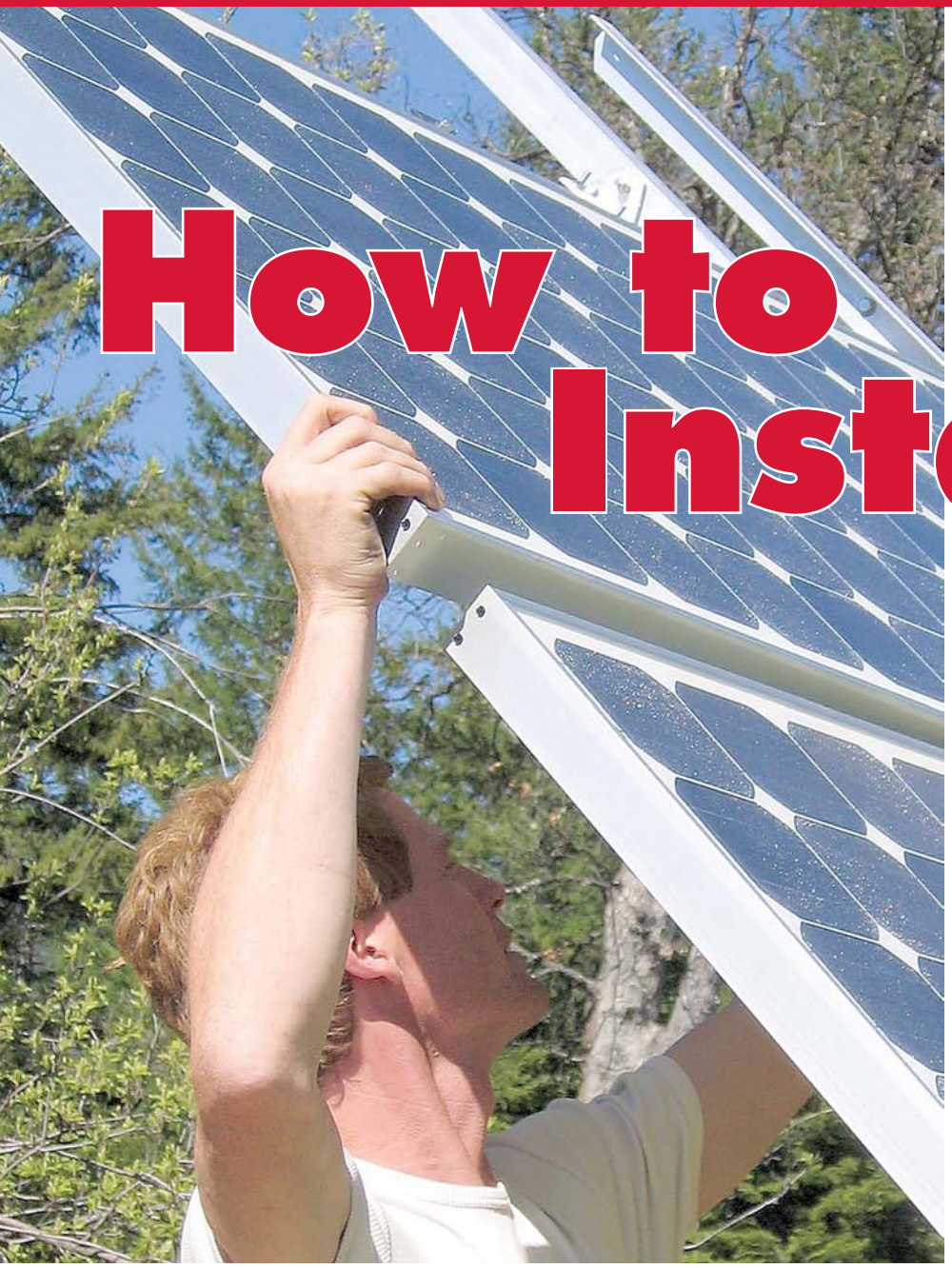

How to Install...

A Pole-Mounted Solar-Electric Array: Part 2

Joe Schwartz

Pole-mounted solar-electric (photovoltaic; PV) arrays are a great option for many sites. You don't need to worry about the orientation or angle of an existing roof, or about roof penetrations. Pole mounts allow easy, manual adjustment of the array's tilt angle, or you can choose automatic tracking mounts to optimize energy production. They provide great air circulation to keep PV temperature down and power output up during warm weather, and make clearing snow off the array a simple task in wintry climes.

Last issue, I covered the groundwork—setting the pole. This time, I'll walk you through each step of the array assembly and wiring. Even if the equipment you use is different than mine, the information will be a useful installation guide for your own pole-mounted PV array.

1 Assemble the Mount

Most pole mounts are designed and manufactured for specific PV modules. When you contact your mount supplier, they'll need to know the brand, model, and quantity of PV modules planned for your system. Each mount will come with step-by-step assembly instructions. Getting your mount assembled on the top of the pole is as easy as following the directions, but I have a couple of tips that will help simplify the job.

First, don't fully tighten the bolts that fasten the PV-mounting rails to the rest of the structure until all of the modules are in place. This will give you some wiggle room if any of the predrilled mounting holes in the rack are a little off. Don't forget to fully secure the rail hardware once the PVs are in place.

Second, pole mounts are designed to allow seasonal adjustment of the tilt angle of the array. While you're installing the array, it can be laid flat, at close to vertical, or anywhere in between. In general, I like to set the angle of the array at about 45 degrees. This limits the amount of uncomfortable overhead work. If the array is mounted on a tall pole, securing it in a horizontal position will make the whole array easier to reach.


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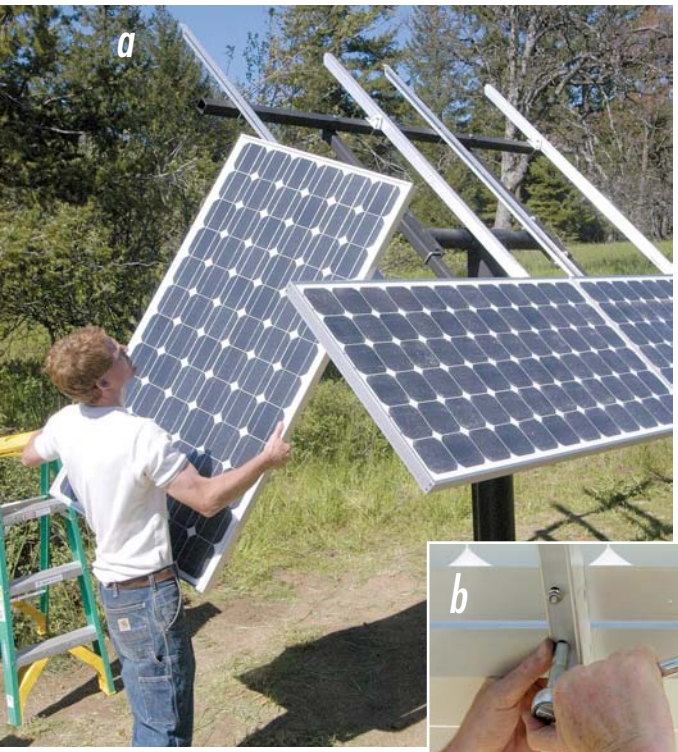
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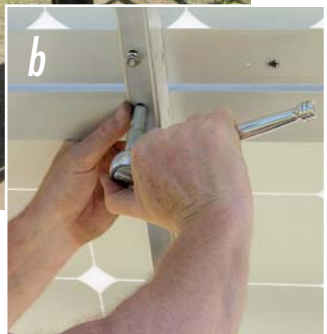
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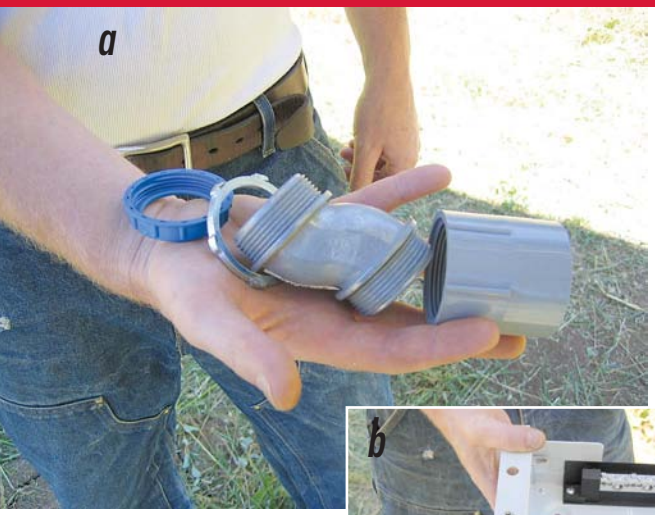
2 Mount the PVs

Once the rack is assembled, it's time to install the PVs. If you're assembling the array while it's fixed in a tilted position, install the bottom row of PVs first. Then you can rest the next row of modules on the first row while you're positioning them, which makes the job faster and easier.

The mounting hardware for the PVs will be included with the rack, not the modules. This hardware should be stainless steel to resist corrosion, and include either lock washers or lock nuts that will not loosen over time. It's easier to work with the mounting hardware if you insert the bolts through the module mounting holes from the inside of the PVs, and then through the rack. This gives you better clearance to get the washers and nuts in place.

An open-end wrench used in conjunction with a ratchet and socket (usually $^{7}/_{16}$ inch) will allow you to quickly fasten the PVs to the rack. If you have a big array, or several to install, a cordless drill fitted with a socket driver will definitely speed up the job. If you use this approach, make sure to set the driver's clutch to release before the hardware is overtightened. If you don't, you may snap off bolts.



3 Determine Combiner Box Conduit Fittings

The *National Electrical Code (NEC)* requires a dedicated breaker or fuse in line with each series string of PV modules (except with some high voltage inverters). To meet this code requirement, a combiner box is required in most pole-mounted array installations.

First, determine what conduit fittings you'll need to connect the combiner box to the conduit that runs up the pole. I typically run the conduit right against the pole. To make the transition from the conduit to the combiner box, you'll need a PVC female fitting, an offset, a nut, and a bushing.

Single-hole straps (clamps) are used to secure the conduit. Another channel and strapping system using Unistrut (not shown) is commonly used to secure the vertical length of conduit to the pole. This is a good approach, but requires a few more fittings.

4 Mount the Combiner Box

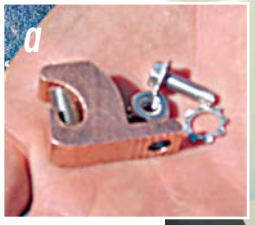
Attach the conduit fittings to the combiner box finger-tight, and position the assembly on the conduit (no glue yet). Grab a marker and a torpedo (short) level. Adjust the offset until the back of the combiner box rests evenly against the pole, and then level the box. Now that everything is in position, mark the location of the mounting holes on the pole itself.

Depending on the size of the pole and the combiner box you're using, the box's predrilled mounting holes may not be positioned where you need them. If this is the case, line it up where you want it, and mark the back of the combiner box to predrill custom mounting holes. Then mark the location of the new holes on the pole.

Use self-tapping screws to fasten the combiner box to the pole (I prefer square-drive screws). Even with self-tapping screws, pilot holes are necessary when mounting to steel pipe. Make sure to choose a drill bit that is slightly smaller than the screws you use. The curve of the pole will typically cause your pilot bit to drift off your mark, so use a center punch to make a starting point for the drill bit. This will ensure that everything lines up when you fasten the box to the pole.

Once your holes line up, apply PVC glue to the conduit, and slide the combiner box/fitting assembly into place. Wipe off any excess glue and drive the screws. I always neatly apply some high-quality 50-year silicone caulk over the screw heads, and seal any unused, predrilled mounting holes in the back of the box. Finally, use straps to secure the vertical conduit to the pole.

5 Install the Array Equipment-Ground Lugs



All PV arrays need to be properly grounded per the *NEC*. Pole-mounted PV array equipment-grounding systems have three main components—lugs that attach the ground wire to the PV module frames, the ground wire itself, and a ground rod driven into the earth at the base of the pole.

Lay-in lug kits, available from solar energy equipment resellers, are appropriate for long-lasting, corrosion-free connections between the ground wire and the module frame. Lay-in lugs are designed to accept wire from the side, so the hassle of feeding the ground wire through successive lugs is eliminated.

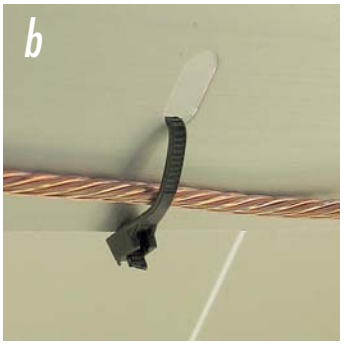
Lugs should be either bronze or stainless steel. They'll come with stainless mounting bolts or screws, and star washers that will cut through the anodizing on the module frame (ensuring a low-resistance connection). Low-cost aluminum lugs are not suitable, since the fastener will be exposed to weather in this application and corrosion will result.

Only the module grounding locations identified on the modules themselves should be used. Before you begin fastening the lugs to the module frames, plan the route the ground wire will run between each module, and then down to the combiner box. Use a cordless driver to fasten the lugs to the module frames.

6 Install the Array Equipment-Ground Wiring

Once the lugs are installed, it's time to run the ground wire from PV frame to PV frame, and then route it into the combiner box, where it will terminate at the box's equipment-ground lug. To ensure the lowest resistance electrical path, equipment-ground wire installed on PV arrays should be continuous.

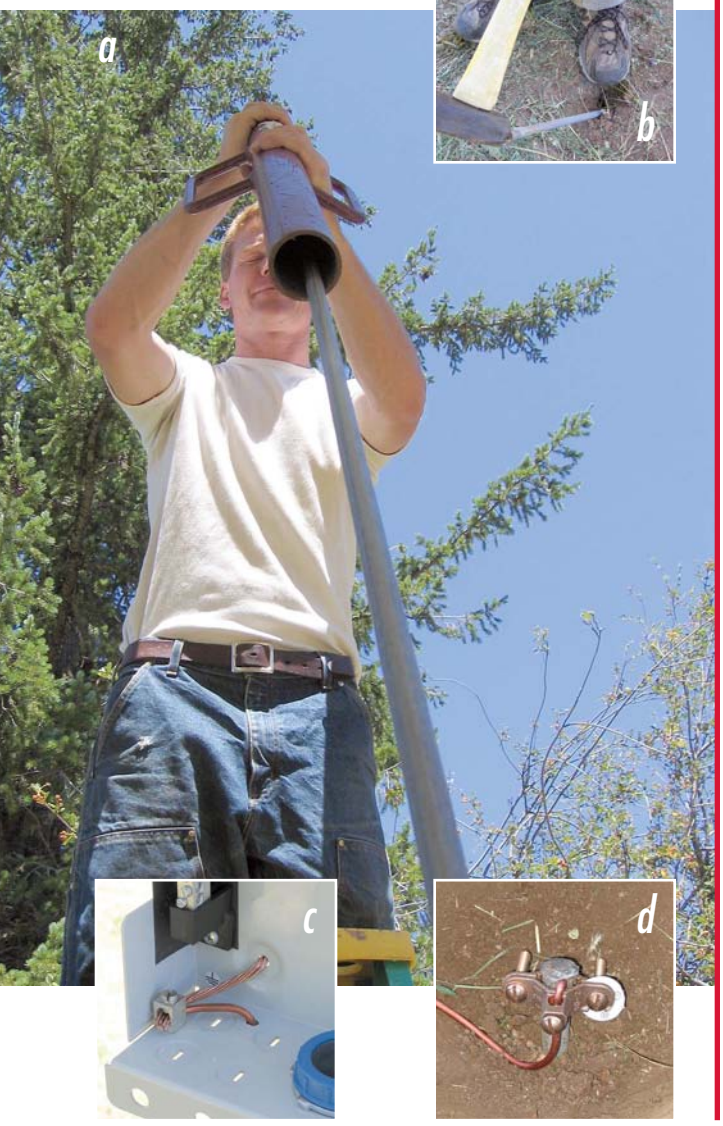
On the array, I always use #6 (13 mm^2) stranded, bare copper wire, which is more flexible than solid. Trying to bend #6 solid wire in the tight radiuses required when grounding module frames is not recommended. In some cases the *NEC* will allow smaller-gauge ground wire to be used, but I opt for #6 since it will better resist any physical damage.

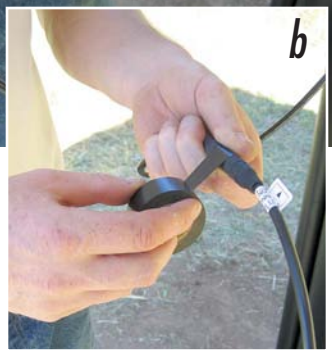


7 Install the Ground Rod & Wire

Next, pound a ground rod into the earth at the base of the pole, outside the edge of the concrete footing. Driving the ground rod at an angle can help you get it in all the way if bedrock is close to the surface.

Once the rod is driven, run #6 bare, solid, copper wire from the combiner box's ground lug, down along the vertical conduit, and then over to the ground rod. Where possible, I like to use a ground rod clamp approved for direct burial, completely bury the ground rod, and trench the ground wire in. This looks better, and won't trip people or animals if they pass by the base of the array.





8 Wire the PVs

When wiring the PVs, remember that they will generate electricity whenever the sun is shining, even in overcast conditions. So pay attention, and make sure you're qualified to get the job done right and safely. Some people even opt to cover the modules with an opaque material when wiring the array.

Almost all modern PV modules come with prewired, multicontact (MC) connectors. These connectors simply plug together, allowing fast installation and a low-resistance, weather-tight connection. MC connectors should be firmly pushed together and given about a quarter turn to make sure the seal is tight. Your system design will determine how many modules will be wired in series, and how many series strings your array will have. (See my article on wiring configurations for a PV array in *HP87*.)

Once the series strings are wired, the next step is to fully secure the wiring. All MC connectors should be either taped with high-quality electrical tape or sealed with heat-shrink tubing. While the connectors themselves are watertight, these methods will further weatherproof them, and provide some strain relief to keep them from being inadvertently disconnected. Finally, no PV wiring should be left hanging, since this looks sloppy and just invites trouble. Use UV-resistant (black) zip ties to secure the module wiring to the module frames or mount structure. Clips that attach to the module frame and hold the wires are available as well.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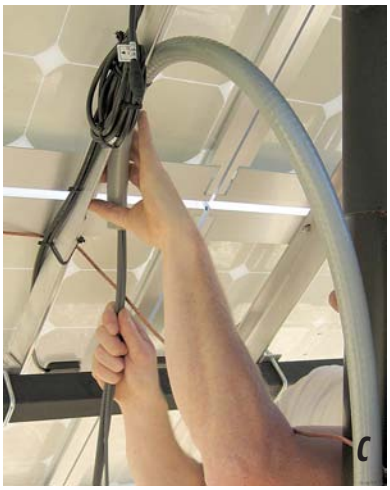
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9 Install the Home-Run Wiring

Your array will require an additional MC cable to run from each series string of PVs to the combiner box. Purchase extra lengths of pre-made, MC cable that have a female connector on one end and a male connector on the other. When cut in half, these cables will need to be long enough to reach from the PVs to the combiner box. This wire is referred to as a "home run."

The ends of the home-run wiring destined for the combiner box should be taped off and handled carefully to avoid shock hazard and electrical shorting. To keep polarity straight, positive leads should be taped with red electrical tape and negative leads with white.

While working with this wiring, the safest approach is to leave one of the home-run conductors of each series string open (disconnected) at the PV arrays until the home runs are in place and terminated in the combiner box.

I like to put the home-run wiring running down the pole and into the combiner box in nonmetallic, watertight, flexible conduit for extra physical protection. The PV end of the conduit will not have a fitting on it, so make sure to seal it with silicone caulk to keep water from running down the wiring and into the combiner box.

The flexible conduit can be secured to the pole using self-tapping screws with pilot holes, and heavy wall (HW) conduit straps. Finally, because pole mounts allow for seasonal adjustment for the tilt of the array, make sure to cut both the home-run wiring and flexible conduit to a length that will allow full adjustment of the array without placing any strain on the wiring.


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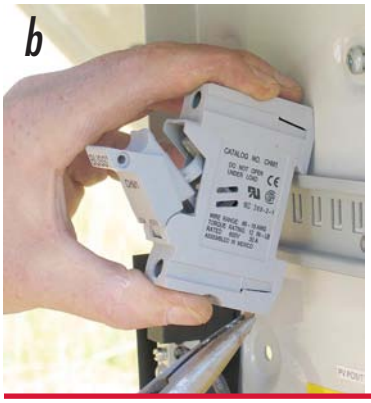
10 Wire the Array to the Combiner Box

Breakers should be in the off position (or fuses removed) during combiner box wiring. Positive PV array home runs will terminate at series breakers or fuses, and negative ones at the negative bus (combiner) bar. Use a torque wrench to fully tighten all electrical connections inside the combiner box to the manufacturer's specifications.

Once all the wiring in the combiner box is completed, double-check that the series breakers are in the off position, and then make the final connection in each series string's home-run wiring at the PV array. This strategy will ensure that you're not working with "hot" (energized) wiring during the installation. Use a digital multimeter to double-check that each series string's polarity is correct. The transmission wiring that runs between the array and the power room will also be terminated in the combiner box once it's pulled.



Done Deal

Once the pole is set and the concrete is cured, assembling and wiring a pole-mounted solar-electric array can be done in a single day, or over a leisurely weekend. One person can easily get the job done, but it's nice to have a second set of hands when assembling the rack and mounting the PVs.

If you want a solar-electric array, and your site is suitable for a pole mount, definitely consider it. Pole mounts are one of the most fun—and most productive—things you can plant in your backyard.

Access

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Fixed pole-mount manufacturers:

Direct Power & Water, 4000-B Vassar Dr. NE, Albuquerque, NM 87107 • 800-260-3792 or 505-889-3585 • Fax: 505-889-3548 • info@power-fab.com • www.power-fab.com

General Specialties, 206 N. 4th Ave., #200, Sandpoint, ID 83864 • 208-265-5244

UniRac Inc., 3201 University Blvd. SE, Ste. 110, Albuquerque, NM 87106 • 505-242-6411 • Fax: 505-242-6412 • contact@unirac.com • www.unirac.com

Zomeworks Corp., 1011 Sawmill Rd. NW, Albuquerque, NM 87104 • 800-279-6342 or 505-242-5354 • Fax: 505-243-5187 • zomework@zomeworks.com • www.zomeworks.com

Combiner box manufacturer:

OutBack Power Systems, 19009 62nd Ave. NE, Arlington, WA 98223 • 360-435-6030 • Fax: 360-435-6019 • sales@outbackpower.com • www.outbackpower.com