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

Generally, for a grid tied system, we calculate that we will lose about 23% due to losses in the system, from voltage drop in the wires to bird poo on the panels. Now let's do some math! We take that daily average kwh from earlier, multiply it by 1000 to get watt hours, divide it by your annual average sun hours, to get 11,254W. We divide it by 77% to take into account the system losses, which gives us 14,615 W of solar to provide 100% of our electricity needs. As we said earlier, most grid tied systems don't try to make all of their power, just cut their existing bill. So, for this example, I'm going to cut that in half to provide half of my electricity with solar [1-5]. Therefore, I need a solar array of about 7300 watts. Now let's use this information to pick out the rest of the system. Grid tied inverters are sized based on the size of the solar array they are connected to. There is a certain window of number of panels in series and in parallel that will work with the inverter. When selecting the inverter, you'll find that most inverter manufacturers these days have an online calculator called a "String Sizer" to help select the right inverter for your panels. You just have to enter the temperatures that the panels will be seeing during daylight hours, and if I'm mounting them on a roof or on the ground [6-11]. This matters because the solar panels' voltage changes pretty dramatically based on temperature, so the string sizer needs to be able to calculate the highest and lowest voltages it will see. You also will have to select the solar panels I'm going to use. I picked Kyocera's 250W panels, they are a terrific panel at a very good price. Since I'm looking at around 7300 watts of solar, I picked the ABB Uno 7.6kW inverter. I can see that depending on how many parallel strings I do, I can use series strings of anywhere from 4 to 14 long in series. However, these may not be the ideal string lengths, if there are any warnings, the string sizer will alert you in a note. I picked 2 sets of 2 strings of 8, for a total of 8000W, the inverter is very happy with that size. It's a little bigger than my 7300W that I calculated that I needed, so it will actually generate more than half my power. So now I've got 32 Kyocera 250W panels, and an ABB Uno 7.6k Transformerless inverter. So how will I mount them? Luckily for those of us doing a lot of designs, IronRidge also has a time saving Design Assistant to help speed up the design work. They've got one for roof mounts, and one for ground mounts. I'll give you an example with the roof mount one. You enter what solar panels you are using, how many, and how they are laid out. For example, 2 rows of 16, flush against the roof. For my area, the building code requires the system be designed to withstand 100mph winds and a snow load of 40psi. For 4' spacing between mounting feet, which lines up with every other rafter, it tells me I can use the IronRidge XR100 rails. Just a few more inputted details, like what color clamps to match the panels and it outputs a bill of material, and the manufacturer's suggested retail price. They do suggest a flashing for an asphalt shingled roof, so if you have a different type of shingle, you may need a different flashing to prevent leaks. The last piece is over current protection, protecting your system in the event something goes wrong. In a grid tied system, there are 2 locations we need to put in over current protection, on the DC side by the solar panels, and on the AC side in the main breaker box. The combiner box I would chose for this example is a disconnecting combiner box. It allows you to turn off the power coming out of the panels right by the panels, in compliance with NEC 2014 Rapid Shutdown requirement. Each string of panels gets its own fuse. The datasheet of the panel usually tells you what size fuses to use, for grid tied panels under 300 watts, it's usually 15A. To calculate it, you take the solar panel's Short Circuit

Current, and multiply it by 1.56. The combiner box wires the strings into parallel, and gives you a place to transition the wire into conduit. It's also a good place to put a lightning arrestor [12-18]. The AC output of the inverter goes into a dual pole breaker in your home's main breaker box. To calculate the size breaker to get, you take the watts of the inverter, in this case 7600 watts, divided by the AC voltage output, 240V, and multiply it by 1.25 to oversize for NEC's requirement for devices being used for more than 3 hours continuous. This gives you a 40 amp dual pole AC breaker. So, what have we got? We have a combiner box with 15A fuses, 32 of the Kyocera 250W panels, wired in 4 strings of 8, an ABB 7.6k Transformerless inverter, and just over 200' of IronRidge XR100 rail, with the and clamps, and mounting feet. You would enter the details for whatever physical layout works for your roof. Then you would get a 40A AC breaker that fits in your main breaker box. There are two types of DC protection devices are essential to guarantee the safe and effective functioning and operation of any PV system: fuses and circuit breakers [19-22].

Fuses are overcurrent protection devices that contain a filament inside that heats up as current flows through it. When a specific current located above the permissible limit passes through the filament, the filament heats up above its thermal capacity and melts. When the wire inside the fuse melts, the circuit gets opened.

An overcurrent can be produced by:

An overload caused by excessive current demand from the electrical loads, above the design limit.

A short-circuit caused by a fault that occurs in the circuit.

A circuit breaker is a thermal protection mechanism is based on a bimetallic contact that heats and expands when an electric current located above the rated value is present. This protects the circuit against overload. A magnetic protection mechanism instantly responds to high fault currents that protect the electrical circuit against short-circuits or over-currents.

Inside the DC breaker, two contacts split when an overcurrent passes through the protection device, automatically switching it to the OFF position.

The DC breaker needs to be put back in the ON position to allow electric current flow again through the circuit. There is no functional difference between fuses or circuit breakers.

If a fault occurs with a fuse, you need to replace it. With a breaker, you flip the switch back in the on position; but fuses are cheaper than circuit breakers.

Keep in mind that for solar power applications, you must choose circuit breakers that work on DC to protect solar panels and batteries. Circuit breakers that work on AC are used solely to protect the AC loads.

So, which protective device should you use for each applicationI recommend using fuses for parts in your circuits that do not easily trip.

This is the DC part of your solar system.

Circuit breakers can be reused each time that they trip, and they are intended to protect multiple electrical circuits.

You will need to use fuses specifically for protecting the battery bank as higher currents flow through this circuit, and the protection speed of these devices will guarantee that the batteries will not suffer any damage.

Finally, for the main AC panel, it is more common to use circuit breakers to protect loads in residential-sized or off-grid PV systems.

Because of the high current in DC systems, it can get very expensive to use DC circuit breakers. Therefore, fuses are preferred [23-28].

Fuses and circuit breakers can also be classified according to their response speed.

The acting speed is the time it takes for the fuse to open once a fault current or overload passes through the filament. This is dependent mainly on the material used for the fuse element.

Selecting the accurate fuse type also involves selecting the appropriate speed response for the particular application that you are using. Choosing a fuse that acts too fast may not allow normal current operations to run, while choosing a fuse that is too slow may not interrupt faulty currents quickly enough.

There are 3 main types of fuse speeds: ultra-rapid, fast-acting, and slowacting

Ultra-rapid fuses are mainly used for semi-conductors’ (electronics) protection.

Fast-acting fuses can be used to protect cabling and less sensitive components such as batteries and PV modules.

Finally, slow-acting fuses feature a built-in delay that temporarily allows the flow of inrush electrical currents in electrical motors.

When checking the datasheet of the fuse, you may find some of the following marks, as described in the following table:

The tool is generally built with a high-quality carbon steel material that ensures a long service life, and that is equipped with an ergonomic grip that is wrapped up with an anti-slip rubber material that makes it comfortable to use. The stripping of the cable to introduce the lug must be done with another tool.

Hammer Lug Crimper

Another option for the same purpose is a hammer lug, which is a manual and more economical solution to crimp the cable lugs for your battery bank. The tool is capable of crimping cable lugs for gauges between #8AWG and 4/0AWG (which covers all possible cable gauges for battery applications). The crimping process with a tool like this is done very simply by adjusting the ram head according to the wire and the terminal sizes. Then, the lug is placed in the jaw of the crimper while it is struck with a hammer (1-2 times is enough) to press the lug against the copper or aluminum.

Crimping Tool

This tool is suitable for crimping individual wires. It integrates a ratcheting mechanism that has an adjustable clamping force useful for precise and repeatable crimps that also adds more crimping power into each squeeze. Its ratcheting mechanism allows you to secure a wire connector even before inserting the stripped wire into the small barrel.

You will be able to crimp wire terminals for gauge sizes between 22 and 10AWG split into three cramping options marked by the colors red, blue, and yellow that will indicate the gauges ranges for each purpose. It has also been designed with an ergonomic material that offers a comfortable and secure grip.

Conduit Cutter

The next tool in our list is the conduit cutter. Conduit is generally used in electrical installations to protect cables or wires from water and/or physical damage.

However, for the conduit to fit your wiring installation, you must be able to cut it to adjust the length properly. For this purpose, a conduit cutter tool is needed.

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