



## SOLAR PANEL INSTALLATION REQUIREMENTS AND INSTALLATION PROCESS

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**Abstract:** The article first discusses the various requirements for installing solar panels, including local building codes, permits, site assessment, and equipment selection. It also highlights the importance of evaluating the structural integrity of the roof or ground where the solar panels will be installed. Furthermore, the article delves into the installation process itself, covering key steps such as mounting the panels, connecting them to an inverter, and integrating them with the electrical grid. It also explores safety considerations and best practices for ensuring a successful installation. Overall, this article serves as a valuable resource for individuals and professionals interested in understanding the essential requirements and process involved in installing solar panels. By providing insights into these critical aspects, it aims to facilitate informed decision-making and promote the adoption of solar energy technology.

**Key words:** Solar panel, installation slope, electricity Production capacity, network connection, solar panel size

Dimensions of the panels The first item to consider is the dimensions of the panels themselves. In essence, the greater the capacity on the panels, the larger the size. This relates specifically to the number of cells contained in the panel [1-2]. Thus, more cells mean more surface to capture sunlight and therefore produce more energy. Given this rule of thumb, you can then proceed to figure out the best spot for your panels. As I mentioned earlier, many folks like to mount their panels on their roofs. This is a good idea when you have a Gable roof. In addition, having a sloping roof pitched to one side would certainly be of benefit. Of course, given the dimensions of the panels themselves, they may be too big or too heavy for your roof. This is something that you might want to get a second opinion [3-5]. The last thing you want is to put additional weight on your roof, thus compromising the structure



of your home. Furthermore, roof mounting may not be the best course of action if you have an older roof that's not in the best of shape. However, roof mounting may be your best choice especially if you don't have much land on which to mount your panels. You could have smaller panels though having multiple panels may be more of a hassle than a benefit. Also, if you choose to mount your panels on the ground, make sure that they are in a spot where they can get direct sunlight most of the day. Before actually mounting them, monitor the area in which you would like to mount your panels [6-7]. It could be that shadows set in at a given hour in the afternoon. This could severely limit the overall effectiveness of your solar power system. Tilting panels However, you choose to mount your panels, bear in mind that they need to be at an angle. The reason for this is that when panels are mounted on an angle, they will capture the greatest amount of sunlight for the longest period of time. Tilt your panels at a  $45^\circ$  angle. Now, this is not set in stone as conditions may vary in your part of the world. One interesting calculation is as follows: If your latitude is below  $25^\circ$ , then multiply the latitude by 0.87. This factor represents the ideal angle for your panels, given your geographical location. Due to the curvature of the Earth, sunlight does not hit the surface of the Earth at an even angle. So, you need to compensate for this. So, if you are at a latitude of, say,  $23^\circ$ , you would multiply this by 0.87. Thus,  $23 * 0.87 = 20.01$ . This means that you would have to tilt your panels to a  $20^\circ$  angle. The previous calculation is intended to maximize exposure to sunlight during daylight hours [8-9]. That is why roof mounting may not be your best option, especially if you live around taller structures. Hence, the afternoon shadows may block out your afternoon sunlight. In the event that your latitude is between  $25^\circ$  and  $50^\circ$ , then take the latitude and multiply that by 0.76. Then, add an extra 3.1 degrees to the equation. For example, if your latitude is  $45^\circ$ , then you would have  $45 * 0.76 = 34.2$ . Add in the extra 3.1 degrees,  $34.2 + 3.1 = 37.3$  degrees. This is the angle at which you should tilt your panel. This will ensure the greatest amount of sunlight given the latitude at which you find yourself. In case you are unsure about what latitude you are located at, don't worry. You can search for your geographical position. With the aid map tools such as Google Maps, you can easily determine your current position. Which way to face A common mistake that newbies make is placing their panel in a random direction. Given the fact that the sun rises in the east and sets in the west, there is a predictable pattern in which sunlight will travel. In addition, the curvature of the Earth will not distribute sunlight evenly. In fact, sunlight will be distributed in a specific direction, given your geographical location [10-11]. For instance, if you live in the northern hemisphere, then your panels should face south.



If you live in the southern hemisphere, then your panels should face north. Unless you are living in the exact equator, you should point your panels in the opposite direction of your hemisphere. If you are unsure about which direction is north and which is south, you can look at a map tool such as Google Maps, or you can use your car's GPS. Those are two very simple ways in which you can determine your north/south position. The reason for tilting in the opposite direction of your hemisphere is related to the way the Earth itself is tilted. The Earth tilted axis is the reason why we have seasons. As such, when it is winter in the northern hemisphere, it is summer in the southern hemisphere and vice-versa. The only part of the world, which gets an equal amount of sunlight throughout the year, is the exact equator [12-14]. So, unless you are living right at the Earth's equator, heed this recommendation.

**Peak hours** Earlier, I mentioned that the peak hours for sunlight were roughly between 10 am and 2 pm. This is when the sun is at its brightest and will deliver the most amount of sunlight. In addition to the tilting of your panels, your system should capture the greatest amount of energy during these peak hours. Now, depending on the part of the world you live in, your days may be longer or shorter. That is why you need to maximize your exposure to sunlight. This is especially important if you live in a part of the world that doesn't get much sunlight. Of course, you might be tempted to place your panels on a flat surface facing straight up. Sure, this will work best when the sun is directly above your position. However, it will not be very efficient once the sun begins to set, and it is at an angle. Furthermore, the north-south facing tilt will ensure that the panel begins to capture sunlight right from sunrise all the way through sunset. This is something that would be virtually impossible if the panels are facing straight up. One good rule of thumb, if you are partially connected to the grid, is to switch to regular electrical power during peak hours. That way, you can give your batteries a good chance to charge up. Once the peak hours have passed, then you can resume using your solar power system. This will help you to charge the batteries faster.

**The mounting structure for your panels** Since the panels will be at an angle, your most immediate option would be to use your roof. The best type of roof to use is a Gable roof since it has the two sides parted down the middle. Since each side is on an angle, then it might be feasible to use your roof. In that case, you can look for the support beams that hold up the roof [15-16]. Next, you will find that the panels have holes where screws, or bolts, can be used to fasten it to the surface that they will be mounted on to. You can use long, 2-inch bolts to drill through the shingle and the support beam. If you decide to drill all the way through the support beam, then make sure you go straight through the middle. This will not comprise the



integrity of the beam. However, if you drill at an angle, then you might weaken the beam at that point. Once you have the hole drilled, you can place the mounting bracket. Bear in mind that you will not place the panels directly on the shingle. Rather, the mounting brackets will support the mounting rail. It is on the rail that you will place the panels on. Then, you can screw the panel onto the support rail. Using the support rail system is a good idea, especially if you have larger panels. If you are using smaller panels, then you could just install the mounting bracket and place the corners of your panel on the bracket. This is doable, especially since the panel won't weigh as much as a larger one. If you are home or structure has steel beams with tin sheet roofing, then mounting will be a lot easier because you can use the same spots where the tin sheets and bolted into the support beams. All you would have to do is remove the bolt, place the mounting bracket, and away you go. The main reason for not mounting panels directly onto the roof is related mainly to rain and snow. If the panels were to be mounted directly on to the surface of the roof, the rainwater would flood the panels. If the panels are slightly raised above the surface of the roof, the water can flow beneath it. The same goes for snow. Concrete roofing Now, let's assume you are mounting panels onto a building with a flat, concrete roof. This job poses a higher degree of difficulty, as most concrete roofs are flat. While they may have an angle in order to allow water to flow, this angle will be inadequate for efficient sunlight capture. So, you will have to fabricate your own mount that takes into account the recommended angle. There are two ways in which you can fabricate your own mount. You can make these mounts out of wood or metal. The mount will look like two triangles joined by straight beams [17-18]. If you are looking for a quick and cost-effective way of making your own mount, you can use regular lumber to make the mount. Depending on the size and weight of the panels, you can use regular 2 x 2 lumber all around. If you use the larger and heavier panels, you might consider using 3 x 3 or 2 x 4 lumber. This will give your panels the support they need. Don't worry about using lumber to mount the panels as the panels will not catch on fire. If anything, it is the batteries that pose a greater fire hazard. Mounting on to wood is a lot easier since the screws that you use will dig into the wood. So, make sure you use wood screws, or at least, cone-shaped screws that have the spiral thread. Try to avoid using the flat-tip screws as you will have to drill into the lumber in order to pass the screw through the wood. Alternatively, you could nail it down with a regular flathead nail. Ideally, you would use a nail gun to do this. You could use good, old-fashioned elbow grease and hammer the nail in. However, you must be very careful not to hammer the surface of the panel. If you do, you may damage



individual cells or the entire panel altogether. Personally, when working with wood, I would prefer to use 1-inch wood screws. They will go a good job of holding the panel in place. If you must nail the panel in, make sure the head of the nail doesn't go through the hole of the panel. Otherwise, it would be as if you hadn't nailed the panel down. Another type of mount that really works very well is a steel frame mount. These can be made by a blacksmith to suit the exact needs of your panels. You can use regular aluminum, such as the frames used in windows, or you can use heavier steel [19-20]. The blacksmith will take the measurements of your panel, and then weld the pieces of metal together. If you wanted to save yourself the hassle of screwing down the panel, you could have the blacksmith weld the frame of the panel onto the mount. This can be done by soldering a few points all around the panel and the mount. The only downside to this is that if you ever need to remove the panel, you will have to work quite a bit to break to weld points. In addition, the blacksmith needs to be very careful not to heat the panel too much. Otherwise, it could blow the whole panel. So, your best option here is to screw the panel down with a nut and a bolt. The blacksmith can drill the holes in for you so that all you have to do is line up the holes, thread the bolt through, and secure it on the other end with a nut. You can then fasten the nut with a wrench. All you need to do is just hand-tighten the nut and bolt in order to securely fasten it to the mount. If you use a gun to tighten the bolt down, the added torque of the gun may crack the frame of the panel. Breaking through the roof Even if your panels are big and heavy, it is always a good idea to secure them to the roof. This is especially true if you live in a windy area, or an area prone to tornadoes and hurricanes. In order to mount your wooden or metal mount, you can break open a small hole into the roof itself. It doesn't have to be very deep. Usually, an inch deep is enough. Don't feel like you need to bust through all the way to the rebar. Now, let's assume you have a wooden mount. Wood and concrete don't mesh very well together. So, you can just set the lumber into the holes in the roof, pour some concrete on it and let it sit there. Of course, you could do that. However, the wood might rot, and you will have to break open the same spot again and remove the rotten mount. So, the solution is to open a small hole, about two inches wide and about an inch deep. Then, you can get large, two-inch bolts. You can set the bolts into the hole and pour concrete around the bolt, thereby filling in the hole [21-22]. What you will have is the bolt protruding from the roof. Next, you can drill a hole all the way through the wood, set the mount over the bolt, and then tighten with a nut over the bolt. You can use four bolts, one for each corner, to fasten your mount to the roof. If you would like added security, you use 6 or 8 bolts. As long as you let



the bolts set into the concrete properly, you should have no trouble with the wind blowing your panels away. If you are using metal mounts, then you can break the holes into the concrete roof just like before, but this time, you can actually set the frame directly into the concrete. Since metal and concrete get along very well, you won't have to worry about your panels blowing away [23-24]. You can set each corner into the roof, and you will be good to go. So, when you get the blacksmith to make your mount, you can ask them to leave a one-inch tip. This is the tip that will go into the roof. When setting metal mounts into a concrete roof, be sure that the spot you choose is the spot that will hold the panels forever. Since metal sets very well into concrete, you will find it nearly impossible to pull the mount out without tearing the roof apart. While you could just hacksaw through the metal tips, removing a metal mount will require additional time and effort. In this regard, wooden mounts are much easier to deal with. Installing panels on the ground If you choose to install your panels on the ground, try to avoid installing them on grass or plain dirt. This is especially important if you get a lot of rain. The reason for this is the ground will get soft, become muddy, and then the panels will sink under their own weight. So, if you have grass or simply dirt, you can pour some concrete down to hold the panels in place. Ideally, you would lay down a concrete slab the size of the panels. This will ensure that your panels will not blow away [25-28]. Now, if you are on a tight budget, you could lay down smaller slabs around each other corners of the mount. You can dig a one to the two-inch hole, pour the concrete in, set the mount, and let dry. Once the concrete is dry, you can lay the panels down. I If you are unsure about how to do this, you can enlist the help of a mason or a foundation expert. They are good at setting solid supports in the ground. The only caveat with installing your panels on the ground is that you need to make sure they have enough open space so that they are not covered by shadows at various points throughout the day. If you have a large backyard of a good piece of land, then you might just get away with it. If you are laying your panels down in a forest, say, for a cabin, then you need to see if the trees around the land may cast a shadow on your panels. Otherwise, mounting panels on the ground provide a good option for you to set them up any way that suits your best.

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