

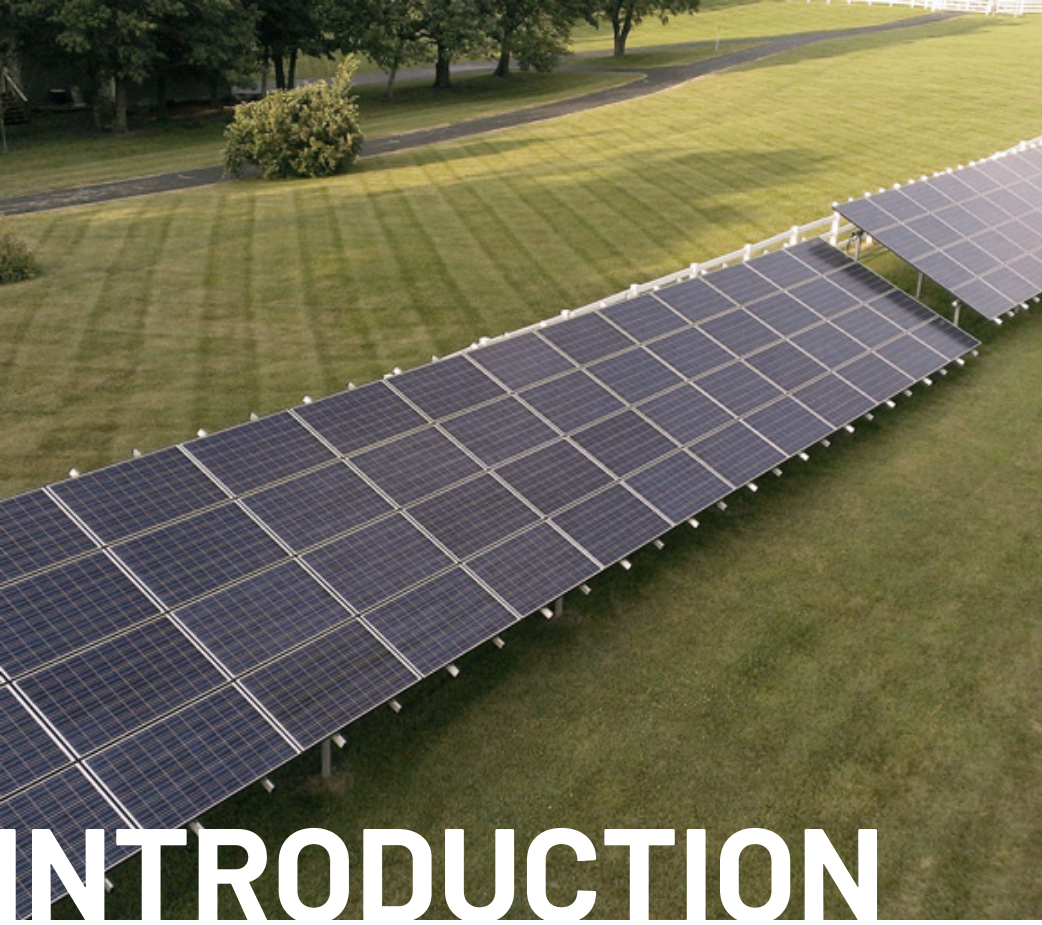
DO IT YOUR WAY SOLAR

# SOLAR PANEL GUIDE



DO IT YOUR WAY

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# INTRODUCTION

## Introduction

Thanks for reading our Solar Panels Guide! This handbook will walk you through everything you need to think about as you pick out the right solar panels for your system.

### What this guide covers:

- ➔ The major factors that influence the cost of solar panels
- ➔ How to mount your solar panels to maximize their energy production
- ➔ Our recommendations of the best solar panels on the market
- ➔ Current & historical pricing data for panels, complete systems, and installation

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## HOW MANY **PANELS** DO YOU NEED?

Solar research can be a long and involved process, but most people start with the same basic questions:

- How many panels will I need to buy?
- How much will the system cost?

To that end, let's start by finding a ballpark system size and cost based on your energy use:

- ➔ Figure out how many kilowatt hours (kWh) of electricity you use each month. This should be printed on your electric bill.
- ➔ Enter your ZIP code and kWh usage from your bill into our solar cost calculator. We'll estimate what size system you need.
- ➔ Divide that system size by the output of the panels you plan to buy. If you haven't picked them out yet, 300W is a good benchmark. For example,  $3000W \div 300W \text{ panels} = 10 \text{ panels}$ .
- ➔ Make sure you have space on your property to build your system. 60-cell panels are about 66" by 40", while 72-cell panels are about 78" by 40".

The measurements can vary by an inch or so depending on the manufacturer, so be sure to consult the spec sheet before you plan everything out.



## WHAT TO CONSIDER WHEN YOU PICK YOUR PANELS

When we judge the quality of panels, here are some of the things we look for. Most of this information can be found on the product spec sheet, which is available for download from the product pages on our website.

### String Inverters

Full-sized panels typically deliver anywhere between 275W to 400W of output. But higher output doesn't always mean a better deal.

Cost-per-watt is the more useful metric for determining how to value a solar panel.

For example, we currently sell a 360W Mission Solar panel for \$275, which comes to 76 cents per watt. Compare that to this 325W Astronergy panel (\$165), which has a lower output, but is less expensive at 51 cents per watt.

To make a fair assessment, divide the panel price by its wattage to find the cost per watt, which will help you judge the price of all panels on a level playing field.

# Efficiency

A solar panel's efficiency rating refers to the amount of sunlight the panel can convert into usable energy. 15-22% is an acceptable efficiency range for panels produced by major manufacturers.

The more efficient the technology, the more output the manufacturer can squeeze out of their panels.

For example: Mission Solar's 295W panel is 17.82% efficient, while their 305W panel is 18.36% efficient.

They're both 60-cell panels, which means they're the same physical size. The increase in efficiency allows them to squeeze an extra 10 watts out of the same form factor.

More efficient panels may cost a bit more, but that may allow you to use 20 panels in your system, rather than 24, for example. If you have limited space to build a system on your roof or property, efficient panels can be a real game-changer to help you save space.

## Size (60-cell vs. 72-cell)

This is an extension of the last point. Full-sized panels come in two main configurations:

- 60-cell: 40" x 66" (+/- one inch)
- 72-cell: 40" x 78" (+/- one inch)

Size doesn't have much to do with price. Panels that are the same size can have different efficiency ratings, which equates to different overall output.

However, you may care about panel size if you have limited space to build your system. For example, the dimensions of your roof may require you to use one panel size over the other, based on how the array will fit on your roof.



## Warranty

There are two different warranty categories: performance and workmanship.

The performance warranty guarantees your panels will produce energy at an acceptable rate. A standard panel warranty guarantees panels will produce at least 80% of their rated output for 25 years.

So if you buy a 300W panel today, it should still produce at least 240W of power 25 years from now.

Then there's the workmanship warranty. This protects against manufacturing defects and other physical problems with your panels.

The workmanship warranty is shorter than the performance warranty. A generous workmanship warranty gives a great indication that the manufacturer knows they are putting out a reliable product.

The industry standard workmanship warranty is 10 years, with some companies offering 25-year guarantees.



# Temperature Coefficient

Solar panels are tested in ideal conditions. When manufacturers measure panel output, they perform tests inside a climate-controlled factory.

But the real world introduces less-than-ideal conditions. During those sweltering days in the dead of summer, your system will lag behind its rated efficiency.

The temperature coefficient measures the impact temperature has on the production of your panels. It tracks how much efficiency is lost for each degree above or below test conditions.

We'll give an example in Celsius, because that's what most manufacturers measure: energy loss per  $1^{\circ}\text{C}$  temperature change.

Let's say a panel was tested at  $25^{\circ}\text{C}$ , but its current temperature is  $35^{\circ}\text{C}$ . If the temperature coefficient is  $-0.4\% \text{ Wp}$  (Watt power), you can multiply that by the difference in temperature ( $10^{\circ}\text{C}$ ). That panel is operating 4% below its rated power output.

In general, temperature doesn't have a noticeable impact on system performance unless you live in an extremely warm climate. If you live in a place like Southern California or Florida, it might be worth it to look for panels with lower temperature coefficients.

Otherwise, it's probably not worth splitting hairs over a 1-2% difference in production.

# Company History

The longevity and reputation of the panel manufacturer play a part in our recommendations. What good is a warranty if the company goes out of business before they get a chance to honor it?

For that reason, we look at companies with the right track record. Every product on this list is produced by a major manufacturer with a long and stable history in the solar industry.

You can also keep an eye out for companies with third-party backed warranties. If they do go out of business for some reason, the responsibility for honoring the warranty transfer to a third-party insurance company, so you still have a way to file a claim. It gives a bit more peace of mind in case something unexpected happens.

## Country of Origin

American-made goods are more expensive, thanks to stricter regulations and some of the highest manufacturing labor costs in the world.

Solar panels are no exception. US-based companies like SolarWorld USA and Mission Solar will charge a bit more for their panels simply because the manufacturing costs are higher.

Imported panels from the likes of Astronergy will be less expensive from a cost-per-watt perspective.

Some of our customers choose to buy domestic panels to support American manufacturing efforts. Others stick with the cheapest option to make their target budget.

You'll get high-quality panels either way, but be aware that American panels come at a bit of a premium.





## Design

If you care about how your system looks, don't forget to check the design on the spec sheet and in product photos. Look for three things to make sure you know what you're getting:

- Panel color: the face of the panel. Monocrystalline panels are black while polycrystalline panels are blue, due to differences in the manufacturing process.
- Frame color: the edges of the panel. Usually black or silver.
- Backsheet color: the back of the panel. Usually white or black.

If you live in a community governed by a homeowner's organization, the HOA may have rules in place about the design of your system. We have encountered several projects where the customer's HOA required black-on-black panels, and we had to design the system accordingly.



## MOUNTING PANELS FOR **MAXIMUM OUTPUT**

### Roof Mount or Ground Mount?

Most people choose roof mounts by default. They cost less, take less time to build, and take advantage of unused space on your property.

Even though ground mounts have extra material and labor costs associated with the installation, they offer a number of benefits as well. Building your system at ground level makes it easier to clean, maintain and replace the equipment.

You also may discover that you don't have enough space to build your system on your roof, due to obstructions, sharp angles or simply a lack of roof space. In these cases, ground mounts may be your only option.

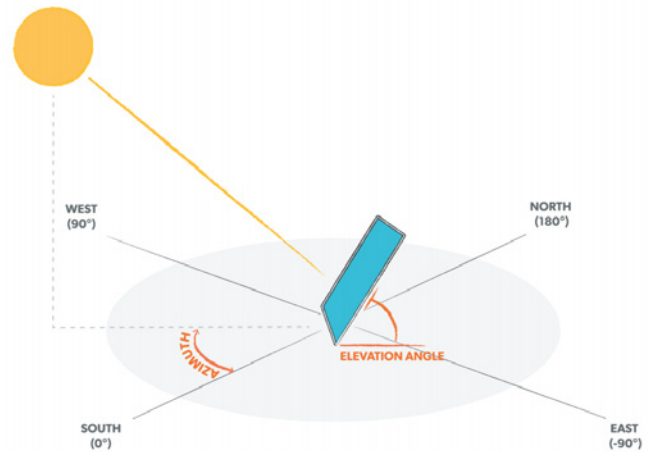
Likewise, if you don't have a yard (common if you live in a big city, for example) then the roof would be your only viable place to build.

For more advice on which to choose, read our article: [Roof Mounts Vs. Ground Mounts](#).

# Angle & Azimuth

Solar panels should point directly toward the equator for maximum exposure to the sun. If you live in America, you want to face your panels as close to true solar south as possible. If you live south of the equator, face them north instead.

East and west work at a reduced efficiency, if you're building on your roof and can't change the orientation. (Never build a system facing away from the equator. It won't produce a significant amount of power.)



The horizontal facing (in relation to the equator) is known as the **azimuth** of your panels. That's half the equation: you also have to find the right **angle** to tilt your panels.

As a rule of thumb, you should set your panels at an angle equal to your latitude to get the most output year-round. For example, Los Angeles is located at a latitude of  $34.05^{\circ}\text{N}$ . In L.A., you'll get the most out of a system built at a  $34^{\circ}$  angle.

Throughout the year, the angle of the sun in the sky will change by about  $15^{\circ}$  in either direction. Special mounts are available to track the sun's position throughout the year: pole mounts (which must be adjusted manually) and trackers (which follow the sun automatically).

In theory, these sound like a nice idea to squeeze a bit of extra production from your panels. In practice, they rarely make sense for residential systems because it's almost always cheaper to buy a few extra panels to get more output.

Trackers really only make sense in large-scale commercial projects when you need to squeeze every last drop of output from a large-scale system.

# Shade

If at all possible, try to build your panels where they will never be covered by shade. Keep in mind that shadows grow longer in the winter, and try to anticipate how shadows from your house, trees and other obstructions will cover the area where you plan to mount your panels.

Solar panels only output their rated efficiency in full sunlight. Shade not only reduces production of the panel it touches, it can potentially hamper an entire string of panels depending on the kind of inverter you are using. With a string inverter like the SMA Sunny Boy, if shade falls on one panel in a string, the entire string is affected.

If some shade is unavoidable, though, you can turn to micro-inverters or shade optimizers to address the problem. These systems provide shade mitigation and allow panels to produce energy independently from each other. If shade falls on a panel, the others in the string aren't affected.

# Maintenance

Solar panels don't require a ton of maintenance. It's smart to clean your panels occasionally so that dust, leaves and other debris don't impact their production.

The good news is that precipitation often takes care of this process naturally. Rain or snow will remove debris when it slides off the panels. In heavy snow regions, pole mounts are useful for lifting your system above snow banks and tilting your panels so that snow slides off naturally.

In dry, dusty areas, we'd recommend wiping down and cleaning the face of the panels once a year. In more temperate regions, once every few years is fine. This becomes more important for lower tilt angles, where debris can more easily build up and pooling water might leave spots.

# THE BEST **SOLAR PANELS** ON THE MARKET

## Best Value: Astronergy 325W

Looking for panels that won't break the bank? Astronergy makes the best solar panels you can get from a pure value perspective.

Of the major module producers, Astronergy has the lowest cost-per-watt panels we've found. The Astronergy 325W panel retails at \$165 (at the time of publication), which shakes out to 51 cents per watt.

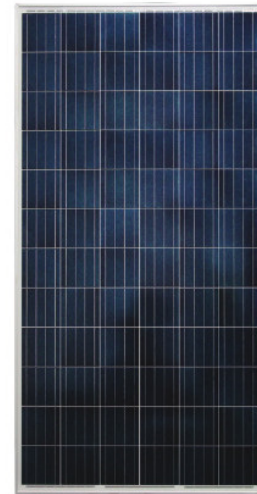
A few of our employees run their home systems on Astronergy panels, and we also picked them for the system that powers the Wholesale Solar flagship office.

Their 16.8% efficiency is very respectable at this price point, and the warranty is on par with industry standards.

If you are simply looking for high-quality panels at the best possible price, the Astronergy 325W panel is our go-to recommendation.

Astronergy has a long, stable history in the solar industry. We have been working with them for about 10 years and have found their panels to be remarkably consistent in quality.

They're also part of the Chint Group, one of the largest electronics companies in China. That kind of backing gives us extra reassurance that Astronergy will be around for the long haul.



### **Astronergy 325W**

- Cost: \$165 (51 cents/watt)
- Workmanship warranty: 10 years
- Performance warranty: 25 years
- Efficiency: 16.8%
- Degradation: -0.7% / year
- Temperature coefficient: -0.408% Wp
- # of cells: 72
- Cell type: Poly



## Best American Panels: Solar 305W / 360W

Among the American solar panel manufacturers, Mission Solar is our top pick. They design and assemble high-efficiency panels in San Antonio, Texas.

With solar panels getting cheaper all the time, the price gap between imported and American panels has shrunk considerably. Imported 325W Astronergy panels now sell for 51 cents per watt, while American-based Mission Solar sells 360W panels at 68 cents per watt.

Compare that to the premium LG panels featured in the next section, which go for \$1.38 per watt.

Looking at the price distribution, Mission Solar's place in the market is clear. Their prices are competitive with imported panels, and they also give the high-efficiency models a run for their money on output (while blowing them out of the water on the price tag).

If you want to pick up some high-efficiency American panels at a competitive price, Mission Solar is the go-to choice. We recommend their 305W (60-cell) and 360W (72-cell) options.



### Mission Solar 360W

- Cost: \$245 (68 cents/watt)
- Workmanship warranty: 10 years
- Performance warranty: 25 years
- Efficiency: 18.36%
- Degradation: -0.7% / year
- Temperature coefficient: -0.377% Wp
- Cells: 72
- Cell type: Mono

# Best Premium Panels: LG 360W

We feature LG's 360W panel in our premium packaged systems. They are super space-efficient, packing more output into a 60-cell panel than most 72-cell panels on the market are capable of producing.

Every solar project is different, and some people have the challenge of building a system in a compact space. For example, you may only have room for 10 panels on your roof. These LG panels will help you squeeze as much output as possible out of the limited space available to you.

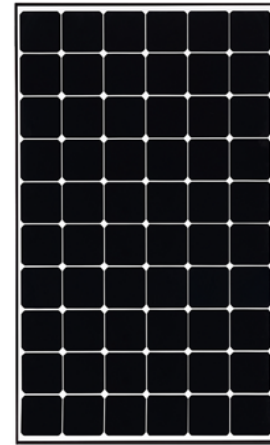
They also have a long lifespan. At  $-0.4\%$ /year, the degradation rate of these panels is  $0.3\%$  better than our featured Astronergy 325W panel.

That may not sound like a lot, but when you work the math out, it means LG panels will retain  $7.5\%$  more efficiency than Astronergy panels at the 25-year mark.

And LG's solar panel warranties are a thing of beauty.

Where most companies aim for a 10-year workmanship warranty, LG covers the full 25 years.

On the performance warranty side, LG ensures their panels will still be  $87\%$  efficient after 25 years. Most panel warranties promise  $80\%$  output after 25 years, meaning LG panels should be a bit more efficient after the warranty is up.



## LG 360W

- Cost: \$495 (\$1.38/watt)
- Workmanship warranty: 25 years
- Performance warranty:  $87\%$  efficiency after 25 years
- Efficiency:  $20.8\%$
- Degradation:  $-0.4\%$  / year
- Temperature coefficient:  $-0.3\%$  Wp
- Cells: 60
- Cell type: Mono

# Best RV / Boat Panels: SunPower

Solar is also a great solution for mobile applications like RVs and boats. But you'll need smaller panels to work around any space constraints.

The solution for this is SunPower 50W and SunPower 100W flexible panels.

The lower profile helps you find the right configuration with limited space available. And since these panels can bend up to 30 degrees, they can flex around curved surfaces to make the most of the space you have.

These panels are lightweight, easy to install and perform well in low light. They're built to adapt to rough and changing conditions that come with living life on the road.

At close to \$2.50 per watt, they're more expensive than traditional panels (even the premium LG panels). But it's a fair trade-off for a mobile-ready solar panel solution built to perform in harsh conditions.



## SunPower 100W

- Cost: \$249 (\$2.49/watt)
- Workmanship Warranty: 5 years
- Performance Warranty: 5 years
- # of cells: 32
- Cell type: Mono





## Best Industrial / Remote Panels: Solarland 140W-190W

The last category we'll look at is the best solar panels for small-scale remote applications.

These are used to power remote equipment for a variety of industries, including telecommunications, security & surveillance, oil & gas, traffic signals, and more.

This equipment is frequently set up in a remote location (like at the top of a mountain or floating on a buoy in the middle of a lake) and designed to run autonomously.

We recommend Solarland's product line for this application. The 160W (12-volt) and 190W (24-volt) panels are both good options.

For certain industrial applications, you may need panels that are certified for use in hazardous locations. SolarLand's C1D2 (Class 1, Division 2) panels work well for this. Take a look at the 150W (12-volt) and 140W (24-volt) configurations.

These can also be used on RVs and boats. If you don't need the flexibility of the Sunpower panels, Solarland's panels come out 25-50 cents/watt cheaper depending on the output.



### **Solarland 160W**

- Cost: \$325 (\$2.03/watt)
- Workmanship Warranty: 2 years
- Performance Warranty: 25 years
- # of cells: 36
- Cell type: Poly

# PRICE COMPARISON CHART

Solar panel technology is still evolving at a rapid pace. Panels have gotten 6-8% cheaper each year since 1998, and we don't expect that trend to change anytime soon.

To close out this guide, let's look at the current and historical prices of grid-tied and off-grid systems, as well as the expected cost to install your system (if you choose to hire a contractor).

For the sake of comparison, we will start with the standard 60-cell or 72-cell panels that we use by default in our system packages. These are the "full-sized" panels you are going to use when you build a complete system for your home or office.

Manufacturer	Price (as of 10/30/18)	Output (watts)	Cost per watt	Material	Made in...
Astronergy	\$155	280W	\$0.55	Poly	Malaysia
Astronergy	\$165	325W	\$0.51	Poly	Malaysia
Mission Solar	\$219	305W	\$0.72	Mono PERC	America
Mission Solar	\$245	360W	\$0.68	Mono PERC	America
SolarWorld	\$189	285W	\$0.66	Mono	America
Panasonic	\$453	330W	\$1.37	Mono	Japan
LG	\$495	360W	\$1.38	Mono	Korea

And here's the picture for small panels with more limited use cases. These are the ones you'll use on your RV/boat, industrial worksites, and other remote applications.

Manufacturer	Price (as of 10/30/18)	Output (watts)	Cost per watt	Material	Made in...
Solarland	\$324.80	160W	\$2.03	Mono	China
Solarland (Industrial Rated)	\$337.13	150W	\$2.25	Poly	China
Sunpower (flexible)	\$253	100W	\$2.53	Flexible	France

# CONTINUE YOUR RESEARCH

## More Resources

### Getting Started With Solar

We all start out in the dark. Download our Getting Started Guide to learn the basics of solar.

[Get the Guide »](#)

### Solar Permitting Guide

Permitting is the most time-consuming part of the process. Get a head start with our Solar Permitting Guide.

[Get the Guide »](#)

### Federal Tax Credit Guide

You can claim a portion of your project costs as a credit toward your taxes. Follow our guide to learn how to claim the credit.

[Get an Estimate »](#)



## TALK TO A SOLAR EXPERT.

Ready to get to work? Connect with our design team for a free consultation.

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