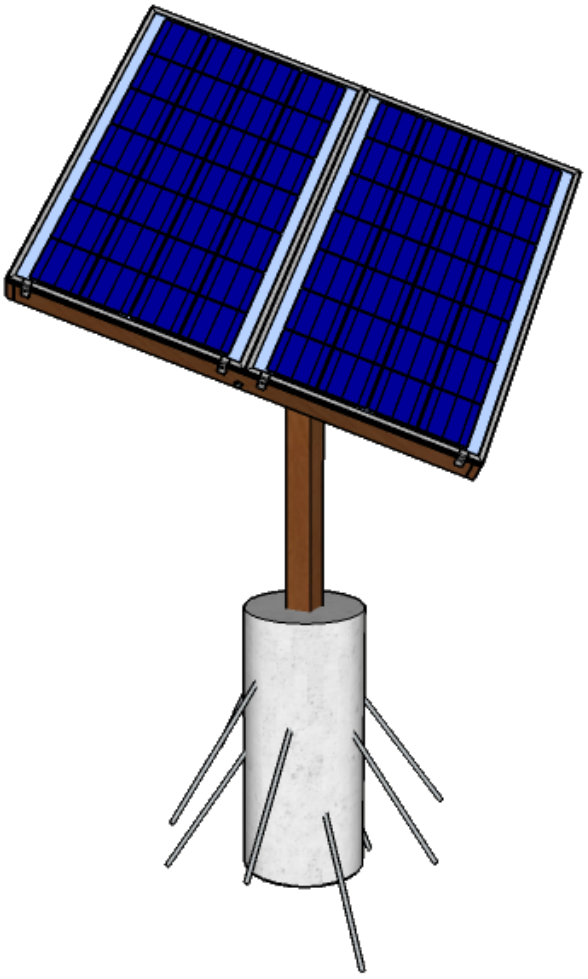
Build A DIY
Solar Tracker



A step by step build guide from

RST

RENEWABLE SYSTEMS TECHNOLOGY

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Introduction

This is a step by step instructional guide on how to build a solar tracker. The build video for this project can be viewed at the following link: https://www.youtube.com/watch?v=hr07xKWM6tw

Solar PV has become a popular way to produce clean energy almost anywhere, thanks to decreasing manufacturing and installation costs over the past decade making it an economically practical option for more people. However, solar PV still isn't cheap so making systems as efficient as possible is very important.

The most common installations done today involve either rooftop mounted panels, fixed ground racks, or solar tracking systems - and in some cases all of the above. Each has it's pro's and con's; for instance a rooftop system is the most affordable in terms of initial costs, but in most cases will be the least efficient due to variances in roof orientation and pitch, and a lack of airflow behind the panels to keep them cool (the hotter a PV panel is, the less electricity it will produce).

Panels mounted on a fixed ground rack is another affordable installation method that tends to yield a slightly higher efficiency because the back of the panels are more exposed to the air in a cooler environment where they can release heat easier.

The most efficient but unfortunately the most costly method (until now) has been to mount PV panels on a solar tracker. A solar tracker is equipped with a light sensor which signals to a controller where the sun is in relation to the PV panels so that the controller can activate a motor to turn the tracker accordingly so that the panels are always facing directly at the sun for optimum energy gain. Solar tracking systems can increase daily production by up to 25% compared to fixed arrays.

The tracker detailed in this build guide is designed to do just that, but for an affordable price too. It is a dual axis tracker capable of supporting two ~100 watt PV panels but can be easily upscaled for larger systems. East-west orientation is managed by a light sensor (mounted on the tracker) and a controller, and the north-south orientation is a simple manual adjustment done once at the beginning of each season (the exact angle settings will depend on your geographic location. It's highly recommended that you visit www.suncalc.org to determine what you need. It's a great program that tells you everything you need to know about the sun's location in relation to yours at any given time of day/year, and also establishes shadows for any given size object on your property so that you can ensure you won't have any shade affecting your system's production).

Specifications

Platform dimensions: 60.5” x 47”

Height (from surface of ground): ~6 ft

Foundation: reinforced concrete, 4 cu.ft

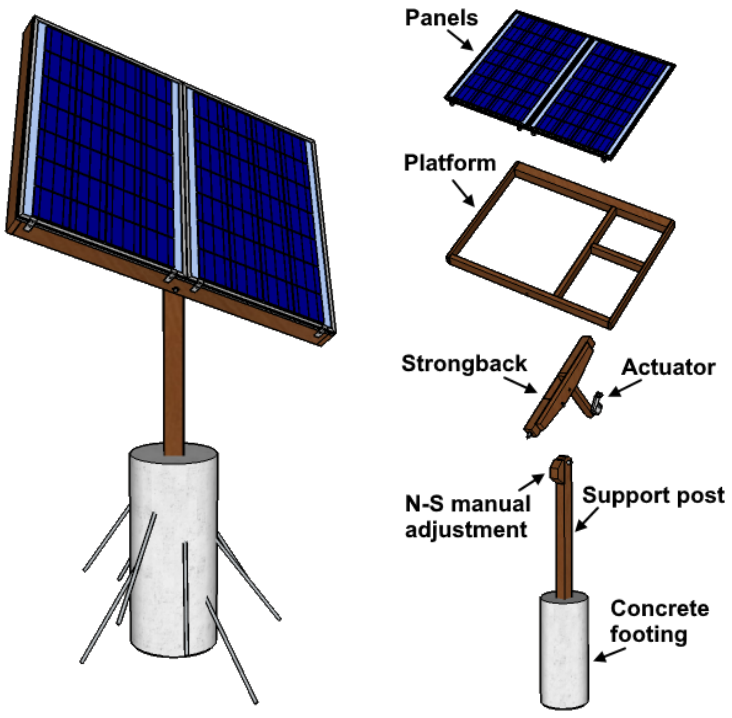
Capacity: two ~100W PV panels

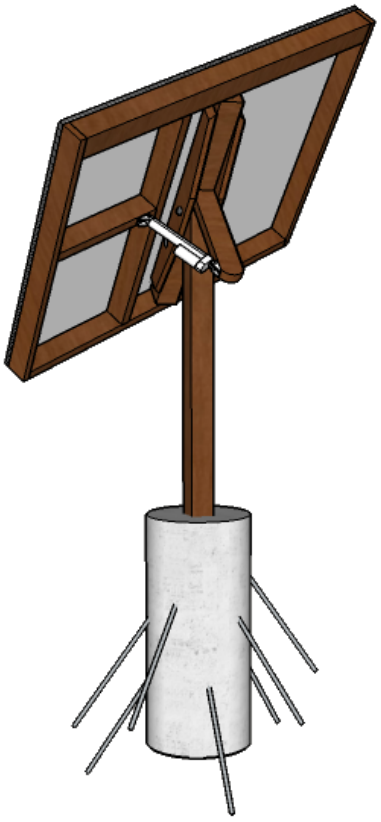
Axis: Dual, auto east-west tracking, manual north-south seasonal adjustment

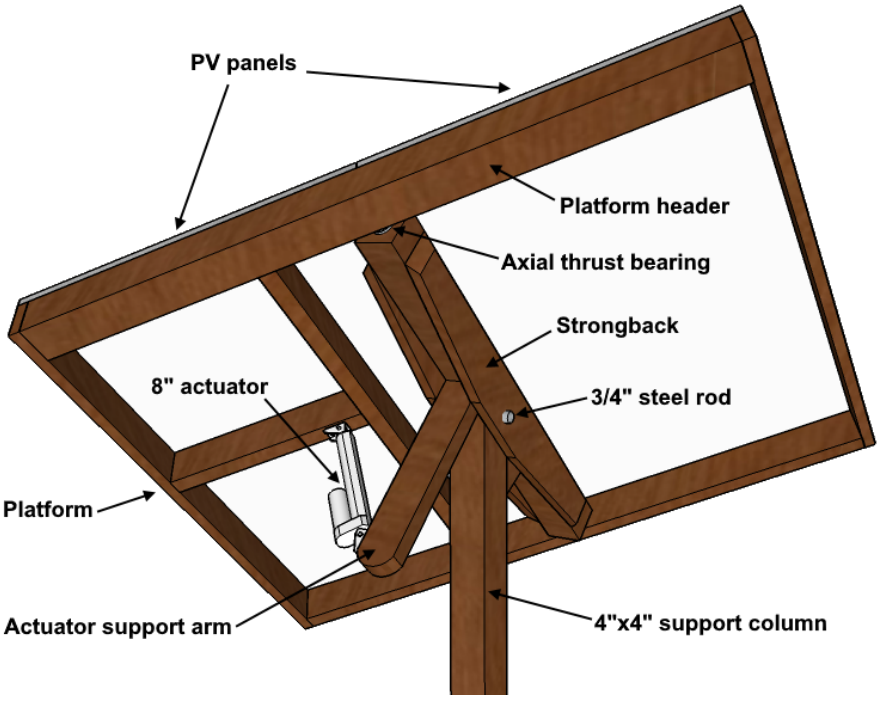
Degrees of rotation: ~80°

Motor: 12VDC/~30W, 8” linear actuator

Control system: WST03-5 single axis tracker controller






PV panels
Platform header
Axial thrust bearing
Strongback
8" actuator
3/4" steel rod
Platform
Actuator support arm
4"x4" support column

Tools required

Measuring tape & pencil

Utility knife, wire cutters/strippers

Tin snips

Hammer

Builder’s square & level

Speed square or angle finder

#2 Robertson & Phillips screwdrivers (or bits for drill)

¼”, ⅜”, ½” & ¾” drill bits

Small adjustable wrench

Hacksaw or mini-grinder

Hand saw or reciprocating saw

Circular saw

Electric drill

Shovel, rake, wheel barrow

Bill of materials

One piece of 4”x4”x16’ pressure treated lumber

One piece of 5/4”x6”x8’ pressure treated lumber

Three pieces of 2”x4”x8’ pressure treated lumber

One piece of ¾”x14” steel rod

One piece of ¼”x6” steel rod

One ¾”ID axial thrust bearing

One ½”x4” hex bolt w/ large washer

One piece of ½”x16’ steel rebar

4 cubic feet of concrete (mix ratio: 1 part cement, 3 part sand, 3 part aggregate)

50 pcs of #8x3” Robertson wood screws

One 12V, 8” linear actuator

One WST03-5 single axis tracker controller

Two ~100 watt PV panels (consult manufacturer spec’s for panel dimensions)

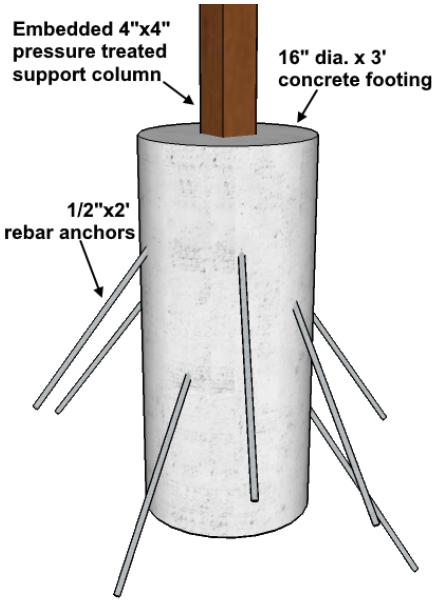
One SRNE MPPT 2440 solar charge controller (if battery charging - use appropriately sized and certified grid-tie inverter for grid-tied systems instead)

Fine strand insulated copper wire (consult panel and controller spec’s and refer to the calculator at the following link to determine the size of wire that you will need - the further the power has to travel, the thicker the wire you will need: http://www.solar-wind.co.uk/cable-sizing-DC-cables.html)

One weatherproof junction box

Marrets

Pouring the foundation



Step 1:

Visit www.suncalc.org to help you determine the best location to install a solar tracker on your property. Once a suitable location has been established, dig a hole in that location that's slightly larger than the foundation's proposed dimensions. Bare in mind that the dimensions in the image above are the minimum - make the hole according to the form size that you intend to use. In the companion video to this build guide, an old plastic barrel was used as the concrete form.

If you live in a frost prone area, it's best that the bottom of the foundation reaches below the expected frost line to help prevent uplift. If you live in an area where bedrock is just a few feet from the surface, use a hammer drill to drill ½" holes into the rock at various angles to later receive rebar anchors. The anchors should be placed with a good portion of them sticking out of the bedrock so that after the concrete is poured and cured, the anchors will lock the concrete foundation to the bedrock.

Step 2:

Place your form into the hole, then cut 6-8 pieces of ½" rebar at 2' long, and tap them through the inside of the form and into the surrounding soil at various angles and locations to form a 'root' system which will provide more security against strong

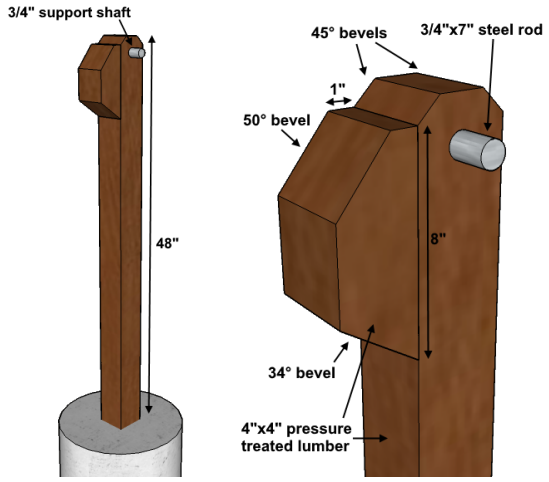
winds. Once the rebar is installed, cut a piece of 4”x4” pressure treated lumber at 48” plus the depth of your form, then install and brace it level using ‘A’ frames as shown in the companion video.

Step 3:

In a wheel barrow, mix the concrete needed to fill your form (or what your wheel barrow can handle) using bagged pre-mixed dry concrete mix or your own mixture of 1 part cement, 3 part sand and 3 part aggregate (¼-¾” dia. stone). The mix shouldn’t be too dry or too wet otherwise strength will be compromised and cracks will form - the mix should resemble a really thick (muddy) stew when it’s ready to pour. Once the concrete is mixed, pour it into the form and use a stick or shovel to shove into the concrete after the pour to help work out any air bubbles that may have become trapped below. Give the concrete at least 24 hours to cure before buildling.

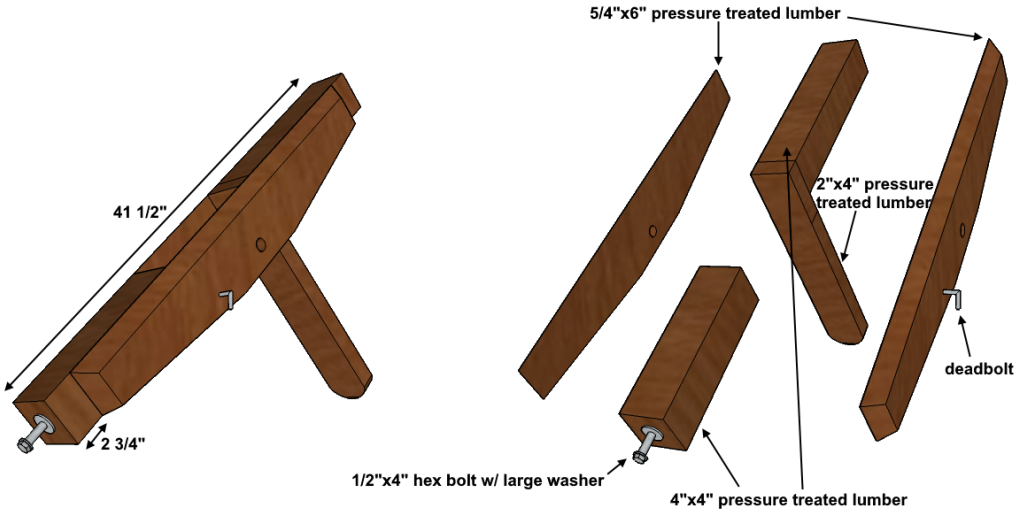
Step 4:

After the concrete has had sufficient time to cure, remove the ‘A’ frame braces and cut a 45° bevel on the north and south edges of the top of the support post as shown below. Then cut and attach the manual adjustment block to the support post as shown below using #8x3” wood screws.



Once the adjustment block is installed, drill a ¾” diameter hole through the centre of the east-west faces of the support post, approx. 1 ¾” from the top of the post to the centre of the hole, then install a ¾”x7” steel rod in the hole and leave an equal portion projecting from each side to receive the strongback later.

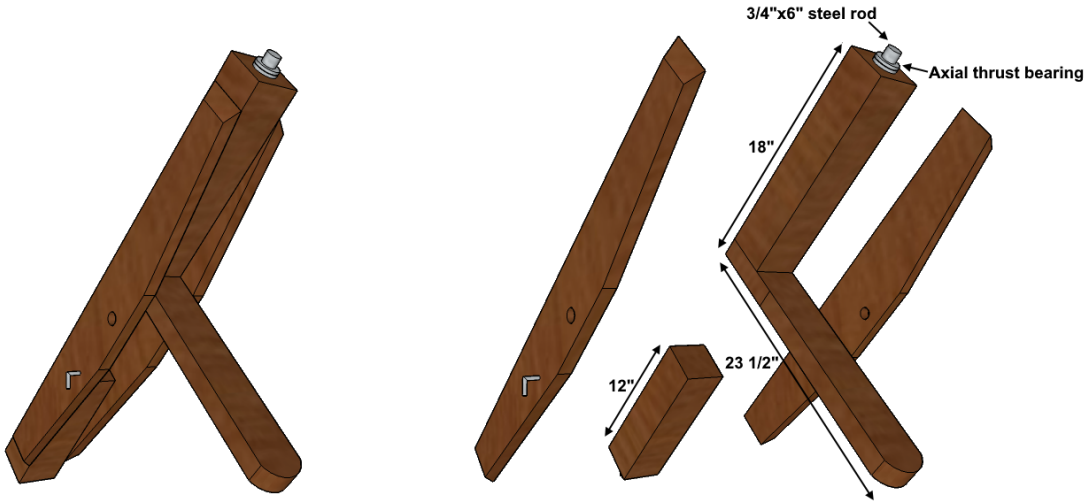
Making & installing the strongback



Step 1

If you're building the tracker to spec then follow the dimensional drawings exactly. If you need to customise the platform size according to your panel size (consult manufacturer's spec's), then you will need to customise the length of the strongback and it's components accordingly too (please be aware that this tracker is designed to carry just two 100 watt panels - if you need to install more panels then it's highly recommended that you upgrade to using 6"x6" lumber for supporting members instead of 4"x4" lumber).

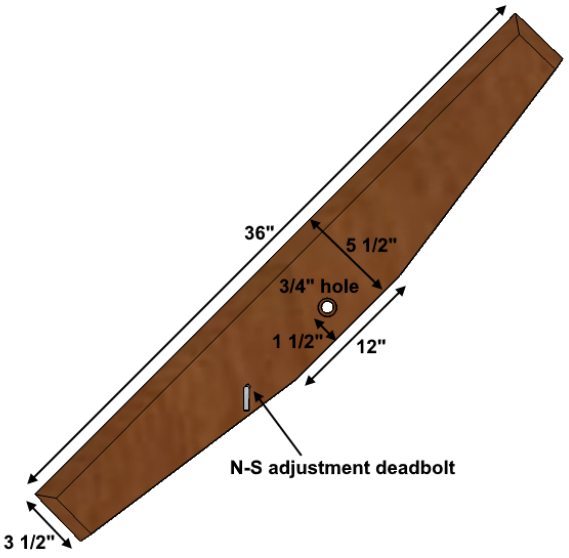
Cut a piece of 4"x4" pressure treated lumber at 12", and another piece at 18". Then cut a piece of 2"x4" pressure treated lumber at 23 ½". Drill a ⅜" x4" deep hole through the centre of one end of the 12" long piece, then drill a ¾"x4" deep hole through the centre of one end of the 18" long piece. Then tap a ¾"x6" long steel rod into the hole - this will be the pivot point for the panel platform and where the majority of the weight is supported. If you need to do any drilling/recessing for your axial thrust bearing here, it's recommended that be done before drilling the ¾" hole.



Once the holes are drilled, screw one end of the 23.5” long 2”x4” to the 18” piece of 4”x4”, at the opposite end to the one holding the steel rod.

Step 2

Cut the strongback sides out of 5/4”x6” pressure treated lumber according to the dimensions below (be sure to put a 45° bevel on the top edges). Then drill a ¾” hole in the required locations and pre-assemble the strongback using one side piece only. Screw the side piece to the faces of the 4”x4” blocks so that the blocks project from each end of the side by 2 ¾”, as shown in the images above. The 18” block should be at the top of the strongback with the ¾” steel rod pointing up/north (if you live in the northern hemisphere), and the 12” block will help form the opposite end of the strongback with the ⅜” hole in the end pointing down/south.



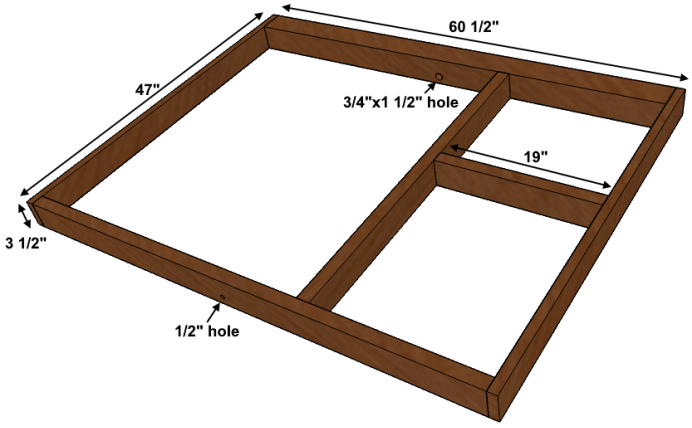
Step 3:

Install the partially assembled strongback onto the shaft of the support post, then install the other side of the strongback and secure it with #8x3” wood screws. Check that the strongback rotates freely, and add shims between the strongback sides and 4”x4” end blocks to eliminate any resistance if necessary - you don’t want to struggle with the manual adjustment when there’s a couple hundred pounds and a few hundred $ worth of PV on top. If you haven’t already, install and grease the axial thrust bearing.

Step 4:

Visit www.suncalc.org to determine the angles that you need for north-south orientation at the beginning of each season. Transfer those angles to the adjustment block on the support post and adjust the strongback to the summer angle. Use a ¼” drill bit to drill a hole through the strongback side and into the adjustment block. Then bend a piece of ¼”x6” steel rod into an ‘L’ shape and insert it into the hole that was just drilled. Repeat this with each seasonal position (or as many as you like) and, if desired, you can make permanent markings for each position on the adjustment block for easy reference using a hand saw (see the companion video).

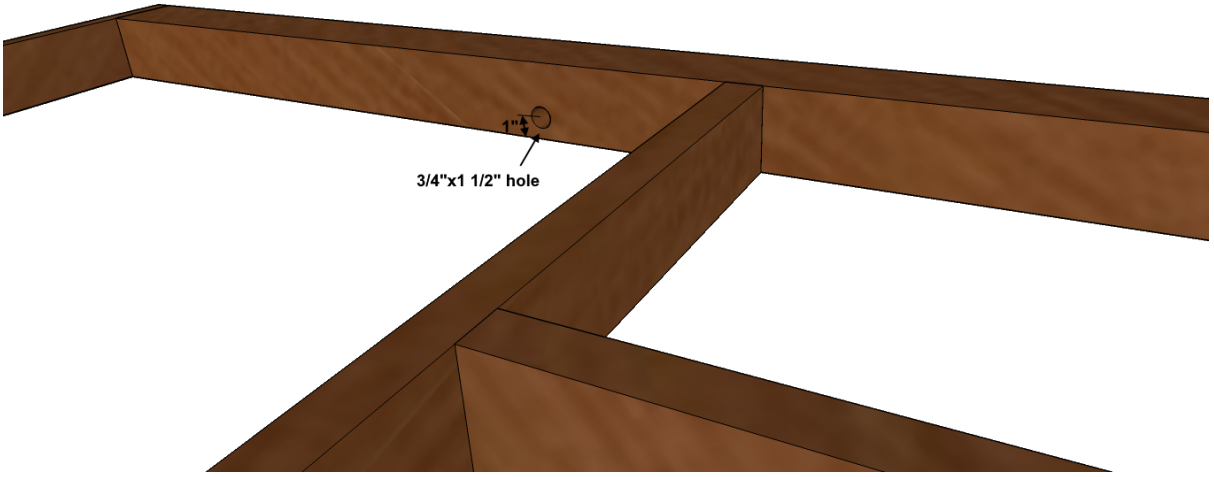
Building the platform



Step 1:

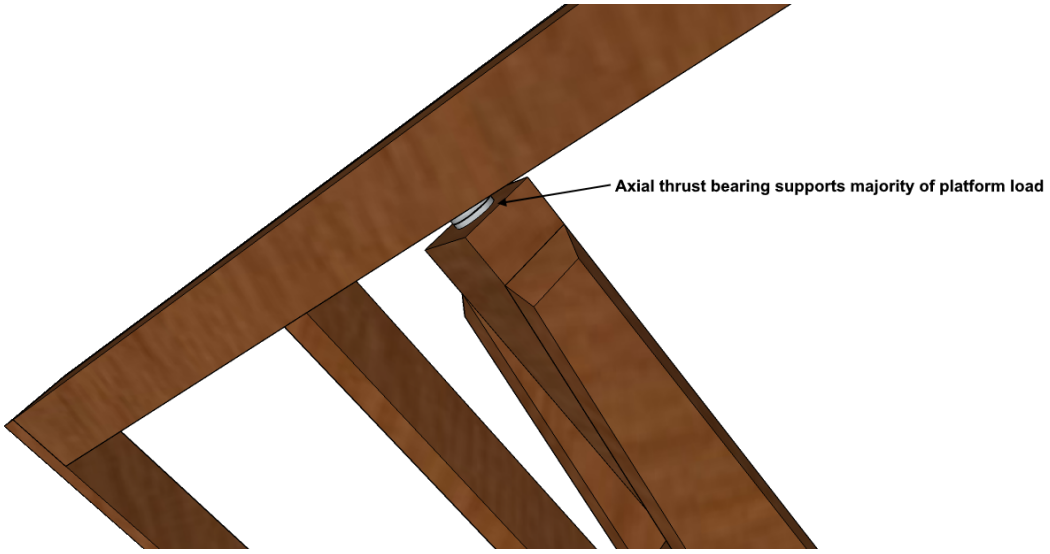
Cut the required pieces from 4”x4” and 2”x4” pressure treated lumber according to the dimensions detailed in the image above (unless you need to customise for a different panel size), then fasten them together using #8x3” wood screws.

The top side of the platform, or ‘header’, is made from 4”x4” because this is the end that will support and transfer the majority of the vertical load to the strongback and into the support post/foundation below. Drill a ¾”x2” deep hole at the required location in the header to receive the support shaft in the strongback, then drill a ½” hole at the required location through the bottom framing component of the platform.

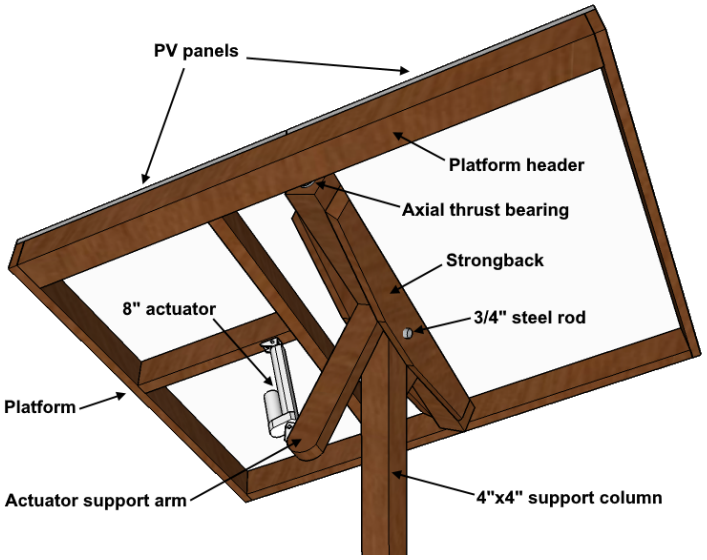


Step 2:

Once the platform is assembled, install it on the strongback by first placing the header onto the support shaft at the upper end of the strongback (where the axial thrust bearing should be located), then rotate the bottom end of the platform into place and slide a ½”x4” hex bolt through the ½” hole that was drilled earlier and tighten the bolt until the head just touches the platform to minimise friction/resistance. Use a large washer on the bolt between the strongback end block and the platform framing.

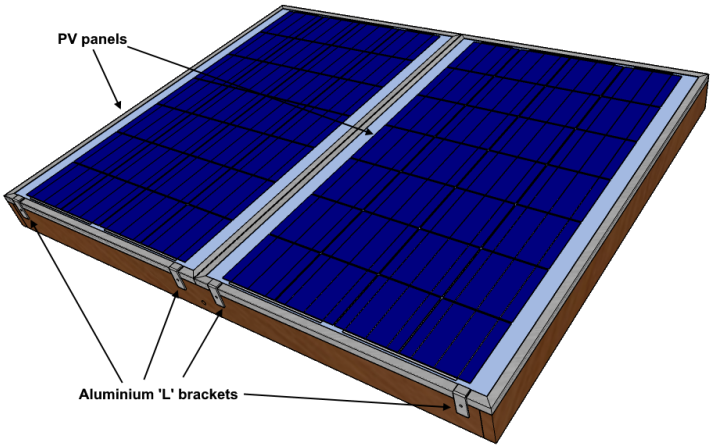


Installing electrical components



Step 1:

Carefully install the PV panels to the platform and wire them to your charge controller or grid-tie inverter according to the manufacturer's recommendations. If you need to bury transmission wires underground, be sure to run them through an appropriate plastic conduit to protect them from water and load damage as shown in the companion video. Make sure that all wiring has 'drip loops' below any connections so that condensation and precipitation will roll away from them and drip easily onto the ground. A drip loop is simply a sag in the wire that allows gravity to pull moisture to it's apex. The wiring should also have enough slack so that it can move freely with the platform as it rotates without rubbing against other components or twisting/bunching up. All connections should be made in a waterproof boxes as well.



Step 2:

Install the earth ground wire & rod. In the event of a lightning strike, this will give the surge of power a short, direct path to ground and help protect sensitive control and storage equipment. The ground wire should be at least 6 awg, with one end fastened to the PV panel's aluminium frame, and the other end should be attached to a copper plated steel rod that is driven into the ground. Dry regions will require more rod/soil contact to ensure the power surge is transferred to ground effectively. Refer to local electrical codes to determine minimum requirements.

Step 3:

Install the linear actuator on the support arm, with the motor side facing the ground - you may need to adjust the placement during testing, so be sure to allow enough slack in the wiring to do so. Then install the light sensor for the tracking controller at the top of the platform so that it can move with the panels - refer to the manufacturer's installation instructions for proper orientation.

Using your new solar tracker

Once the system is wired up to the controller then it's ready to go. If you're using the WST03-5 single axis tracker controller, simply press the power switch to turn it on and the controller will automatically begin tracking. If you're using a different controller, refer to it's user manual for operation instructions.

Press the 'Set' button on the remote (WT03-5) to enter 'manual' operation mode, then rotate the tracker east-west to make sure everything is working fine and that no wires are being tangled, rubbed, or pinched during operation. After testing, press the 'Set' button again to enter auto tracking mode. Follow the user manual instructions to set homing position time intervals if desired.

With regular maintenance your tracking system should last many years. Use aluminium cladding or an exterior stain or wood treatment to prolong the structure's life. Check that the axial thrust bearing is sufficiently lubricated on a monthly basis. Pay particular attention for cracks in the wood structure at any point load locations, especially during the first week after installation. If you use wood screws to fasten the components together then it will be fairly easy to replace anything that splits from temperature/humidity and moisture content changes. Also check that the bolt in the bottom of the platform is secure during regular inspections.

That's it, not much to it! Please BE SAFE and enjoy your new solar tracker & power generating system! If you have any questions or comments please forward them to contact@resystech.com

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