (SOP) mount:** A steel bracket clamps to the mast with U-bolts and holds the panel at an adjustable tilt. Generic U-bolt side-of-pole brackets (for example the Renogy Solar Panel Side of Pole Mount, which fits panels up to ~100 W) are widely available for roughly $15 - 30 (prices as of 2026-06-08). The panel faces south and the bracket tilt is fixed at installation.
- **Top-of-pole mount:** Panel mounts above the mast on a swiveling head. Larger capacity (40 - 100 Wp panels), more wind load. Several manufacturers (Unirac, IronRidge, MT Solar, Tamarack) make pole mounts; for a single small panel, Renogy's single-panel pole mount (rated for panels up to ~100 W, roughly $40 - 60 as of 2026-06-08) is a common choice. Confirm the mount's rated panel size and the current price before purchasing.

J-Mounts (Roof Rafter Mounts)

J-mounts bolt through the roof into rafters and hold the panel parallel to the roof surface, adding 2 - 4 inches of standoff for airflow. IronRidge, Unirac, and Quick Mount PV are the main suppliers. J-mounts fix the panel tilt to the roof pitch - generally acceptable for slopes between roughly 15° and 40° facing south. Note that on shallow slopes the panel sits well below latitude tilt, so annual yield is reduced compared with a latitude-tilt mount.

Flush Roof Brackets

For panels mounted flat on a low-slope roof or equipment enclosure lid, industrial hook-and-loop adhesive mounts (for example VELCRO Brand Industrial Strength or 3M VHB tape) or through-bolted HDPE brackets work for small panels up to about 40 Wp. Adequate ventilation between panel and surface is critical - at a cell temperature of 75 °C (about 50 °C above the 25 °C STC rating), a panel loses roughly 15 - 20% of its rated Wp, assuming a typical temperature coefficient of about −0.35 to −0.40%/°C.

Ground-Mount Frames

For larger gateway installations (100 - 400 Wp), commercial aluminum ground-mount frames (for example IronRidge's ground-mount / Osprey PowerRack line, or kits from MT Solar or Tamarack) provide adjustable tilt and, with proper engineering, wind resistance up to about 140 mph. The actual wind rating depends entirely on the specific anchoring, soil, and panel - do not assume the frame alone guarantees a high-wind rating; engineer the foundation for your site. Concrete ballast blocks or driven ground screws provide the foundation.

Keeping Panels Shadow-Free Throughout the Day

Shade is the single largest cause of underperforming solar nodes. A shadow covering just one cell in a 36-cell string drops the entire string's output by 50 - 70% (partial bypass diode protection reduces this but cannot eliminate it).

1. **Use the Sun Surveyor app or SOLMETRIC SunEye** to measure shade at the proposed mounting location at both 9 AM and 3 PM local solar time on the worst day (December 21). Any obstruction that casts shadow during these hours will significantly reduce winter output.

2. Trees grow. A tree 30 ft away that doesn't shade the panel today may shade it in 5 years. Add 30% to the estimated shadow cone radius when evaluating obstructions.
3. Nearby LoRa antennas, lightning rods, conduit runs, and fence posts can all cast thin shadows that track across the panel during the day. Route everything above or well to the side of the panel.

Clearing Snow

In snow climates, steep tilt angles (above 45°) allow snow to slide off naturally. Panels tilted below 30° will accumulate snow and may be buried for days. Solutions:

- Set winter tilt to 60° or greater if the installation allows adjustment.
- Mount the bottom edge of the panel at least 18 inches above the expected snow depth to prevent burial.
- Do not scrape panels with metal scrapers - use a soft brush or wait for natural sliding (the panel warms as soon as any light penetrates the snow cover).
- Black-frame monocrystalline panels absorb more heat and shed snow faster than white-back polycrystalline panels.

Bird Deterrents

Bird droppings on panels cause significant localised shading. Common solutions:

- **Bird wire / netting:** Stainless steel spikes (Daddi Long Legs, Bird-B-Gone) or polycarbonate mesh installed under and around the panel perimeter. Do not run wires over the glass surface.
- **Owl decoys:** Marginally effective for the first few weeks, then ignored.
- Regular cleaning with deionised water and a soft sponge removes existing droppings. A Rain-X solar panel coating reduces adhesion.

Marine and Boat Mounting for Floating Nodes

Floating LoRa nodes on buoys, boats, or floating platforms require stainless steel or anodized aluminum hardware throughout. Standard steel J-mounts will rust within one season in saltwater. Key requirements:

- All fasteners: 316 stainless steel (not 304).

- Tilt adjustment: Bobstay-style adjustable bracket allows panel to be angled away from most wave wash directions.
- Strain relief: Marine-grade cable glands (Blue Sea, Wiley) with EPDM seals. Cables must have enough slack to accommodate platform motion without straining MC4 connectors.
- Anti-corrosion treatment: Corrosion-X or Boeshield T-9 applied to all metal-to-metal contacts and terminal blocks annually.
- Prefer a panel with an IP67-rated, sealed junction box and conformal-coated connections for salt-spray service. Most quality terrestrial panels already use IP67 junction boxes, but in continuous salt-spray conditions confirm the J-box seal rating rather than relying on an informal "marine grade" label, which is not a formal standard.

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