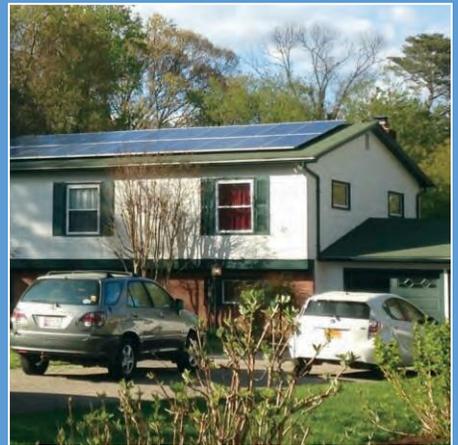




A Maryland Consumer's
GUIDE TO SOLAR



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Prepared for the Maryland Energy Administration
by members of the Maryland Energy Administration
and the Clean Energy States Alliance.



About the Maryland Energy Administration (MEA)

The Maryland Energy Administration (MEA) promotes affordable, reliable and cleaner energy for the benefit of all Marylanders. To achieve this mission, MEA advises the Governor and General Assembly on matters relating to energy policy. MEA administers grant and loan programs to encourage clean energy technologies in all sectors of Maryland's economy: residential, commercial, agricultural, and transportation. To learn more, go to <http://energy.maryland.gov/Pages/default.aspx>.



About Clean Energy States Alliance

Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country. CESA works with state leaders, federal agencies, industry representatives, and other stakeholders to develop and promote clean energy technologies and markets. It supports effective state and local policies, programs, and innovation in the clean energy sector, with an emphasis on renewable energy, power generation, financing strategies, and economic development. CESA facilitates information sharing, provides technical assistance, coordinates multi-state collaborative projects, and communicates the views and achievements of its members. Learn more at www.cesa.org.

**Unless otherwise indicated,
all photos are courtesy of MDV-SEIA.**

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Disclaimers

This report is for informational purposes only and does not constitute legal or financial advice from the U.S. Department of Energy, the Maryland Energy Administration, CESA, or other contributors.



Maryland
Energy
Administration

A Note from the Director

So you are considering “going solar?”

This booklet is designed to provide an educational resource for Maryland residents who are considering installing a solar photovoltaic system on their home. As solar PV systems are expected to have lifetimes of 25 years or more, it is important for residents to have a good understanding of all aspects of the decision to “go solar.” Among other things, this guide discusses the attributes of a good residential solar system, different methods of system ownership or finance, and key questions to ask BEFORE signing a contract. Many of the topics addressed in this document are based on frequently asked questions regarding solar submitted to the Maryland Energy Administration, the State of Maryland’s energy office.

This solar guidebook also discusses Community Solar, a new pilot program in Maryland that provides solar options for those who rent, as well as for those households who may not have good solar access due to shadowing from trees or other buildings.

If after reading this booklet you have additional questions, feel free to consult the Maryland Energy Administration website (www.energy.maryland.gov) or call 410-537-4000.

Mary Beth Tung
Director

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ABOUT THIS GUIDE

If you're a Maryland resident considering solar power (also known as photovoltaics or PV), this guide will equip you with information you need in order to make sound decisions. Solar power has many benefits, but investing in it may not be for everyone. There are many different ways to structure and finance a solar system. This guide will help you decide if there's an approach that will work for you.

This guide is for reference. You do not have to read it from cover to cover. Some readers will be more interested than others in learning the technical details of how panels work, or in learning how to sell Solar Renewable Energy Certificates. You may want to refer to certain sections at different points in the decision making and installation process. Understanding all of the factors that describe a solar installation is complicated, but keep in mind that thousands of these systems have been installed and most of the project owners are not experts in physics, economics, or electrical engineering. This guide provides information in the following sections:

- SECTION 1:** Reasons Maryland residents are choosing solar
- SECTION 2:** The physical components of a PV system
- SECTION 3:** Consumer needs, opportunities, and system design considerations
- SECTION 4:** Ways to finance a solar system
- SECTION 5:** Solar savings and incentives, including the federal tax credit, net metering, and Renewable Energy Certificates (RECs)
- SECTION 6:** Choosing a solar contractor and reviewing a solar contract
- SECTION 7:** Solar system permitting
- SECTION 8:** What happens after your system is installed
- SECTION 9:** A list of questions to ask a prospective solar contractor
- SECTION 10:** A checklist for going solar

Solar panels are a big investment, whether you buy them outright, finance them over a number of years, or sign a contract to purchase the power from an array. Take some time to learn about solar power, and about your contract, so you can be confident that your investment is a good one.



10 KEY THINGS TO REMEMBER

If You're Thinking about Solar

1. Consider energy efficiency.

Consider installing energy efficiency measures first, before you install solar. Reducing the amount of energy used by your home will allow you to install a smaller, less expensive photovoltaic system. See “Energy Efficiency First” on p. 10.

2. Solar is a significant investment.

Going solar is a significant investment, comparable to buying a car or making major home improvements. Make sure you think it through carefully.

3. Financing options are available.

There are four main ways to pay for a solar photovoltaic system, each of which has advantages and disadvantages. See “Financing Your Solar PV System” on p. 24.

- Paying cash up front
- Financing a system through a loan
- Signing a solar lease
- Signing a power purchase agreement

4. Net metering is key.

Net metering is an arrangement in which the utility credits you for electricity your system generates that is not used onsite and is instead added back onto the grid. See “Net Metering” on p. 29.

5. Community solar is an option.

If installing solar on your own home or land isn't viable, or if you don't own your home, there are still solar options for you. Both renters and homeowners can potentially participate in a community solar project, which is an offsite solar array that serves multiple customers. See "Community Solar" on p. 21.

6. Federal incentives are available.

For those solar photovoltaic system owners that pay federal income taxes, the federal government provides a significant tax credit that helps reduce the total cost of your solar system. See "Federal Tax Credit" on p. 28.

7. Several contractor bids are better than one.

Consider proposals or bids from at least three different solar contractors to help select the best solar installer for you. See "Choosing a Contractor" on p. 31.

8. Calculate the financial deal.

Before selecting a bid and signing a solar contract, calculate your net savings, return on investment, and/or payback period. See "Calculating Savings" on p. 52.

9. Understand the impact of changing utility rates.

In any calculation of how much money your solar system can save you, assumptions about future utility rate increases are very important. Make sure that you and your contractor are calculating future electricity costs appropriately. See "Understanding Utility Rate Increase Impacts" on p. 33.

10. Know what you are signing.

Make sure you read and understand your solar contract before you sign it. See "Contract Provisions" on p. 25 as well as "Signing a Contract" on p. 34.

Reasons Maryland Residents Are Choosing Solar

Energy Efficiency First

Energy efficiency should always come first. It is usually more cost efficient than solar; it reduces the cost, size and footprint of the final solar system; and it is often subsidized by the local utility under the EmPower Maryland program. Installing insulation in the attic and walls, adding weather-stripping, using energy efficient lights (such as LED lighting), and using energy efficient appliances (such as those identified as EnergyStar®) can provide energy savings month after month while also reducing the size of the desired solar system. Every home is different, so homeowners should have a complete home energy audit conducted to guide the energy efficiency effort. The size of a solar system is often based on the total amount of electricity used in a year; for the most accurate results, the energy impacts of efficiency measures should ideally be tracked for a year to determine the correct new baseline for solar array sizing. Alternatively, the new energy baseline can be estimated given the old baseline and the estimate of energy savings from the energy efficiency measures.

There are a variety of reasons to choose solar. Below, we list some of the most common:

Financial

As the cost of solar panels has fallen significantly over the past decade, many Maryland residents have been able to save money with solar panels.

Environmental

Much of the electricity used in Maryland comes from power plants that burn fossil fuels.¹ When fossil fuels are burned, they produce emissions that contribute to air pollution, as well as producing carbon dioxide, a greenhouse gas which causes global warming. Solar panels can reduce the need for electricity production from fossil fuels and thereby decrease the emission of greenhouse gasses.

Local Economic Development

Solar installations in Maryland give rise to in-state solar construction and maintenance jobs. According to the Solar Foundation 2016 Solar Jobs Census, Maryland employed over 5,429 people in jobs directly related to the project development, manufacturing, installation and sales of solar energy systems. This was a 27 percent increase over the 2015 Solar Job Census.²

Solar Goals

The Maryland Renewable Portfolio Standard (RPS) sets requirements for the renewable energy attributes of the state's electricity. In addition to a general renewable energy requirement, the RPS includes a specific amount of electricity which must come from solar energy (commonly called the solar carve-out).³

Energy Independence and Resilience

Some Maryland residents choose solar because they want to be more independent and produce their own power, or because they are far

¹ While only about 40 percent of the electricity produced in Maryland comes from fossil fuels, Maryland imports electricity from surrounding states which tend to be more dependent on fossil fuels. Electricity generated in Maryland (and producing pollution in Maryland) includes: nuclear 45.5%, coal 25.4%, natural gas 16.3%, hydroelectric 8.3%, non-hydroelectric renewables 4.0%, and petroleum fired generators 0.4%. U.S. Energy Information Administration webpage. Maryland State Profile and Energy Estimates, accessed 8/31/2017 <https://www.eia.gov/state/?sid=MD#tabs-4>

² The Solar Foundation webpage. Solar Jobs Census 2016. Accessed 8/31/2017 <https://solarstates.org/#states/solar-jobs/2016>

³ Annotated Code of Maryland: Public Utilities, Section 7-703.

from the power grid. Residential solar systems can be either off-grid (not connected to the electric grid) or grid-connected. To be completely independent of the grid requires investing in a stand-alone inverter system and installing battery storage. Most people who go solar don't choose an off-grid system. A grid-connected PV system will not function in the case of an electricity outage unless the home has an accompanying electricity storage system and the ability to "island" (completely disconnect from the grid). But even a simple grid-connected system provides some cost independence as it reduces the amount of electricity purchased from the grid and therefore subject to utility rate fluctuations.



As the cost of solar panels has fallen significantly over the past decade, many Maryland residents have been able to save money with solar panels.

What Is a Solar PV System?

Photovoltaic (PV) systems convert sunlight into electricity. Sunlight strikes the solar panel material and frees electrons, creating electricity.

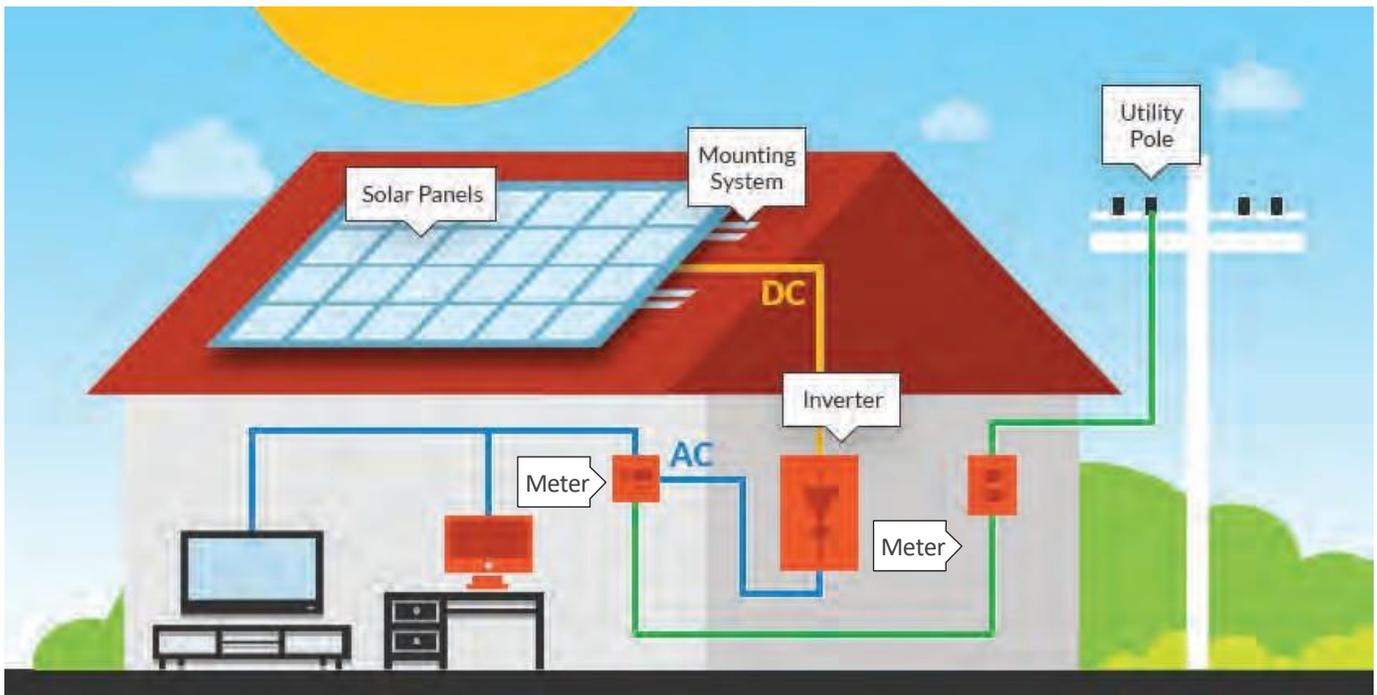
The electricity produced in a photovoltaic system is direct current (DC). Other than some off-grid homes and specialized appliances, homes use alternating current (AC). The PV system changes the DC into AC through the use of an inverter. The output of the inverter is then connected to the home's electrical system so that the electricity produced by the PV system can power the home.

PV systems have few moving parts and are generally very reliable. They require little maintenance. Understanding the components of a PV system can help you decide whether to go solar, and how.

The Solar Cell and Panel

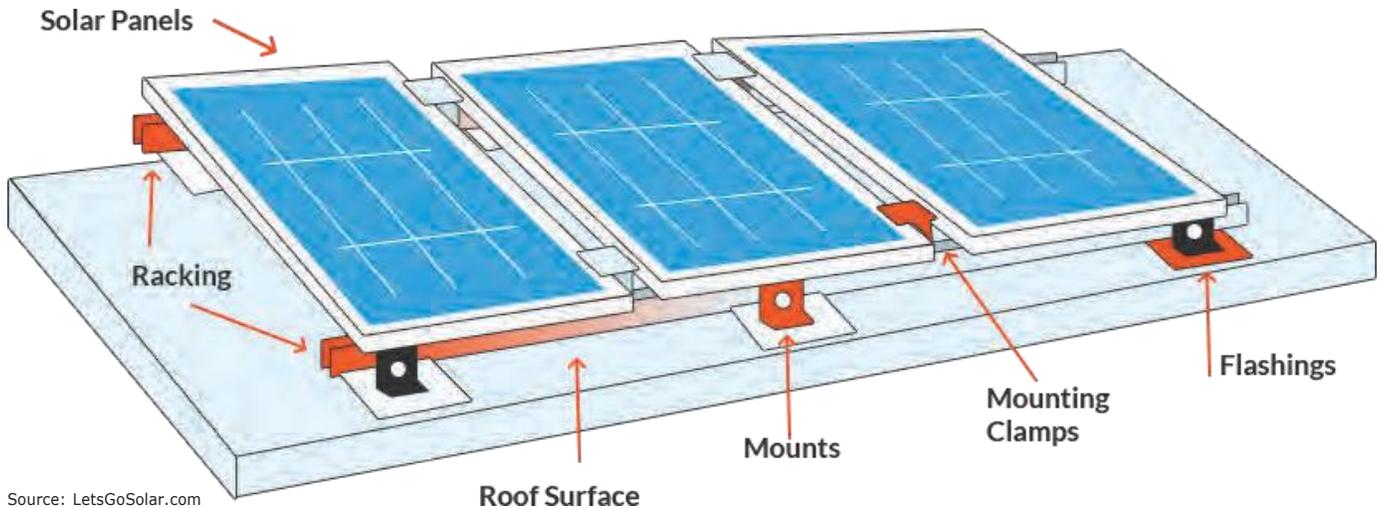
The basic electricity producing structure is the solar cell, which is normally comprised of silicon and electrodes. Cells are strung together in a module (often called a panel). A number of panels connected together electrically (in series) and fed into the inverter (described below) is known as a string. The entire system, consisting of one or more strings connected together in parallel, is referred to as the solar array.

FIGURE 1 *Typical Component Placement*



Source: LetsGoSolar.com

FIGURE 2 *Traditional Rooftop Mounting System*



The output of a panel is measured in DC-watts.⁴ The nameplate output of a panel represents the amount of power produced under rated conditions. Lower output panels have fewer cells and come in smaller sizes. Choice of panel size, output and shape will usually depend on the installation method and location. Solar panels are available in varying colors, shapes, power outputs, efficiency and appearance.⁵

Materials

The external components of a solar panel include the cover (usually glass with an anti-reflective coating), composite backing, aluminum frame along the perimeter and sometimes along the back, and wiring to connect the panel to the rest of the system. A back frame, when present, helps to support the weight of the panel under snow loads.

Inside the panels, different kinds of cell materials are used to generate electricity. Currently, the most widely used material is a polycrystalline silicon, which is inexpensive to manufacture and can be recognized by subtle shades of blue and blue-black in the cells. Another, more expensive option is to use monocrystalline silicon, which uses purer silicon grown into a single crystal structure. This material results in a uniform color and slightly increased output efficiency. Another option is thin film manufactured cells, which are less expensive to manufacture but are also less efficient. This material is used in a wide range of installations, including flexible panels and roofing materials.

Building-integrated panels (BIP) refer to solar panels that replace the need for conventional walls and roofing and are used both as the weathering surface of a building and for solar generation. These and other emerging technologies currently in commercial development may result in new opportunities in the future.

⁴ A DC-watt is equal to the DC voltage multiplied by the DC current.

⁵ Most modern full-sized panels are rectangular and measure around 17.6 square feet for a 60 cell/275-watt panel, and about 21 square feet for a 72 cell/350-watt panel.



Racking and Mounting

Racking and mounting systems secure solar panels together and attach them to the building structure or to the ground, usually as part of the system's electrical grounding. (Proper grounding is required by electric codes to ensure safe system operation.) Since most panels are warranted to last 25 years and will likely last longer, it is good to have quality racking that can last at least 25 years without corrosion or other degradation and can withstand wind, ice, and snow loading. Racking is comprised of several parts. Panels are clipped to the racking rails (primarily aluminum), and the rails in turn are secured to mounting units. These units secure the system to the support structure (either a roof, pole or the ground). The racking can also provide channels for wiring, offering protection and aesthetic benefits for the system. Some racking is available in different colors to match roofing and panel composition (such as silver and black).

In a roof-mounted system, the mounts are usually secured to underlying rafters and include multiple layers of waterproofing and flashing to protect the roof from water damage and leaking. Mounting is a critical component to protect the roof and ensure the long-term viability of the system and the home. Homes with standing seam metal roofing can have the solar panels clipped directly onto the metal roofing, avoiding the need for any roof penetration or flashing. Roofing material, age, and quality can affect the choice of racking and mounts.

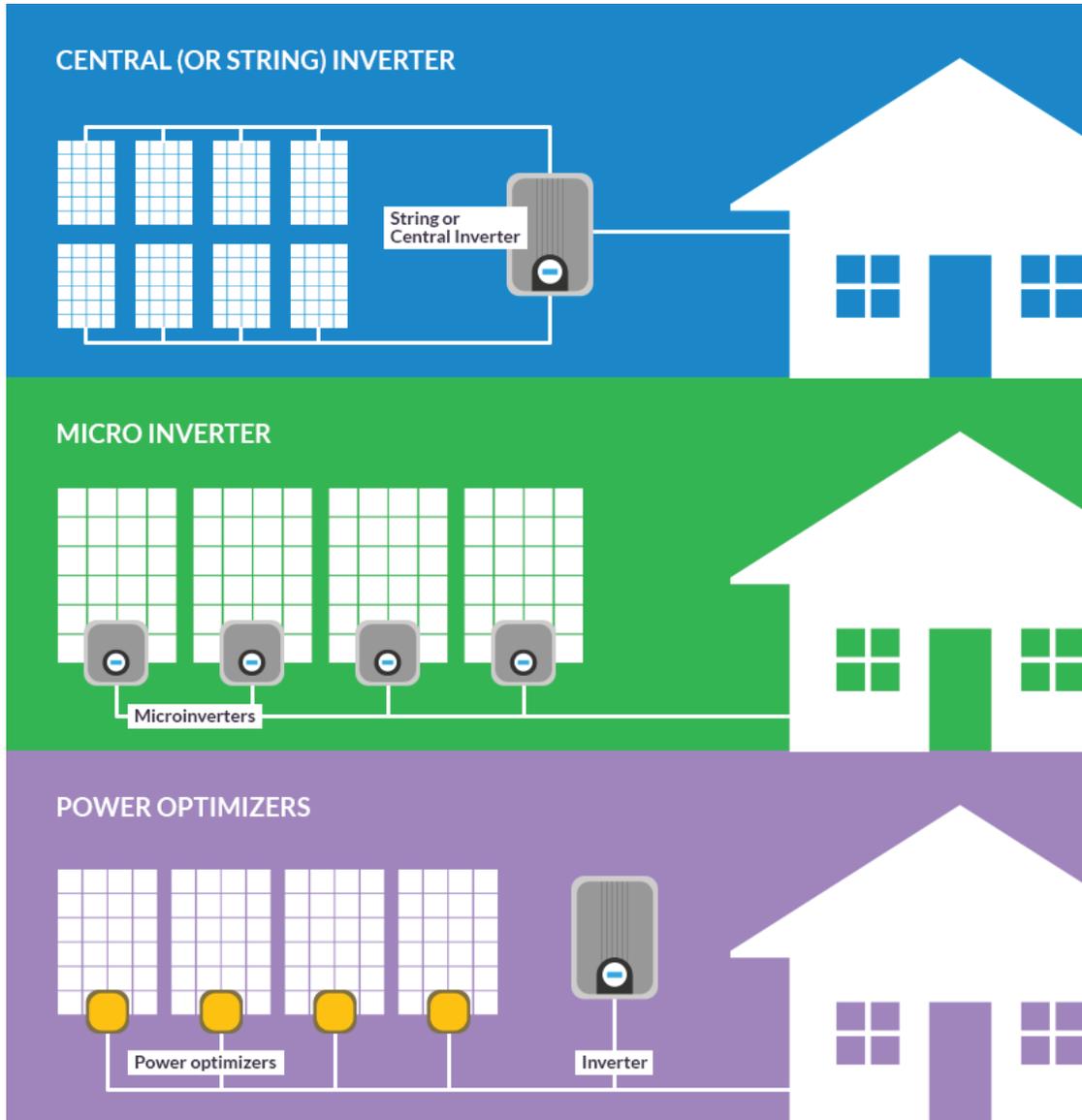
In some cases, a ground or pole-mounted system is a better option than a roof-mounted system. Some roofs may be old and in need of repair/replacement, or they may not be strong enough to carry the extra weight of the panels; orientation or shading may limit the output of a rooftop system; or there could be an aesthetic concern. In these cases, solar arrays can be mounted directly to the ground using racking systems manufactured for this purpose. Ground systems may also be mounted on the side or top of a pole. Although ground-mount installations can increase the installation cost due to additional construction time and materials, as well as the added cost of running connecting wiring to the electricity panel, it may provide greater flexibility in location. It is critical to ensure the ground-mounting solution matches the site's soil bearing capacity and is secured at a sufficient depth to prevent frost heaving (vertical ground movement caused by freezing and thawing of the moisture in the soil). For ground-mounted systems, it is necessary to consider the average snowfall in the area when determining the minimum height of the lowest solar panel as snow sliding down from the panels can build up and block the lower level of the panels.

Ground mounted systems (both pole and rack types) are available that allow the panel tilt to be seasonally adjusted to maximize solar production. These systems are usually adjusted two to three times a year and can increase annual solar production by about five percent.

Trackers

Some pole-mounted systems use trackers to keep the panels pointed toward the sun on a daily basis. Tracking systems track on either one or two axis. Single-axis trackers (moving the panels east to west over the course of a day) can increase output by up to 20 percent over a fixed system. Dual-axis trackers move both east and west and up and down to keep the panels always pointing directly at the sun. These trackers can increase output by up to 30 percent over a fixed system. Trackers increase the installed cost of a system and, because they involve moving parts, they require additional maintenance. Consumers should carefully weigh the benefits and costs of such systems when deciding what type of system is best for their needs.

FIGURE 3 *Types of Solar Inverters*



Source: LetsGoSolar.com

Wires

A PV system will require wiring between the panels, from the array to the inverter, and from the inverter to a building's electrical panel. Wiring that runs outdoors has different specifications than normal building wiring. The wiring must last a long time and should be enclosed in conduit when necessary to protect it from the elements and from rodents (especially squirrels). Running wiring along racking underneath the panels can ensure a clean looking installation and protect the wiring from the elements. Plan for additional wiring if the PV system might be expanded in the future.



Inverters

The inverter changes the direct current (DC) power coming from the panels (or from a battery) to alternating current (AC). The inverter includes protective devices such as fuses, breakers, and the necessary components to automatically disconnect from the grid in the case of a power outage. Inverters can include heavy-duty enclosures that allow them to be installed outdoors.

There are two primary types of inverters: central inverters and micro-inverters. Central inverters manage parallel strings of panels. Because the panels of a string are wired together in series they work together as a single unit, and shading on one panel will impact the efficiency of the entire string. With micro-inverters, each panel is individually managed by its own dedicated inverter. While this means that shading of individual panels will not affect the entire array's output, it comes with a higher monetary cost. Individual panel output can also be monitored through the use of micro-inverters. If your system will be impacted by partial shading, it may make sense to consider micro-inverters. Ask your solar contractor if using DC-DC optimizers⁶ or micro-inverters are worthwhile given your specific installation conditions.

Inverters generally don't last as long as solar panels, so inverters may fail and need to be replaced during the life of a solar system. The failure of a central inverter will stop the output of the entire solar array; if micro-inverters are used, the failure of a single micro-inverter will only stop the output of the individual panel.

6 A DC-DC optimizer matches the output characteristics of a solar panel, or a string of solar panels, to the input requirements of the inverter. While this improves the performance of the central inverter and the solar system as a whole, it comes with an added monetary cost.

Meters

When you install a PV system, the utility company may install a second electric meter to measure the output of the solar array. This would be in addition to the regular electric meter provided by the utility company to measure electricity usage and provide reliable service. In some cases, the utility will simply install a meter that can run backwards, depending on the direction of power flow.⁷

Including Storage—On-grid and Off-grid Options

Off-grid solar systems always require energy storage to provide electricity when the sun is not shining. For grid-connected systems, battery storage is an option that can provide some electricity when the grid fails during storms or other events. This can be especially appealing if a home experiences frequent outages, or if there are essential systems, such as medical equipment, that need to operate at all times.

With storage comes some additional equipment and cost. Additional components and monitoring will be required to ensure the battery system is maintaining its proper charge and system functionality. Charge controllers, specialized inverters, and batteries are the major components of a system with electrical storage. If you are interested in having storage, you should work with a system designer/installer that specializes in storage-based systems.

Several battery systems are designed to be low or no maintenance and relatively easy to operate. Some of these newer systems benefit from advances in battery materials and technology. They are sealed, produce no off-gasses, and do not require electrolyte levels to be checked.

Solar Photovoltaics vs. Solar Thermal

This guide focuses on using sunlight to make electricity with PV panels. Sunlight can also be used to make things hot, including heating water for household hot water use. PV panels and solar hot water panels are sometimes side-by-side on the same roof, but they function completely differently. Solar hot water panels can reduce water heating bills. Some installers have experience with both PV and solar hot water panels.

Another option for heating hot water sustainably is to install a highly efficient electric heat pump water heater, and power it with electricity from PV panels. Heat pump water heaters pull ambient heat from the surrounding environment into a storage tank where it is used to heat water. Heat pumps are an added expense, but might save money in the long run through reduced fuel costs. Some utilities offer an incentive for heat pump water heaters.⁸

⁷ These bi-directional meters may also allow for time-of-use billing, an optional rate structure in which the cost of electricity changes during the course of a day. Consider asking the advice of the utility company or an energy advisor when selecting an electrical rate structure, such as a flat rate or time-of-use rate (if offered).

⁸ BGE incentive can be found at: <http://bgsmartenergy.com/residential/appliance-rebates/hybrid-water-heaters>
Pepco incentive can be found at: <https://homeenergysavings.pepco.com/appliance-rebate-program/overview/electric-heat-pump-water-heater>
Delmarva incentive can be found at: <https://homeenergysavings.delmarva.com/appliance-rebate-program/overview/electric-heat-pump-water-heater>
Potomac Edison incentive can be found at: <http://energysavemd-home.com/appliance/water-heater-rebates>

Battery Storage

Battery storage comes in two primary forms. For most off-grid systems batteries are DC-coupled, meaning the direct current from the solar panels is fed directly to the batteries, and the batteries can run both AC equipment (through an inverter) and DC equipment (if your home is equipped with such equipment). Most grid-connected systems use the alternative, an AC-coupled system, which is connected directly to the AC electrical system in your home and uses a bi-modal inverter that can both supply AC power from the batteries or produce DC power to charge them. These systems operate in standard “grid-connect” mode until utility power fails at which point they disconnect (island) from the utility and draw power from the batteries to power a home. Some battery-based systems can be structured to accommodate additional energy sources, such as diesel generators.

Is a PV System Right for You?

Solar power has a lot of benefits, but it may not be for everyone. Before you decide to go solar, consider your particular circumstances and what benefits you are looking for.

Efficiency

Whether your priority is saving money or tackling climate change, it often makes sense to pursue energy efficiency measures. Unless you already have a very energy efficient home, consider energy efficiency measures *before* you invest in solar panels. Switching out lightbulbs, replacing old appliances, air sealing, and increasing insulation can reduce the amount of energy your home needs.

Another reason to invest in efficiency first (or simultaneously) is that efficiency improvements will affect the size of the PV system you may need. Once you've made your home more energy efficient, your electricity use will be reduced and a smaller, less expensive PV system will meet your electricity needs.

Start by contacting your electric utility to identify a company that can provide a low-cost energy audit to identify the efficiency opportunities in your home:

- **Pepco:** <https://homeenergysavings.pepco.com/home-performance-with-energy-star-program>
- **Delmarva:** <https://homeenergysavings.delmarva.com/home-performance-with-energy-star-program>
- **BG&E:** <http://bgesmartenergy.com/residential/home-performance-energy-star>
- **Potomac Edison:** <http://energysavemd-home.com/home-performance>
- **SMECO:** <https://www.smeco.coop/save-energy-and-money/home-performance>
- **Choptank:** <http://choptankelectric.com/content/home-energy-audits>

You can also go to the Maryland Home Performance with Energy Star website⁹ or call the Maryland Energy Administration at 410-537-4000.

Renter or Owner

There are ways to invest in solar whether you own your home or rent it, but the options and things you need to think about are different. If you rent, community solar (net metering from an off-site solar array) is likely the best option. Community solar may also make sense for homeowners whose home is heavily shaded or otherwise not ideal for solar.

Electric Bill

You should examine and understand your electric bill in order to help determine whether solar makes sense for you.

Residential electric bills in Maryland consist of a customer charge, an energy charge, and a transmission and distribution charge. The customer charge is an amount that is the same no matter how much electricity you use. It is generally between \$6 and \$18 per month, depending on the utility and the rate structure. The customer charge pays the utility company for account maintenance (booking, meter reading, etc.).

⁹ Maryland Home Performance with Energy Star website: <http://mdhomeperformance.org>

The energy charge pays the energy provider for the produced electricity. Through Maryland's Electric Choice efforts, Maryland residents have an option to select the electricity supplier who they want to provide their energy. Residents are then charged the electricity supply rate specified by the selected electricity supplier. If a customer does not select an energy provider, the local distribution company provides the energy and charges based on the electricity sources that they use. The local distribution utility normally sells this electricity on what is called a "Standard Offer Service" or "SOS."

The energy charge is based on the amount of electricity you use, which is measured in kilowatt-hours (kWh). For instance, the line item for your energy charge might say, "1,000 total kWh @ \$0.08/kWh = \$80." In most cases, Maryland residents pay a fixed rate per kWh, regardless of the amount of electricity that they use. But in some cases, electric customers pay varying amounts per kilowatt-hour depending on how much electricity they use. For instance, a customer may pay a certain amount per kWh for the first 800 kWh during the month, and a different amount per kWh for any amount over 800 kWh.

The transmission and distribution charge (sometimes called a T&D charge) pays the local utility to get the power from the major substation to you.¹⁰ For residential customers, the T&D charge is normally based on the amount of energy that is used, such as "1,000 total kWh @ \$0.023/kWh = \$23."

As authorized by the Public Utility Commission, additional charges may be added to your bill through "riders." Riders may be temporary or permanent and may be geographically applied. Riders may be fixed charges (the same for every customer, regardless of the amount of energy used), or based on energy use (dollars per kWh).

The difference between the customer charge, the energy charge, and the T&D charge is important because these charges are treated differently under Maryland's net-metering rules. See the net-metering section on p. 29 for more information.



¹⁰ Electricity is delivered to the major substation at a very high voltage. The utility transforms the electricity to a lower voltage, and then delivers it to you at a voltage suitable for your residence. Most residences receive 240 volts AC, which is distributed within the home as 240 V and 120 V.



Roofing Material, Roof Age, and Roof Condition

If you want to put solar panels on your roof, you need to have the right kind of roofing material, and it should be reasonably new and in good condition. Asphalt and metal roofs are often good candidates for solar panels. Installing solar panels on slate roofs is generally not recommended because of the potential to damage the slate.

Solar panels are usually warrantied for physical defect for 10 years. They also have a performance warranty of 25 years, guaranteeing that in the 25th year of operation they will still produce 80 percent of the energy produced in the first year of operation. Many solar panels have been able to produce power for much longer than 25 years. Every roof has a life expectancy. It may not make financial sense to install panels on a roof that will need to be replaced in the next 10–15 years, as costs would be incurred to take down and reinstall the solar panels. Have your roof professionally evaluated before solar panels are installed. Metal roofs typically last longer than asphalt, but you should still determine the condition of your roof before you install solar panels so you know when the existing roof is likely to need replacement.

If you anticipate needing to replace your roof, but you still want to go solar, your options include replacing the roof first and then installing solar panels, replacing the roof and installing the solar panels at the same time, getting ground-mounted solar panels, or participating in a community solar project. It is possible to remove the panels when you replace the roof, and then re-install them on the new roof, but it may cost 20 percent or more of the original installation cost.

Another possibility is the solar shingle, a kind of roofing material that also functions as a solar panel. Their recent improvement has renewed interest in the technology. They combine the power generating capability of a solar panel with the environmental protection and water-proofing abilities of a good roofing material.



How Much Direct Sunlight Does Your Roof Get? (Orientation, Tilt, and Shading)

Orientation refers to the direction your roof faces. The best orientation for solar panels is true south, but southeast or southwest might also work. In Maryland, true south is about 11 degrees west¹¹ of magnetic south. (If you take the direction from a compass and subtract 11 degrees, then you get the direction in degrees True.)

Tilt refers to the slope of the solar panel. Some solar panels are attached parallel to the tilt of the roof while others are placed at an angle to the roof. The best roof tilt for solar panels in Maryland is 35–40 degrees, but other slopes can work. Flat roofs may work using special ballasted mounting systems.

Shading refers to the extent to which objects (trees, other buildings, or parts of your house such as chimneys and dormers) cast a shadow on your roof. Partial shading can significantly reduce the energy output of the panels, especially if a system uses central inverters. Full sun in the middle hours of the day (9 am to 3 pm standard time, or 10 am to 4 pm daylight savings time) is especially important.

Orientation, tilt, and shading together determine how much sunlight your roof panels will get, and how much electricity they will produce. If your roof is not well suited for solar panels because of orientation, tilt, shading, or the shape of the roof, but you still want to invest in solar, your options include getting ground-mounted panels (if you have a sunny piece of ground free from shading) or participating in a community solar project.

Neighborhood Concerns

When you install solar panels, they may be visible to your neighbors. Some neighbors may like the way they look; others may not. If possible, talk with affected neighbors before installing the panels. They may have preferences about where and how you install your panels, and it may be possible for you to realize all the benefits of going solar while also satisfying your neighbors. It might also encourage them to explore adopting PV. You have no legal obligation to talk to your neighbors about your plans to install solar panels, but it may prove worthwhile.

For those living in a Homeowners Association (HOA), the law provides guidance on the HOA’s authority over the installation of solar panels.¹² Paraphrased, the law states that an HOA may not impose unreasonable limitations on the installation of a solar collector system on the roof or exterior walls. The phrase “unreasonable limitations” means 1) significantly increasing the cost of the solar collector system, or 2) significantly decreasing the efficiency of the solar collector system.¹³ The law can be found in Appendix B.

Community Solar (Off-site Solar)

Community Solar allows electric customers to gain the economic benefits of solar without having an array located on their own home or property, by subscribing to an offsite solar array. Community Solar projects allocate the electrical generation from a jointly owned or third-party-owned PV array to offset many customers’ electricity consumption. A community solar system can be structured in a variety of ways. No matter the structure, the community solar project will be administered by a subscriber organization that recruits project participants. The subscriber organization could be a solar developer, a nonprofit organization, or a group of electric customers. A community solar project may offer subscribers an ownership interest (i.e., owning a

¹¹ 10 degrees west in Cumberland, MD and 11 degrees 45 minutes in Salisbury, MD. See <https://www.ngdc.noaa.gov/geomag-web/#declination> for other locations.

¹² Annotated Code of Maryland, Real Property, Section 2-119

¹³ As of the date of this publication, the issues of “significantly increasing” or “significantly decreasing” have not been clearly defined or litigated in court.

portion of, and/or the electricity produced by that portion of the array) or a Power Purchase Agreement (PPA) (i.e., the right to purchase electricity from a portion of the array at an agreed upon rate while array ownership remains with a third party). See page 25 for an explanation of Power Purchase Agreements.

The community solar system that you participate in could be right next door, or it could be many miles away, but it must be in your electric utility's service area. One of the advantages of community solar is that even if you move to a new home, you'll be able to maintain your participation in the same community solar project as long as your new home is served by the same electric utility as your old home.

What is Community Solar?

"Community solar" is a term that means different things in different states. Maryland uses the term to specify a program that allows for virtual net energy metering. Do not compare the Maryland community solar program to the program of another state without fully understanding how the other state defines "community solar."

If, instead of signing an agreement with a community solar project, you're interested in developing your own community solar project, you'll need to explore issues that are beyond the scope of this guide. A good place to start is the Maryland Public Service Commission webpage focused on community solar: <http://www.psc.state.md.us/electricity/community-solar-pilot-program>.

What Happens with Your Solar Panels if You Move to a New Home?

What occurs when you move to a new home depends on whether you own the solar panels or have signed a lease or power purchase agreement with a third-party owner. (See Financing on p. 24.) It also depends on whether your solar system is located at your home or off-site at a community solar project.

If you own panels at your home, you may remove the solar panels and take them with you to your new home, or you may leave the solar panels on your existing home with the hope that they will increase the value of your house to the home buyer. A 2015 study from Lawrence Berkeley National Laboratory showed that buyers in various parts of the country were typically willing to pay about \$15,000 extra for a house with "an average-sized 3.6 kW PV system."¹⁴ However, there are no guarantees; home prices depend on local market conditions, as well as the personal preferences and energy knowledge of the individual buyer.

If you sign a lease or power purchase agreement, the panels on your property are owned by someone else. You should carefully read the part of your contract that talks about what happens if you sell your home. In some cases, the buyer of the home, if interested, may be able to take over the lease or power purchase agreement. In other cases, it may be necessary for you to buy out the lease or power purchase agreement in order to sell your home. You may also have to remove a fixture filing if one was attached to your property. (See Fixture Filings on p. 27.) Find out from your solar financing company what buying out your lease or power purchase agreement would involve.

If you are thinking of participating in a community solar system, you will need to carefully read the part of your contract that discusses what happens if you move to a new home. If your new home is served by the same utility as your old home, you should be able to continue participating in the same community solar system. If you move out of the utility service territory, you will no longer be able to benefit from the agreement. If you own a subscription, then you may need to sell it. If you participate by a power purchase agreement, you will need to check with your subscriber organization to determine what is required to terminate your agreement.

¹⁴ Hoen, B., Adomatis, S., Jackson, T., et al. *Selling into the Sun: Price Premium Analysis of a Multi-State Dataset of Solar Homes*. Lawrence Berkeley National Laboratory, 2015. <https://emp.lbl.gov/publications/selling-sun-price-premium-analysis>

FIGURE 4 *PVWatts Calculator (NREL)*



Source: NREL

Online Solar Calculators

Online solar calculators are tools that estimate how much energy a solar array (with given characteristics) is likely to produce and how much money is estimated to be saved. These calculators ask you to enter information such as your address, your utility electric rates, and how large a system you want to install. The calculator then estimates your potential benefits from solar.

The PVWatts online calculator from the U.S. Department of Energy (DOE) National Renewable Energy Laboratory (pvwatts.nrel.gov) is a relatively straightforward online solar calculator. PVWatts asks the user to input an address, system specifications, and electric utility rates. It then returns a month-by-month estimate of estimated electricity production (in kWh) as well as the financial value of the electricity generated.

There are dozens of other solar calculators online. Be careful about which calculator you use. Some calculators are provided by companies whose goal is to sell you solar panels. They may require you to participate in a “live chat” with a salesperson before they provide any information. They may also require you to reveal personal information. While a physical address is necessary to estimate how much sun shines on your property, there is no reason that a solar calculator needs to know your name, email address, or phone number in order to calculate what your benefit from solar will be.

Your Goals

When considering going solar, it's useful to think about your own goals and motivations. What is it about solar electricity that appeals to you? Are you most interested in the financial savings, the environmental benefit, the community benefits, or the opportunity to achieve greater independence from your utility?

Make sure you know what you want your solar system to do for you; then work with your solar designer to make sure the system that you receive (through purchase, lease, or contract) will accomplish your goals.

Financing Your Solar PV System

With the soaring popularity of solar in Maryland and around the country, new and creative financing options have been developed. The options fall into two basic categories: one in which the homeowner owns the PV system and another in which a third party owns it.

DIRECT OWNERSHIP

Purchasing your PV system outright, whether through the use of a loan or cash purchase, has its own set of benefits. As the owner of the PV system, you could claim any available tax benefits for which you are eligible. All savings on your electrical bill will be 100 percent yours. You will also own any Solar Renewable Energy Certificates (SRECs) that are produced. (See SRECs on p. 29.)

There are many solar loan products available. Home equity loans, special solar loans from banks and credit unions, and loans by the solar company may all be options. Loans vary greatly in terms of length of loan, interest rate, requirements, and security necessary.

Secured vs. Unsecured

A “secured” loan is backed by an asset, such as your home, and allows a lender to take a lien on your property. An “unsecured” loan is not backed by an asset. Secured loans can be more complicated and risk loss of the collateral asset if you default on the loan; however, secured loans often have lower interest rates.

Market Rate vs. Credit Enhanced

Market rate programs offer loans at the usual interest rates offered on the financial market. In contrast, credit enhanced programs offer customers more favorable interest rates or offer loans to customers with low credit scores, by providing some insurance to lenders. Credit enhancements are not widely available in Maryland at this time.

THIRD-PARTY OWNERSHIP

Within this broad category, consumers can choose between a lease and a power purchase agreement. As with any financial obligation, signing a lease or PPA may have consequences for your credit rating if you are unable to make payments.

Lease

A solar lease is an arrangement in which somebody else, typically a company, owns solar panels located at your home, and you lease the panels from the solar PV system owner. A solar lease generally involves a fixed monthly payment from you to the solar PV system owner over the term of the lease, which is usually 20 years. There may be little or no up-front cost. You can save money as long as the value of the electricity produced from the panels is greater than the cost of the lease. You may be able to begin saving money immediately.

Because the company owns the panels, the company, not you, is eligible to take advantage of the federal tax credit. As the solar PV system owner, the company is also responsible for maintaining and monitoring the system. Be sure to read the section below covering lease and power purchase

agreement contract provisions *before* you sign a lease contract; your monthly payment amount could be subject to change under the terms of the contract.

Power Purchase Agreements

A power purchase agreement is another arrangement in which somebody else, typically a company, owns solar panels located at your home. In this case, rather than leasing the panels, you agree to buy the power generated by the panels. Under this model, you only pay for the amount of power generated and delivered to your home, which will vary in amount from month to month. As with a lease, there may be no up-front cost, and you may begin saving money immediately. As with a lease, the company, not you, is eligible for the federal tax credit. Be sure to read the section below covering lease and power purchase agreement contract provisions *before* you sign a contract; your monthly payment amount could be subject to change under the terms of the contract.

Contract Provisions: Leases and Power Purchase Agreements

Leases and power purchase agreements involve many of the same issues:

- **System Performance:** Monitoring the system output is an important consideration for a contracted third-party system. If solar PV output is reduced due to a lack of maintenance or a defect by the system owner, you will be affected. This is most critical in leases but still important in power purchase agreements. Look for clauses in the contract that discuss what happens if the system doesn't perform as expected. How will the system be monitored? If there is a problem,



how quickly will it be fixed by the system owner? Will your payments be reduced in the meantime? Is there an annual “true-up” that adjusts your payments to match the actual output received, and if so, when does this occur?

- **Payment:** You will make a monthly payment to the company that owns the panels. If you have a lease, the monthly payment should be stable and predictable. If you have a power purchase agreement, the monthly payment will vary based on the output of the panels. You will also still have a monthly bill from the utility company, but it should be lower than your current utility bill, offset by the production from the solar system.
- **Operation and Maintenance:** You may have some maintenance responsibilities for the system, including limited cleaning. You may also be responsible for ensuring that no trees, other plant growth, or home modifications cast shadows on the system. A leasing company may require you to maintain an internet connection to enable them to monitor the system.
- **Escalation Schedule:** Most contracts will include a clause that increases the lease payment or power purchase agreement power rate over time. In theory, this escalation should match or be lower than the increase in utility power prices. However, if the contract payment accelerates faster than the price of utility power, then you will save less and less each year. It is impossible to predict with certainty what future utility prices will be, so there is inevitably some financial risk involved in signing a solar lease or power purchase agreement. Utility rate increases have varied over the last 20 years and the past is not always a reliable guide to the future. Regional variations, fuel prices, and regulatory changes can all affect power prices. **Remember that lease payment and power purchase agreement power rate increases will compound over time and can become significant. Ask your contractor for a complete schedule of payment amounts or per kilowatt-hour charges over the entire term of the lease or power purchase agreement.**
- **Read the Contract:** Ask questions and read the contract in its entirety to ensure you understand the terms, especially the items highlighted here. If there’s anything you don’t understand, it may be a good idea to consult with an attorney.
- **Renewing the Contract or Purchasing the System:** Some contracts will include an option for you to purchase the system or renew the contract for an extended term. The costs could be specified in the contract or could be based on the market value of the system at the end of the lease.
- **Ending the Contract:** Contracts should list circumstances that will result in termination of the contract. This should include default provisions, property loss, death of one or more of the residents, and what happens if the company goes out of business.
- **Selling Your Home:** Look at provisions in your contract regarding what happens if you sell your home. It may be possible to transfer the lease to the new homeowner, if the new owner is willing. The new owner may have to pass a credit check before assuming the lease. It may also be possible to move the panels to your new home. Some contracts may allow you to continue the contract if you can move the system.
- **Default:** A contract should have a list of events that constitute default on your part or the part of the company. Check for provisions regarding credit reporting, late payments, and other requirements.



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Fixture Filings

If you've signed a lease or power purchase agreement, a third party owns the solar system on your property. Many third-party solar owners will file a Uniform Commercial Code-1 filing statement, often referred to as a "fixture filing" or a "UCC-1 filing," to allow them to legally take possession of the system if the contract is breached. A fixture filing does not create a lien, but it can make it more complicated to refinance or transfer a house. Before refinancing or selling the home, an owner may need to have the fixture filing released by paying off the remaining contract or transferring the obligation.

Upfront Lease Payment Option

In some cases, it may be possible to pay off a lease in the beginning rather than having a monthly payment. Prepaying the lease can offer a lower overall payment because the payment is made up-front. This may be an attractive option for a consumer who has enough cash to pay for the system all at once, but doesn't have enough tax liability to take advantage of the federal tax credit.

Sample Language

The Solar Energy Industries Association (SEIA) and the National Renewable Energy Laboratory have sample language for a solar lease or power purchase agreement at <https://www.seia.org/research-resources/model-leases-and-ppas>.

How You Save Money

Tax incentives, net-metering credits, and SRECs can help make a solar system a potentially good investment. A solar contractor should understand all of these possibilities and be able to explain how they could work for you, but it's best to have some understanding before starting discussions with contractors.

Federal Tax Credit

The federal government currently provides an income tax credit to help with the cost of buying a residential solar system. (There is also an Investment Tax Credit for businesses.) As of November 2017, the solar Income Tax Credit (ITC) is worth 30 percent of the total cost of the solar PV system. In other words, if your system costs \$20,000, then the credit is worth \$6,000. You claim the credit when you file your income tax return.

However, if you don't pay any federal income tax, you won't benefit from the ITC. Nearly half of American households don't pay any federal income tax. Many contractors and online solar calculators will assume that you are eligible for the tax credit, and will include it in their calculations when they are determining your savings. For this reason, when making a decision to purchase a solar PV system, it is important to make sure you know whether you would be paying sufficient federal income tax to benefit from the credit.

The federal ITC does not have to be taken in the single tax year that you install your solar system. If your tax liability is less than the value of the credit, you can carry the remainder of the credit forward and secure the full benefit of the tax credit.

The ITC is scheduled to decline in coming years. The 30 percent credit is slated to be available for systems that are placed in service by the end of 2019. In 2020, the credit will be 26 percent. In 2021, it will be 22 percent. In 2022 and beyond there will be no tax credit available for residential solar systems. Information on the solar ITC can be found on the U.S. Department of Energy (DOE) website at <https://www.energy.gov/savings/residential-renewable-energy-tax-credit>.

The ITC is only available if you're buying a system. If you're leasing or signing a power purchase agreement, the financing company you contract with will own the system, and will likely receive any tax credit. Ask the installer how the tax credit savings the company receives will be reflected in your lease or power purchase agreement before you sign it.

Information in this guidebook should not be considered to be official tax advice. Tax laws change over time and each person's situation is different. Prior to claiming any solar energy tax credits, please consult a qualified tax professional. In particular, the potential eligibility of community solar customers for the 30 percent ITC is not well understood and is likely to require expert tax guidance.

Renewable Energy Certificates (RECs)

RECs¹⁵ are created whenever solar panels (or other renewable sources, like wind turbines) generate electricity; one megawatt-hour (or 1,000 kilowatt-hours) of generation equals one REC.

¹⁵ Although REC actually stands for Renewable Energy Certificate (as a certificate can actually be issued for each REC), they are commonly called Renewable Energy Credits.

RECs represent the environmental value of renewable energy, and they can be bought and sold. RECs initially belong to whoever owns the renewable energy system, rather than the property owner where the renewable energy system is installed. Whoever owns the RECs has the legal right to say that they used that renewable energy. This right is valuable to utilities which are required by the Maryland Renewable Portfolio Standard to supply a certain amount of their energy from renewable resources. It is also valuable to businesses that want to be able to say they use renewable electricity.

In addition to the overall Maryland renewable energy requirements, the state's Renewable Portfolio Standard requires that a certain percentage of the energy sold by each utility come specifically from solar energy from sources connected with the electric distribution grid serving Maryland. The RECs representing solar generated electricity are labeled Solar Renewable Energy Certificates, or SRECs. If you don't own the SRECs that go with your solar energy system, you can't claim that the electricity you're using comes from solar panels. In that case, your panels are generating renewable solar electricity, but effectively, you're using regular electricity from the electric grid; whoever owns the SRECs is using the solar electricity your panels generate.

When you own a solar PV system, you have the option of keeping your SRECs or selling or assigning them to someone else. If one of your goals in getting solar panels is to personally be using solar power, then you will probably want to keep your SRECs. But because SRECs have value, you can probably make money by selling the SRECs, or assigning them to someone else like the utility or the third-party owner. For more discussion of RECs, see the Center for Resource Solutions' short animated video titled, "What is a Renewable Energy Certificate?," <https://www.youtube.com/watch?v=opJMrzNauFQ>, or the US EPA video titled "RECS: Making Green Power Possible," https://www.youtube.com/watch?v=_12VYXms6-c.

Net Metering

Net metering (sometimes called net energy metering) is an electricity billing arrangement that credits solar customers for the electricity they add to the electricity grid beyond the amount they consume during a particular billing period, allowing the resident to benefit at the full retail rate for all the energy produced by the solar array.

Net metering allows consumers to use the electric grid as an effective battery, absorbing excess energy from the PV panels when it is available and returning it to the home when it is needed. Stated another way, net metering ensures that the resident receives credit for energy production, even if the energy is not used within the residence at the moment of production. Excess energy production flows to the grid, and an energy credit is provided. Later, when energy is used but the solar array is not producing, the credit is cashed in for energy to the house. Accounting normally

Selling Solar Renewable Energy Certificates (SRECs)

If you want to sell your SRECs in the market, you will need to first register them online. Maryland, as part of the PJM Interconnection, recognizes the PJM Generation Attribute Tracking System (GATS) for the registration of renewable energy generators, and the development of RECs and SRECs. To learn how to sell your SRECs, go to the Maryland Public Service Commission website (<http://www.psc.state.md.us/#>). In the website's left column go to "Online Services" and select "PV Certification." Follow the guidance of the PSC Solar Certification Process System (SCP) and get a certification number for your solar system as this number will be necessary for the next step. Now go to the PJM Environmental Information Services (EIS) website at <https://www.pjm-eis.com>. Select "Homeowners" and then click on "Getting Started in the Renewable Energy Certificate Market."

occurs on a monthly and a yearly basis. Net metering can be accomplished by installing a generation meter on the output of the inverter, or by installing a power meter that can increase or decrease its reading, based on the direction of energy flow.

During the summer, customers with solar panels often generate more electricity than they use and build up net metering credits. During the winter, when there is less sunshine and therefore less solar generation, customers use the credits they acquired during the summer to offset their winter electric bills. Under Maryland's net-metering rules, credits expire in April each year. When credits expire, any excess credits in the account are paid to the solar owner at a rate close to the annual average electricity wholesale rate. See your utility's electricity tariff for a more in-depth explanation.

During the summer, customers with solar panels often generate more electricity than they use and build up net metering credits. During the winter, customers use the credits they acquired during the summer to offset their winter electric bills.

The net-metering rules could be revised in the future. If that happens, the return you get on your solar panels might be different than you're expecting. This is an inherent risk of investing in a net-metered solar system.

Community solar is a form of virtual net metering (VNM), where the actual array is not at the site of the residence, but nonetheless, the electric bill is credited for the power produced by the solar array.

Net energy metering will never reduce a household's electric bill to zero. The customer is still responsible for the fixed customer charge and any other charge that is a fixed charge not dependent on the number of kilowatt-hours consumed.

Maryland State and Local Property Tax

In Maryland, solar photovoltaic (PV) and solar hot water systems are exempt from state and local property taxes. In addition, solar equipment is exempt from the normal state sales tax.¹⁶ Before claiming any solar energy tax credit, please consult a qualified tax professional.

Maryland State Incentives

The Maryland Residential Clean Energy Grant program, offered by the Maryland Energy Administration, provides incentives for eligible homeowners who purchase solar energy systems for their primary residence. (These incentives are not available to homeowners who sign a lease or power purchase agreement.) Program specifics can be found at: <http://energy.maryland.gov/residential/pages/incentives/cleanenergygrants.aspx>. Other solar incentives may become available in the future. For the latest list of incentives available from the Maryland Energy Administration go to: <http://energy.maryland.gov/residential/Pages/incentives/default.aspx>.

¹⁶ As of November 2017

Choosing a Contractor

Buying solar panels, or signing a solar contract, is a major commitment, comparable to buying a car or undertaking major home renovations. Because a significant amount of money is at stake, it is very important to be careful and thorough in selecting a contractor.

You should learn as much as you can before you begin talking to contractors. Make sure that you:

- Understand the differences between buying a solar PV system, leasing a solar PV system, and signing a power purchase agreement.
- Understand how net metering works, what the federal tax credit is, and how SRECs work.
- Understand your electric bill, and know what your potential is for solar panels to reduce that bill.

Where to Look

If you have friends or neighbors who have recently gone solar, you could ask them who they worked with, and whether they were pleased with the process and the final result. Look at the work that was done.

The Maryland/DC/Delaware/Virginia Chapter of the Solar Energy Industries Association (MDV-SEIA), the solar energy trade association, maintains a listing of solar professionals at: <http://mdvseia.org/directory/#!/directory/map>. In addition, there are commercial websites that can provide a listing of solar installers in Maryland.

Be cautious if you receive cold calls from solar installers and financing companies. You have no obligation to listen or to tell them anything. You are generally better off dealing with contractors *you've* identified as the ones *you* want to talk to.



Qualifications

Be sure that the contractor you choose has experience installing residential solar systems. Ask for the names and phone numbers of previous customers, and then follow up with those previous customers. Find out how many years the contractor has been installing solar systems, and how many systems they've installed. Ask for evidence that the contractor has workers' compensation insurance and liability insurance. The contractor's liability insurance will help protect you.

All solar contractors must be licensed through the Maryland Home Improvement Commission (MHIC) and will have a MHIC license number. Ask for a firm's MHIC number prior to signing any contract to ensure the firm is licensed to perform the work in Maryland.¹⁷ Although a licensed master electrician is required to hook up the panels to the electric system, there are no special certification requirements to install the solar system itself in Maryland. Some Maryland solar installers have certification from the North American Board of Certified Energy Practitioners (NABCEP), the most widely recognized certification organization for solar installation professionals. Maryland requires solar PV installations to be installed by a company with NABCEP personnel for an eligible homeowner to receive a Clean Energy Grant Program grant.

Where to Check for Complaints

Check with the Maryland Better Business Bureau at www.bbb.org/greater-Maryland or 410-347-3990 to see if there have been any complaints filed about a particular contractor.

What Bids Should Include

As with any major project, you should ideally get bids from at least three different contractors before you make a decision. At a minimum, bids should include: total installation cost, including equipment and labor; system specifications, including system size in kilowatts and the manufacturer and model of key equipment, such as the solar modules and the inverter (or microinverters); and estimated annual energy output (in both kWh and dollars), based on the orientation, tilt, and shading of the panels. Ask the contractor to supply a copy of the calculations for estimated energy output.

For a leased system, or if the contractor will be providing financing, then the bid should also include the amount of the monthly payments, and a schedule of changes to monthly payments over the length of the lease.

For a power purchase agreement, the bid should include the price per kWh, how that price per kWh will change over time, and an estimated monthly cost based on how many kilowatt hours the panels will generate.

It is helpful if bids also include your net financial savings over the life of the system. This is especially important if you're considering two different financing mechanisms, such as an owned system and a leased system, because it's difficult to compare them unless you know the net financial savings from each. Ensure the savings calculations are for the same period of time. Again, ask the contractor to include a copy of the calculations for net financial savings. (See Appendix A for a sample net financial savings calculation.)

¹⁷ Active contractor licenses can be checked on the Maryland Department of Labor, Licensing, and Regulation website at <https://www.dlrr.state.md.us/license/mhic>.

Including net financial savings in bids not only allows you to compare bids but enables you to decide if you want to proceed with installing solar. Perhaps your savings estimates will be so low that you decide not to get solar panels after all, or perhaps you will be pleasantly surprised by how much money you can save.

Finally, make sure you understand the assumptions contractors made when they prepared their bids. For example, if you receive a bid to buy a system, is the total cost provided before or after you take the federal tax credit? If you receive a bid for a lease or power purchase agreement, does the bid assume that the solar financing company will take possession of the SRECs? Ask all bidders to clearly state their assumptions.

Comparing Bids

You may receive bids for two systems of slightly different sizes and may wonder how to compare the various offers. The solution is to calculate cost per kilowatt by dividing the total cost of the system by the number of kilowatts. For instance, if the total cost of a 5-kW system is \$20,000, then the cost per kilowatt is \$4,000. If the cost of a 4-kW system is \$18,000, then the cost per kilowatt is \$4,500. Systems can be measured in both kilowatts AC (inverter size) or kilowatts DC (total array size). As inverters are not 100 percent efficient converting DC power to AC, the AC and DC ratings of a system may be different. The Maryland Level 1 Interconnection Agreement Certificate of Completion (which provides permission for small inverter-based systems to operate) lists system size (capacity) in kW DC. When calculating prices and estimated production, the DC kilowatt size should be used since this tracks much more closely with equipment cost and production. Make sure you understand when system size is being described in kilowatts AC or kilowatts DC.

Also, keep in mind that it's not just the numbers that matter. Some bids may include certain installation technologies that others don't. For example, you might want an array that uses micro-inverter technology or optimizers to increase your system's output, even if it means it costs more. Or, you might prefer going with a contractor that will install panels manufactured in the United States even if you have to pay a premium. You may also choose to hire a contractor with a slightly higher cost if they received strong recommendations from past customers, or if they've been in business a long time and you're confident that they'll be around to help with any problems that arise in the future. Also, if you're comparing two bids for two different size systems, consider how big a system you actually need.

Comparing bids becomes more complicated if you've received bids for two very different systems, such as an owned system and a leased system. In that case, your most useful metrics will probably be net financial savings. Again, remember that the system that saves the most money may not always be the best choice. Either owning or leasing a system may simply be a better fit for you and your needs.

Understanding Utility Rate Increase Impacts

When contractors estimate how much money a solar system will save, they have to make assumptions about future utility rate increases. The faster utility rates go up in coming years, the more money you'll save by going solar. Find out what assumptions have been made in each bid about future utility rate increases, and examine these assumptions carefully. To make estimates between solar contractors comparable, consider asking them all to use a standard utility power escalation rate, say 2.5 percent annually. But keep in mind that utility rate changes vary widely in different years and for different utilities. Some Maryland utilities have had rate decreases in some years.



Signing a Contract

Be sure that you read your entire solar contract, and that everything you've agreed to verbally is written in the contract before you sign it. Take your time and ask questions about anything you don't understand. Never let anyone pressure you into signing a contract before you're ready. Seek out legal advice if you need help.

In addition to everything that's in the bid, the contract should include:

- **Warranties**—The contractor should provide you with copies of the warranties. Warranties should cover equipment and workmanship, and should include warranties for any damage to the roof during installation, if applicable. Different parts of the system (like panels, inverters, and mounting equipment) may be warrantied for different amounts of time. Typically, the output performance of the panels is warrantied for 25 years. Panel performance will degrade over time, but solar panels should still be producing at least 80 percent of their original production after 25 years. (See Warranties on p. 43 for more information.)

- **Payment schedule**—If the contractor will be paid off in full when the project is fully installed, the payment schedule may depend on construction milestones. If the contractor is involved in financing the project, the payment schedule may instead involve monthly payments over a longer period.
- **Start and end dates of construction**—The contract should specify when construction will begin and when it will end.
- **Exact equipment to be installed**—It is important to know exactly which equipment a contractor plans to provide (e.g. manufacturer name, model number). Equipment quality varies. For instance, some solar panels operate more efficiently than others, and these will probably cost more. It may be worthwhile to invest in more expensive panels, but you should have a statement in writing of what you will get for your money.
- **Itemized budget**—The budget should include a detailed breakdown of equipment costs and other expenses such as installation labor and applicable permits.
- **List of subcontractors**—In some cases, a solar installation contractor may subcontract out portions of the solar panel installation process. It is important to know what work will be done by the contractor and what work will be subcontracted out. The contract should identify exactly who will be doing each part of the job, and who is responsible for warranties related to work initially performed by subcontractors.
- **Who is responsible for getting and paying for permits**—Because your contractor should have experience with system permitting, it is common for your contractor to take care of this step in the solar panel installation process. Responsibility for permitting tasks should be spelled out in the contract. Make sure that the contract clearly allocates all costs associated with permitting to either you or the contractor. Among the costs that should be accounted for are any charges involved in setting up a net-metering account, including any costs for installing an additional meter.

Be sure that you read your entire solar contract, and that everything you've agreed to verbally is written in the contract before you sign it.

If your contract is for a lease or power purchase agreement, it should include many other provisions. See “Questions to ask” on p. 45 for a full list. Among these are:

- What is the length of the lease or power purchase agreement?
- What happens at the end of the lease or power purchase agreement?
- Who is responsible for system maintenance?
- Who is responsible for removing and reinstalling the solar system if the roof needs to be repaired or replaced?
- What happens if I move?
- What happens if the solar PV system doesn't produce as much energy as anticipated?

Permitting and SREC Registration

In Maryland, the installation of a home solar PV system may involve:

- An interconnection agreement and a certificate of completion from the local utility (always required, unless the solar system will be completely off-grid)
- County building and electrical permits (usually required)
- City permits (sometimes required)

In most cases, the solar contractor assumes responsibility for obtaining all of these agreements, certificates, and permits and passing all permitting inspections as outlined in the terms of the contract. Local contractors will likely be aware of the particular requirements of each jurisdiction, but installers from out of town may not. Be certain to consult your local government to confirm local requirements.

Certificate of Public Convenience and Necessity (CPCN)

While the general rule in Maryland is that all electric generating stations require a Certificate of Public Convenience and Necessity, most residential-sized solar installations meet an exception and therefore are not required to receive a CPCN.¹⁸

Interconnection Agreement

An interconnection agreement is required with the local electric utility for any solar system that will connect with the electric grid. The interconnection agreement enables the utility to ensure that the solar system does not violate any of the utility requirements and procedures needed to keep the grid safe and reliable. After reviewing the application to interconnect, the utility provides the list of conditions that must be met before and while the system is connected to the grid. If there are high levels of renewable energy generation on a particular electrical feeder where the proposed solar PV system is attempting to interconnect, the agreement may require the applicant to pay the utility to upgrade the local electric grid, but this would be very rare for a residential-sized solar PV system. Once the system is installed the electric utility will have the opportunity to observe an operational test of the system. At the end of the test, the utility signs the Certificate of Completion which authorizes the connection of the system to the electric grid and its operation under the conditions in the interconnection agreement.

¹⁸ *The Maryland Code of Regulations (COMAR) 20.79.01.02 states that a "generating station does not include an integral plant or unit less than or equal to 2,000 kilowatts if it is installed with equipment that prevents the flow of electricity to the electric system during time periods when the electric system is out of service." As such, residential solar PV systems connected through inverters that disconnect from the grid when the grid is down are not required to have a CPCN.*

Registering for SRECs

Step 1: Figure out if you should register for SRECs.

If you have signed a lease or power purchase agreement, then you are not the owner of the system and cannot register for SRECs. If you own your system, you can either register for SRECs yourself or work with an SREC aggregator who will register the SRECs for you. Registering SRECs is only necessary if you want to sell them; if you prefer to keep your SRECs, there's no need to register them.

Step 2: Get permission to operate.

Your system must have received a Certificate of Completion from the utility before the SRECs can be registered.

Step 3: Register with the Maryland PSC.

Go to the Maryland Public Service Commission website (<http://www.psc.state.md.us/#>); on the left go to "Online Services" and select "PV Certification." Follow the guidance of the PSC Solar Certification Process System (SCP) and get a certification number for your solar PV system.

Step 4: Register with PJM.

Go to the PJM Environmental Information Services (EIS) website at <https://www.pjm-eis.com>. Select "Homeowners" and then click on "Getting Started in the Renewable Energy Certificate Market." Maryland recognizes the PJM Generation Attribute Tracking System (GATS) for the registration of solar energy generators, and the development of SRECs.



After the System is Installed

Once installed, peak performance and safe operation of your PV system will be aided by good maintenance practices. System monitoring and maintenance starts upon the completion of your system installation. At that time, there may be an inspection by the county or local permitting office and/or the utility to ensure safe operation and code-compliant installation. (See also Permitting, p. 36.) Regardless, your installer should provide you with a written commissioning report indicating that all system components are operational and online. The commissioning report should also include all system documentation and warranties.

If you own the system, then you are responsible for maintaining it, although you may contract with a third party for maintenance. If a third party owns the system, then they will be primarily responsible for maintaining it, though you may have some specific responsibilities spelled out in your contract. But even if someone else owns the photovoltaic system and is responsible for maintenance, it remains in your interest to keep an eye on the system and ensure that it's not damaged, excessively dirty, or otherwise not functioning properly.

System Maintenance

The primary maintenance task is usually inspecting the components of your solar PV system. Periodically check your system for any visible physical damage to panels, wiring, and other external components. Rodents or birds can sometimes invade areas where wiring is located. In Maryland, squirrels can cause problems by chewing on outdoor wiring. Conduits and squirrel guards may be prudent investments. Also, examine the surrounding area to ensure that there is no new shading of panels from tree growth or debris.

Hail and debris from wind storms can result in impacts to panels and in rare events can cause cracks or fractures. These must be repaired quickly to prevent electrical damage and to ensure continued output from the array. Your installer should handle all equipment warranty claims, and often homeowner's insurance will cover the cost of damage done by a storm that isn't covered under a manufacturer's warranty. Normally you must inform your homeowner's insurance company of the solar system installation in order for it to be covered under your policy.

Additional maintenance will be needed for systems that include battery storage.

Cleaning

Panels can accumulate dust, dirt, pollen and other particulates, especially during dry periods without rain. Although the impact of soiling is usually minimal, periodic cleaning may be required to prevent reduced output. Dirt buildup can lower output by five percent or more. Since Maryland has fairly regular precipitation that effectively cleans panels, most solar homeowners do not worry about washing their panels. In winter, snow soiling and buildup can result in a major reduction in output. If solar panels are *safely* accessible, some homeowners will brush off accumulated snow after a large storm.

Most manufacturers recommend that you consider the following factors in deciding if and when to clean the surface of your panels.

1. **Panel tilt**—The angle of your panels affects how dirty they get. The more vertical the panels, the more effectively rain will remove dirt and debris. More flat-mounted panels can form puddles at the lower edge that, when dried, leave an accumulation of dirt that can impact output.
2. **Rain**—Depending on how much rain you get and at what time, rain can be an effective cleaning event for panels.
3. **Wind and pollen**—The amount of wind-blown dust and pollen in your area can affect how often your panels need to be cleaned. Consider scheduling your cleaning following the times of year with the most dust and pollen.

If the solar panels are safely accessible, many homeowners take on the task of cleaning the solar panels by themselves on an infrequent, as-needed basis.

Monitoring Your System

You should ask your installer to provide you with an expected electricity generation output amount based on the time of year to compare to your system’s actual output. You can also estimate projected output yourself using a program like PVWatts (pvwatts.nrel.gov).

Most installers will provide monitoring equipment and monitoring services for your system as part of your installation contract. Monitoring hardware can be embedded in inverters or come as a



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separate device that can track the output of the system. Most monitoring systems are web-based, allowing easy access to system data from any computer or smartphone. Many service providers have an initial period of free monitoring followed by renewal periods and usually offer a user-friendly online portal.

Inverters also have display screens and error lights that can help with monitoring your system. A periodic check of the inverter on a sunny day can confirm that the system is operating correctly. If an inverter goes off-line, the display will usually indicate the cause of the shutdown.

If you have a system with micro-inverters, you can access panel-by-panel data (see Inverters on p. 16). Although central inverters cannot provide data on individual panels, they can provide the overall PV system's output, voltage, and a host of other data. Checking with the installer or equipment manufacturer before choosing a component will let you know what kind of information will be available. You can also tell the installer what information you want available and have equipment selected accordingly.

Aside from the basic information outlined above, most monitoring systems, with simple inputs, can also provide information on estimated monetary savings. As a part of your system operation and maintenance program, monitoring services can help you understand the system's function and whether it is operating within expectations. Checking performance on a routine basis, especially on clear sunny days, can help ensure that the PV system is working properly.

A complete failure is easy to spot—a lack of generation output during the day indicates a failure somewhere in the system—and can be caused by blown fuses, wiring issues, breakers, or ground faults. These issues will require professional service to isolate and correct the error. Remember, the voltages interior to the inverter may be very high, possibly reaching 600 volts DC, so troubleshooting is a job best left for a qualified solar professional. If the system is still under warranty, make a claim through the proper channels to secure a qualified repair (or replacement) and preservation of your warranty (see warranties below).

If you monitor system performance regularly, you can detect any reduction in performance. Low output can result from several factors:

1. **Natural degradation:** Panel cells and surfaces degrade over time. Industry standards usually assume an output drop of 0.5 percent per year. Most warranties protect from degradation greater than this amount.
2. **Dirt buildup:** Reduced output could be the result of increased dirt on panels. If you have not cleaned the panels in some time, inspect the panels to see if the surfaces need cleaning.
3. **Snow:** Snow buildup can shade panels. Output during the winter is lower than in the spring and summer and it may not be worth the effort to clean panels of snow. If you choose to clear snow, use care for your safety and the protection of your array.
4. **Shading:** A small amount of shading on some panels can impact output. Plants and other obstructions can appear over time and must be managed if you want to preserve electricity output.
5. **Damage to cells/panels:** Although it is rare, panels and cells can sometimes become damaged. This damage can be hard to spot. A qualified technician may be necessary to diagnose such impacts and assist with any warranty claims or repairs.



Usually installers offer a period of maintenance and inspection following an installation. If possible, follow the technicians during one of these visits and learn what they are looking for and how they check system performance. Many installers and solar companies can continue to provide maintenance for you, for a fee, beyond any initial free maintenance period.

System Safety

It is critical to ensure that all equipment is correctly installed and that all components meet the requirements of the electric code and the utility. If system safety measures aren't followed, you, or repair workers that you hire, may be seriously injured on your property. Equally important, back-feeding power into the grid could seriously harm utility workers working on lines to restore power after a power outage.

It is good practice to have a central inverter installed in an accessible and protected location. Micro-inverters are usually installed on individual panels and protected by the panel itself.

Solar systems include electrical wiring, and electrical wiring of any kind has the potential to start fires, especially if the wiring is not properly installed. Make sure your selected installer is qualified. If you suspect there is an electrical problem in the system, don't try to fix it yourself unless you're a qualified electrician.

Proper grounding of the system is essential as it protects you and your property. A qualified installer or an electrician should provide you with documentation that the system is properly grounded. A ground fault should trigger the system to shut down and alert you with an error

message. Repair of such situations requires professional assistance to ensure your safety. Again, the inverter will provide error codes that will help in such situations.

If your system includes batteries for storage, additional consideration must be taken.

Insurance

If you own your home and have homeowner's insurance, you should notify your insurer of the solar installation. This ensures that if there is any damage to the photovoltaic system or related to the system, you can file an insurance claim. The insurance company will inform you whether your system is protected with existing coverage or advise you if a separate rider is necessary. Check that your particular installation (roof, ground or pole) is eligible for coverage. Find out what your coverage limits are, what events are covered (fire, hail, etc.), and what coverage includes (repair or replacement). Since there are many policies and companies with different requirements and limitations, it is good to check with your agent or insurance company to get answers *before* you decide to install a system.

If your system is owned by a third party, the third party may be responsible for insuring it. It is prudent to ask this question while getting initial bids for the system and to also follow-up with your homeowner's insurance representative.





Warranties

Most installers offer warranties for installation and workmanship. A generally accepted installation warranty lasts at least five years. The installation warranty may require the system to be maintained by the original installer.

If you own a solar PV system and are selling it as part of a home sale, check to make sure you complete any of the required change-of-ownership forms for your system so that the warranty properly transfers to the new homeowners. These are generally easy to find on manufacturers' websites.

Most major components come with their own warranties. Be sure you understand each component's warranty terms. Although installers should provide you with a copy of your warranties, almost all manufacturers include warranty information on their websites. Remember that warranties are only as good as the companies backing them. If a manufacturer goes out of business, its warranty coverage may cease to exist. Below are the warranties that should be provided with your photovoltaic system:

Panels

Solar PV panel manufacturers may provide workmanship warranties of up to 10 years or more. Such warranties cover defects in manufacturing and materials.

Panels also include output (often called performance) guarantees. Currently, these warranties stretch from 20 to 25 or even 30 years, and protect against significant declines in output. Most companies will ensure at least an 80 percent output up to the end of the warranty period, and some may guarantee a higher output. (You may want to take these differences into account when deciding which panels are best for you.) Making a claim for a drop in output will usually require an inspection by a qualified solar professional or electrician. The qualified solar professional will inspect the panels for electrical output and thermal images to detect "hotspots" that can indicate an electrical failure. Panel warranties usually cover the wiring that comes with the panels.

Inverters

Inverters also have warranties. Most inverters have a standard warranty period of at least 10 years, but longer warranties are often available for purchase at an extra cost. In most cases, you may purchase additional warranty coverage directly through the inverter manufacturer. Inverters are the most complicated component in the solar PV system, so an inverter warranty can be an important part of protecting your investment. Failures of central inverters are easily remedied by swapping out units. Failure of roof-mounted micro-inverters can also be expensive because of the labor involved in removing and replacing individual panels.

Racking and Mounts

Racking and mounting companies provide warranties to cover defects in workmanship and materials. The warranties are generally from 5 to 25 years. If the installation is completed incorrectly, fixing it should be the responsibility of the installer, not the racking manufacturer.



Meters

Your primary electric meter belongs to the utility, and the utility is responsible for maintaining it. Depending on your own goals and financing mechanisms, additional meters may be needed to track the output of your system precisely. Additional metering beyond the utility-installed meter is the system owner's responsibility.

How to Address a Problem with a Solar Company

As with any residential construction project, occasionally a consumer may not be satisfied with the work performed by the solar PV installer. Perhaps the solar system is not producing the amount of electricity expected, the work was not completed in a timely fashion, or the roof or other property was damaged during installation.

As with any contractor dispute, the first step is typically to speak with the company and see if the problem can be solved directly. If there is a problem with performance of the equipment, it might be covered under a manufacturer's warranty. If there is a problem with the installation, it might be covered under the installation warranty.

If you can't agree with the company on how to solve the problem, it might be necessary to get outside help. A good place to turn is the Better Business Bureau (BBB). The BBB office that serves Maryland is in Baltimore, and can be reached at www.bbb.org/greater-maryland or 410-347-3990. They will post your complaint on their website and give the company a chance to solve the problem to your satisfaction. Because complaints to the BBB are posted publicly, it is in the interest of the company to resolve them quickly.

Another option is to file a complaint with the Consumer Protection Division of the Maryland Attorney General's office at: <http://www.marylandattorneygeneral.gov/Pages/CPD/Complaint.aspx> or by calling 410-528-8662. Finally, you can file a complaint with the Solar Energy Industries Association (SEIA). SEIA is a voluntary organization of solar businesses. Businesses that are members of SEIA must abide by the SEIA Solar Business Code. If you believe that a SEIA-member business has violated the Solar Business Code, complaint procedures are described at: <http://www.seia.org/sites/default/files/SEIA%20SBC%20Complaint%20Resolution%20Process%20v%201.1%20-%20Jan%202016.pdf>.

Panel Removal

If you sign a lease or power purchase agreement, it should cover the PV panel removal at the end of your contract term. If you own your solar panels and you would like them removed, you should contact a solar contractor. You should not attempt to remove solar panels yourself unless you're a trained professional.

Some solar panel components can be recycled. Ask your solar panel removal contractor about their plans for recycling and disposing of your panels.

Questions to Ask a Solar Contractor

1. How much experience do you have installing residential solar systems? How many systems have you installed? How much experience do you have installing systems that use the same technology (i.e., solar PV panels, solar shingles) as the system you will install on my house?
2. Can you give me references (with phone numbers) for similar systems you've installed recently?
3. What are your licenses or certifications?
4. Will you be using subcontractors? For which parts of the project? What are their qualifications and references? Who warrants the work completed by the subcontractor?
5. Who specifically will be working on my roof?
6. Do you have workers' compensation insurance? Can I have a copy?
7. When will the installation be done, and how long will it take? For how long, and for what portions of the installation process, do I need to remain on site?
8. Who's responsible for repairing my roof if it's damaged during installation?
9. How much electricity will the system generate in its first year?
10. How much production decline is expected each year?
11. What is the total cost of the system? Is that with or without the federal tax credit, state grant and SREC sales?
12. What is my payment schedule?
13. If there will be a loan, what will my monthly payment be?
14. What will my net savings be? Can I see your calculations?
15. Who gets the SRECs and how do they factor into the (financial) equation?
16. Who gets the tax credit?
17. What utility rate assumptions are included in your calculations of how much money I'll save? What are your assumptions based on?

Additional questions for a system with a lease or power purchase agreement

1. What is the length of the lease or power purchase agreement?
2. What happens at the end of the term?
3. What happens if I want to end my contract early? Can I buy out the contract? At what price?
4. Will my payments increase over time? By how much? What will my monthly payments be each year?
5. If the roof needs to be replaced or repaired after the panels are installed, who is responsible for removing and replacing the panels?
6. What are my responsibilities for maintaining the system?

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7. Who do I notify if there's a problem with my system? Does the installer have a time limit to fix the problem? What if the response time isn't met?
 8. Does the contract include production guarantees? What happens if the guarantee isn't met? How will I be compensated?
 9. Who insures the system?
 10. What happens if I sell my home? Are there fees to transfer the contract to the new owner? Will I have to buy out the contract when I sell my home? What happens if the buyer doesn't want to assume the contract? What if the buyer is willing to assume the contract but has a lower credit score than me?
 11. What happens if I can't make payments and I default on the contract? What happens if my payments are late?
 12. Can the company sell the contract to a new entity? Will I be notified if that happens? May I pull out of the agreement without charge if this happens?
 13. What happens to the system if the owner of the system goes out of business?

Additional questions that only apply to a community solar subscription

1. What happens if I move? Can I maintain my contract with the system if my new home is served by the same utility as my old home? What if I move to a different utility service territory?
2. Has the system already been built, or is it in the planning stages? When will it be built? What happens if it never gets built?
3. If I decide I don't want to participate in community solar anymore, will I be allowed to cancel the contract? Will I have to pay a cancellation fee, penalties, or other costs?

Questions to Ask Yourself

- Have you thought about your overall energy goals and what you are trying to achieve by considering a solar system?
- Have you considered energy efficiency improvements first as a way to reduce your home's energy usage, thereby decreasing the size of the solar system required?
- Have you looked at your electric bills from the last 12 months, and calculated your average monthly kWh usage and your average monthly electric cost?
- If your panels are going on your roof, when did you last replace your roof? Have you had your roof professionally evaluated in order to know when it will need to be replaced in the future?
- Have you evaluated how much sunlight your roof (or other location) gets, including orientation, tilt, and shading?
- Have you considered how long you expect to be in your home?
- Have you talked to your neighbors about your plans to install solar panels?
- Do you understand the difference between buying solar panels, leasing solar panels and signing a power purchase agreement, as well as subscribing to a community solar project?
- If you expect to be able to take advantage of the federal tax credit, have you confirmed with a tax advisor that you are eligible and can actually use it?
- Have you talked to your utility to be sure you'll receive the electricity rate (tariff) that you expect for electricity generated by your system?
- Have you talked to your homeowner's insurance company to inform the company about your plans to install a solar system, to see if it will be covered under your existing policy, or to see about any possible premium increase to cover the system?
- Have you talked to friends and neighbors who have gone solar, and asked them for recommendations of contractors?
- Have you received bids from at least three contractors?
- Have you checked your contractor's references?
- Have you asked to see the contractor's workers' compensation and liability insurance? If they do not have it, find someone else.
- Have you checked with the Better Business Bureau for complaints about your contractor?
- Have you asked to see the contractor's calculations for estimated energy output?
- Do you know who will own the Solar Renewable Energy Certificates (SRECs) from your project?
- Do you know what your payments will be and how they will change over time?
- Have you calculated (or asked your contractor to calculate and review with you) net savings, return on investment, or payback period, to see if your system will be a sound financial investment?

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- Have you considered what assumptions your contractor is making about future utility price increases? What is the basis for these assumptions?
 - Have you read your contract thoroughly before signing? If not, DO SO!!!
 - If you're getting a lease or power purchase agreement, do you know what your responsibilities are for maintaining the system?
 - If you're getting a lease or power purchase agreement, do you know what happens if your roof needs to be replaced or repaired during the term of the contract?
 - If you're getting a lease or power purchase agreement, do you know what happens if you want to sell your home?
 - What are the options for disposal of used solar panels and equipment at the end of their useful life?

Resources

Official Information on Net Metering and Community Solar in Maryland

- Code of Maryland Regulations (COMAR): Net Energy Metering: COMAR 20.50.10:
<http://www.dsd.state.md.us/COMAR/ComarHome.html>
- Code of Maryland Regulations (COMAR): Community Solar: COMAR 20.62:
<http://www.dsd.state.md.us/COMAR/ComarHome.html>
- Maryland Public Service Commission: Community Solar:
<http://www.psc.state.md.us/electricity/community-solar-pilot-program>

Maryland Organizations

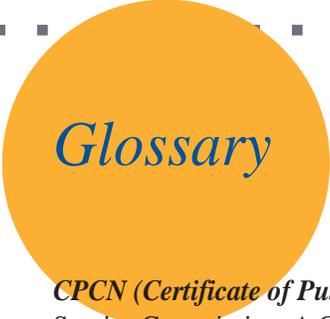
- The Maryland, DC, Delaware, and Virginia chapter of the Solar Energy Industries Association, a regional trade association of renewable energy companies doing business in the Maryland, DC, Delaware, and Virginia region: <http://mdvseia.org>
- Maryland Better Business Bureau: <https://www.bbb.org/greater-maryland>

Other Resources

- Solar Energy Industries Association (SEIA), a national trade organization of renewable energy companies: www.seia.org
- A Homeowner’s Guide to Solar Financing: Leases, Loans, and PPAs, Clean Energy States Alliance: <http://cesa.org/resource-library/resource/a-homeowners-guide-to-solar-financing-leases-loans-and-ppas>
- Department of Energy: A Guide to Community Solar: <https://energy.gov/eere/solarpoweringamerica/guide-community-solar>

Utility Resources

- Pepco—Community Solar: <https://www.pepco.com/MyAccount/MyService/Pages/MD/CommunitySolar.aspx>
- Delmarva—Community Solar: <http://www.delmarva.com/community-commitment/renewable-energy/green-power-connection%E2%84%A2/maryland/md-solar>
- BGE—Community Solar: <https://www.bge.com/SmartEnergy/InnovationTechnology/Pages/BGECommunitySolarPilotProgram.aspx>
- Potomac Edison—Community Solar: <https://www.firstenergycorp.com/content/fecorp/feconnect/potomacedison/community-solar-md.html#gsc.tab=0>



Glossary

CPCN (Certificate of Public Convenience and Necessity): A permit issued by the Maryland Public Service Commission. A CPCN is required for any electricity generator in Maryland that is connected to the grid, including solar systems (although most residential and commercial solar systems are exempt).

Grid (or electric grid): The grid is the coordinated network of electric wires, electricity generators (including big power plants and small solar systems), and electricity consumers. The grid delivers electricity wherever it's needed.

Kilowatt (kW): A unit of power. Solar panels and solar systems are described in terms of kilowatts.

Kilowatt-hour (kWh): A unit of energy. Kilowatt-hours are kilowatts applied over an amount of time. If you use one kilowatt for an hour, you've used one kilowatt-hour. The energy produced from solar panels is described in terms of kilowatt-hours. The energy usage of a home is also described in terms of kilowatt-hours.

Lease: A contractual agreement in which somebody else (a third-party owner) owns the solar system and you lease the use of the system from the owner. The solar PV system that you lease may be at your home or it may be elsewhere.

Net metering: A system that allows a customer with solar panels to receive credits from the utility for excess electricity produced and exported to the grid. See "Net Metering" on page 29.

Orientation, tilt, and shading - Orientation refers to what direction a roof faces (normally in terms of degrees from true North). Tilt refers to the slope of the roof. Shading refers to how much shade falls on the roof in the course of a day. Orientation, tilt, and shading determine how much sunlight your solar panels receive, and how much electricity they will be able to generate. See "How Much Direct Sunlight Does Your Roof Get? (Orientation, Tilt, and Shading)" on page 21.

Power Purchase Agreement: A contractual agreement in which somebody else (a third-party owner) owns solar panels and you buy the power output from the panels. The panels may be at your home or they may be elsewhere.

Renewable Energy Certificate (REC): A tradeable commodity representing the environmental attributes of renewable energy.

Solar Renewable Energy Certificate (SREC): A type of renewable energy certificate representing the environmental attributes of renewable energy produced through a solar system.

Tax credit: A tax credit is an amount that can be deducted from the income tax that you owe. As of November 2017, there is a federal solar tax credit available for 30 percent of the cost of installing a home solar system. This tax credit tails off to zero starting in 2020. Not everyone is able to take advantage of this tax credit. See "Federal Tax Credit" on page 28.

Third-party owner: A company that owns solar panels and either leases them to consumers or sells the power through a power purchase agreement. If you have a lease or a power purchase agreement, the company you sign the contract with is the third-party owner.

Virtual net metering: A system in which enough solar panels to serve multiple eligible customers are grouped together in one physical location. Participating customers do not have to be physically located next to the solar system itself but must be within the same electric service territory. Participating households or businesses then receive net-metering credit for their portion of the output of the solar system. See “Community Solar” on page 21.

APPENDIX A

Calculating Savings from Solar

When deciding whether to invest in solar, and when choosing between different contractors and different systems, it's helpful to calculate your net savings over the life of the system. To help you understand how to calculate your potential savings from solar panels, a sample calculation is provided below. If you don't want to perform the calculation yourself, another option is to ask your contractor to calculate your savings, and then to go over their calculation with you.

This calculation is only an illustration and is not intended to be used for purposes of comparison. This example is based on a solar customer taking out a loan. A lease or PPA would require a different calculation.

In this example:

- Assume a homeowner uses 12,000 kWh/year, which is equivalent to an average monthly electricity usage of **1,000 kWh/month**. (Note: You should be able to find your monthly electricity usage, as well as the cost of electricity, from your monthly electric bill statement.)
- Assume that in addition to a **\$7.38/month** customer account charge, the electric energy costs **\$0.1350/kWh** (the residential rate). (Note: This data may be found or calculated from a monthly electric bill.)
- Assume the homeowner decides to install a solar photovoltaic system designed to generate **80 percent** of his/her needs (800 kWh/month). (Explanation: This is a personal decision of the system owner based on available roof space and the goals for the system. By designing the system to meet 80% of the home's needs, the system will be able to provide most of the home's electricity from solar PV generation but is less likely to generate an annual excess of electricity that would need to be sold back to the grid at a much lower cost.)
- Assume that given the orientation and tilt of the homeowner's roof, each DC kW of solar on the roof is estimated to produce **1,371 kWh** of AC electrical energy from the inverter. (Note: The value of annual kWh AC per kW DC is an output of the PVWATTS calculator. If PVWATT inputs are unknown, strongly consider using the default values provided by the software.)
- Assume a solar contractor is willing to build the system for **\$2.50** per watt.
- Assume the homeowners takes on a 20-year (**240-month**) loan at **3.5 percent** interest for **100 percent of the unreimbursed cost** (i.e., the cost that is not reimbursed, provided as a grant, or provided as a tax credit).
- Assume the federal government is still offering the **30 percent federal solar investment tax credit** and that the homeowner pays enough taxes to take advantage of the credit.
- Assume a Maryland Energy Administration (MEA) grant of **\$80/kW DC** under the Residential Clean Energy Grant Program.
- Assume a Maryland SREC value of **\$6.00/MWh**. (Note: This value is based on typical Maryland SREC rates in effect during the summer of 2017.)



In the table below, the highlighted cells are considered variables whereas other values are constants or calculated values. Over time many of these assumptions will change. Always review the assumptions before performing the calculation.

In order to keep the calculation simple, this example does not include any consideration of future utility rate changes, or the expected degradation of panel output. Future utility rate increases will increase the financial value of the system, whereas degradation of panel output will reduce the financial value. It also does not include consideration of the time value of money, but that's primarily an issue when the payback period is long.

How to calculate net savings for systems purchased with a loan

This is only an example. Each person's circumstances will be different. It is important that you perform your own calculations using actual figures from your own home.

Line	Item	Calculation	With Solar Array	No Solar/ Baseline
1	Average household electricity use per month (kWh/month)	Provided in assumptions above	1,000	1,000
2	Average cost of electricity paid to the utility (\$/kWh)	Provided in assumptions above	\$0.1350	\$0.1350
3	Average monthly electric bill (\$)	Line 1 x Line 2	(\$135.00)	(\$135.00)
4	Percentage of annual energy to be produced by the solar panels (%)	Provided in assumptions above	80%	N/A
5	Solar energy produced per year (kWh/year)	Line 1 x Line 4 x 12 months per year	9600	N/A
6	Assumed annual energy production of solar panels at assumed azimuth and tilt (kWh/kW)	Provided in assumptions above	1371	N/A
7	Size of the required solar array (kW)	Line 5/Line 6	7.00	N/A
8	Average solar system generation per month (kWh)	(Line 6 x Line 7)/12 months per year	800	N/A
9	Cost of system installation (\$/watt)	Provided in assumptions above	\$2.50	N/A
10	Total solar system cost	Line 7 x Line 9 x 1000 watts per kilowatt	(\$17,500.00)	N/A
11	Federal Solar Incentive Tax Credit (ITC) (percentage of installed cost)	Provided in assumptions above	30%	N/A
12	Value of Tax Credit to be returned (\$)	Line 10 x Line 11	\$5,250.00	N/A
13	System Cost after ITC	Line 10 + Line 12	(\$12,250.00)	N/A
14	MEA Solar Grant Rate (\$/kW)	Provided in assumptions above	\$80.00	N/A
15	Value of MEA Solar Grant (\$)	Line 7 x Line 14	\$560.00	N/A
16	System Cost after ITC and MEA Grant (\$)	Line 13 + Line 15	(\$11,690.00)	N/A
17	Loan Rate	Provided in assumptions above	3.50%	N/A
18	Period of Loan (months)	Provided in assumptions above	240	N/A
19	Monthly loan payment (\$/month)	Excel: PMT (Line 17, Line 18, Line 16, 0, 0)	(\$67.80)	N/A
20	Monthly value of electricity generated	Line 2 x Line 8	\$108.00	N/A
21	SREC value (\$/MWh)	Provided in assumptions above	\$6.00	N/A
22	SRECs per month	Line 8/1000 kWh per SREC	0.8	N/A
23	SREC income per month	Line 21 x Line 22	\$4.80	N/A
24	Gross solar value per month	Line 20 + Line 23	\$112.80	N/A
25	Gross solar value per year	Line 24 x 12 months per year	\$1,353.60	N/A
26	Remaining monthly cost of energy from utility (\$/month)	(Line 8 - Line 1) x Line 2	(\$27.00)	(\$135.00)
27	Net costs over 20 years	240 months x (Line 19 + Line 23 + Line 26)	(\$21,599.35)	(\$32,400.00)
28	Net cost over 25 years	Line 27 + (60 months x [Line 23 + Line 26])	(\$22,931.35)	(\$40,500.00)
29	Savings over 20 years	Line 27 (Array) - Line 27 (Baseline)	\$10,800.65	
30	Savings over 25 years	Line 28 (Array) - Line 28 (Baseline)	\$17,568.65	
31	Percent savings over 20 years	Line 29/Line 27 (Baseline)	33.34%	
32	Percent savings over 25 years	Line 30/Line 28 (Baseline)	43.38%	

APPENDIX B

*Annotated Code of Maryland,
regarding Homeowners Associations*

This section of statute addresses the restrictions that a homeowners' association may and may not put on the installation of solar panels.

Real Property:

Section 2-119 Solar Collector Systems—Restriction on Use and Solar Easement §2-119.

- (a) (1) In this section the following words have the meanings indicated.
- (2) “Restriction on use” includes any covenant, restriction, or condition contained in:
 - (i) A deed;
 - (ii) A declaration;
 - (iii) A contract;
 - (iv) The bylaws or rules of a condominium or homeowners association;
 - (v) A security instrument; or
 - (vi) Any other instrument affecting:
 - 1. The transfer or sale of real property; or
 - 2. Any other interest in real property.
 - (3) “Solar collector system” means a solar collector or other solar energy device, the primary purpose of which is to provide for the collection, storage, and distribution of solar energy for electricity generation, space heating, space cooling, or water heating.
 - (4) “Solar easement” means an interest in land that:
 - (i) Is conveyed or assigned in perpetuity; and
 - (ii) Limits the use of the land to preserve the receipt of sunlight across the land for the use of a property owner’s solar collector system.
- (b) (1) A restriction on use regarding land use may not impose or act to impose unreasonable limitations on the installation of a solar collector system on the roof or exterior walls of improvements, provided that the property owner owns or has the right to exclusive use of the roof or exterior walls.

APPENDIX C

County Permit Offices

Note: In some cases the County will conduct permitting and inspections from the County offices. In other cases, the County will issue the permit but will contract the inspection process to one or more designated third parties (identified in *italics*). Contact information has been obtained from the Maryland State Archives website for each individual county as updated by information provided by the various permitting offices.

Information is current as of November 2017. Permit office contact information is being provided to help assist residents in permitting activities related to solar installations. Please check with your local permitting office to confirm all necessary permits.

Allegany County Land Development Services (permits & enforcement)

Land Development Services
Allegany County Complex
701 Kelly Road Ste 109, Cumberland, Maryland 21502
Ph 301-777-5951
Fax 301-777-5950

Anne Arundel County Department of Inspections & Permits

Heritage Office Complex, 2664 Riva Road, Annapolis, MD 21401

PERMIT CENTER

William R. Bryant, Assistant Director, (410) 222-7790
email: ipbrya00@aacounty.org
web: www.aacounty.org/departments/inspections-and-permits/permit-center

Baltimore City Permits & Building Inspections Office

Charles L. Benton, Jr. Building, 417 East Fayette St., Baltimore, MD 21202
(410) 396-3232

PERMITS & BUILDING INSPECTIONS OFFICE

web: www.baltimorehousing.org/permits

Baltimore County Department of Permits, Approvals, & Inspections

Charles L. Benton, Jr. Building, 417 East Fayette St., Baltimore, MD 21202
(410) 396-3232

BUILDING PERMITS PROCESSING BUREAU

Karen L. Lewis, Supervisor, (410) 887-3900
email: kllewis@baltimorecountymd.gov

Electrical (Inspection Only)
Bay Area Inspection Agency, Inc
224 E. Main St #1,
Elkton, MD 21921
(410) 620-6000

or

American Inspection Agency Inc
3106 Polly Drummond Hill Rd,
Newark, DE 19711
(302) 292-2000, (302) 732-6900

Charles County Codes, Permits, & Inspection Services

Codes, Permits, & Inspection Services
Ham Mathur (Acting Chief)
P. O. Box 2150
County Government Building, 200 Baltimore St.,
La Plata, MD 20646–2150
web: www.charlescountymd.gov/pgm/cpis/codes-permits-inspection-services
(301) 645-2623

Dorchester County Planning & Zoning Office

Building (Permit and Inspection), Electrical (Permit Only)

PERMITS, INSPECTIONS, & LICENSING

P. O. Box 107
County Office Building, 501 Court Lane, Cambridge, MD 21613 - 0107
(410) 228-9636

Electrical (Inspection Only)
Middle Department Inspection
8673 Commerce Dr. #2
Easton, MD 21601
410-822-8300

Frederick County Department of Permits & Inspections

DEPARTMENT OF PERMITS & INSPECTIONS

Gary W. Hessong, Director, (301) 600-2028, (301) 600-1172
email: ghessong@frederickcountymd.gov
web: www.frederickcountymd.gov/99/Permits-Inspections
Building Inspections: Steven Blickenstaff, Chief Inspector (301) 600-1076
email: sblinkenstaff@frederickcountymd.gov
Electrical Inspections: James (Bob) Ensor, Chief Inspector, (301) 600-2522
email: jaensor@frederickcountymd.gov

Electrical (Permit and Inspection), Building (Inspection only)
Middle Department Inspection
8673 Commerce Dr. #2
Easton, MD 21601
410-822-8300

Montgomery County Department of Permitting Services

DEPARTMENT OF PERMITTING SERVICES

Diane R. Schwartz Jones, Director, (240) 777-6364
255 Rockville Pike, 2nd floor, Rockville, MD 20850-4166
email: diane.jones@montgomerycountymd.gov
web: <http://permittingervices.montgomerycountymd.gov/DPS/general/Home.aspx>

Prince George's County Department of Permitting, Inspections, & Enforcement

PERMITTING & LICENSING DIVISION

(301) 636-2050
9400 Peppercorn Place,
Largo, MD 20774

Queen Anne's County Zoning & Permits Office

ZONING & PERMITS OFFICE

James H. Barton III, Administrator, (410) 758-4088
email: jbarton@qac.org
County Office Building, 110 Vincit St.,
Centreville, MD 21617

St. Mary's County Inspections & Enforcement

PERMITS

Harry E. Knight, Coordinator, (301) 475-4200, ext. *1560
email: harry.knight@stmarysmd.com
Patuxent Building, 23150 Leonard Hall Drive (near Route 245),
Leonardtown, MD 20650 – 0653

Somerset County Building Codes, Permits, & Inspections

Building (Permits and Inspections)

DEPARTMENT OF PLANNING & ZONING

Gary R. Pusey, Director, (410) 651-1424
County Office Complex, Suite 211
11916 Somerset Ave., Princess Anne, MD 21853

BUILDING CODES, PERMITS & INSPECTIONS

(410) 651-1424

Electrical (Permit and Inspection):
Middle Department Inspection
8673 Commerce Dr. #2
Easton, MD 21601
410-822-8300

Talbot County Planning & Zoning Department

Permits Department
Building (Permit and Inspection)
215 Bay St., Suite 3, Easton, MD 21601

OFFICE OF PERMITS & INSPECTION

Brent Garner, Manager, (410) 770-6840, fax (410) 770-6843
email: bgarner@talbotcountymd.gov
web: www.talbotcountymd.gov/index.php?page=Permits_and_Inspections

Electrical (Permit and Inspection):
Middle Department Inspection
8673 Commerce Dr. #2
Easton, MD 21601
410-822-8300

Washington County Division of Plan Review & Permitting

Department of Engineering and Construction
(240) 313-2460
80 W. Baltimore Street
Hagerstown, MD 21740

Wicomico County Department of Public Works

Building (Permit and Inspection)
Weston S. Young, Director (410) 548-4872, fax (410) 548-4877
P. O. Box 1897
28440 Owens Branch Road, Salisbury, MD 21802
email: wyoung@wicomocounty.org
web: www.wicomocounty.org/143/Public-Works

Electrical (Permit and Inspection):
Middle Department Inspection
8673 Commerce Dr. #2
Easton, MD 21601
410-822-8300

Worcester County Department of Development Review & Permitting

Building (Permit and Inspection)

Edward A. Tudor, Director, (410) 632-1200, ext. 1100, fax (410) 632-3008

Government Center, Room 1201

One West Market St., Snow Hill, MD 21863 - 1070

email: drpdir@co.worcester.md.us

web: www.co.worcester.md.us/departments/drp

Electrical (Permit and Inspection):

Middle Department Inspection

8673 Commerce Dr. #2

Easton, MD 21601

410-822-8300

APPENDIX D

How to Size a Solar System

How big a solar system you should install depends on what your goals are. Some people are primarily interested in the opportunity to save money. Others are interested in helping to reduce air pollution and greenhouse gas emissions, in contributing to local economic development, or in the opportunity to achieve greater independence from the utility. Some people just want to make a renewable energy statement. First, decide on your goal (the purpose of the solar photovoltaic system).

The simplest energy goal may be to just visibly show support for renewable energy technology. In that case the amount of solar on your roof is a function of how much of a statement of support that you wish to make. Should you totally cover your roof, or will just a couple of solar panels make the statement you are trying to convey? Your decision on solar PV system size may depend on how much money you are willing to spend, but not on how much electricity you want to produce.

If instead you want to maximize the financial and environmental benefits of solar, it might make sense to size your PV system to produce as much electricity as you use annually. The average household in Maryland uses 1005 kWh of electricity in a month.¹⁹ For a household in Maryland with a reasonably favorable location and circumstances, generating this much electricity from solar panels would require 32 solar panels.²⁰ Before installing solar, however, you should look more closely at how much electricity your household uses, and how much electricity solar panels can generate at your location.

The amount of electricity that a household uses can vary from year to year, based on efficiency measures, purchase of new appliances, changing personal habits, or changes in the composition of the household. It can also vary if a particularly cold winter or hot summer puts more demand on heating or cooling systems. Your electric bills from the last 12 months can tell you how much electricity you've used over the last year, but you should also think about changes you expect in your future use. Are you planning to make major efficiency improvements? Do you have teenagers who will be moving out of the house soon? These types of events could reduce your future electric use. On the other hand, if the weather over the past year has been particularly mild, you might expect your electric use in future years to be higher.

¹⁹ Electricity Local website <https://www.electricitylocal.com/states/maryland>, accessed November 5, 2017

²⁰ Assumes 1371 kWh ac per 1 kW dc of solar panels and an average panel being rated for 275 watts.

Figure 5 shows monthly energy use for a sample single-family home in Bethesda, Maryland over a number of years.

FIGURE 5 *Sample Home Energy Usage Per Month (kWh vs Month), 2010–2016*

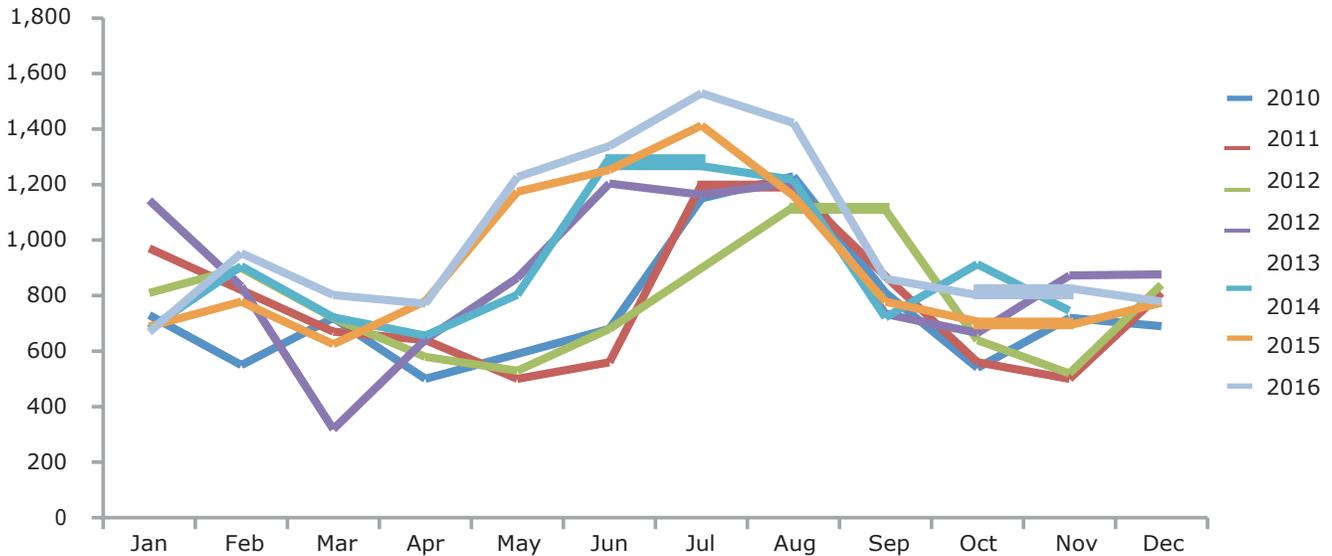
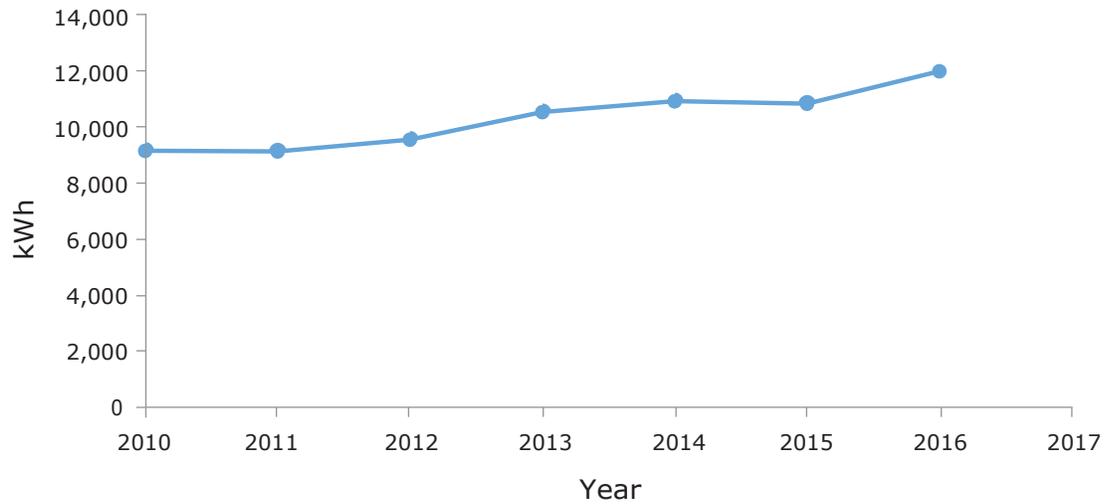


Figure 6 shows the annual electricity usage of this same home over time. While this home has an upward trend, other homes may experience a downward trend as appliances become more energy efficient. Looking at energy use over multiple years can help identify the size and direction of the trend.

FIGURE 6 *Sample Home Energy Usage Per Year (kWh/year), 2010–2016*



Solar systems produce more electricity in the summer than they do in the winter. Net metering allows consumers to be credited for excess electricity they produce in the summer, and to use those credits to pay for electricity in the winter. Consumers who want to get the maximum benefit from their solar systems will usually install a system sized to produce the amount of electricity expected to be used during an average year. Such a system would produce more electricity than is used during the summer months, in order to accumulate credits to be used during the winter. Under Maryland’s net metering rules, credits expire in April each year.

Once you’ve decided how much electricity you will need, the next step is to figure out how many solar panels will produce the right amount of electricity. The quickest way to determine the amount of energy that will be produced by 1 kW of solar panels is to go to PVWatts,²¹ a solar calculator created by the National Renewable Energy Laboratory.

At the “Get Started” block, type in your location or zip code. In this example, Baltimore MD is selected.

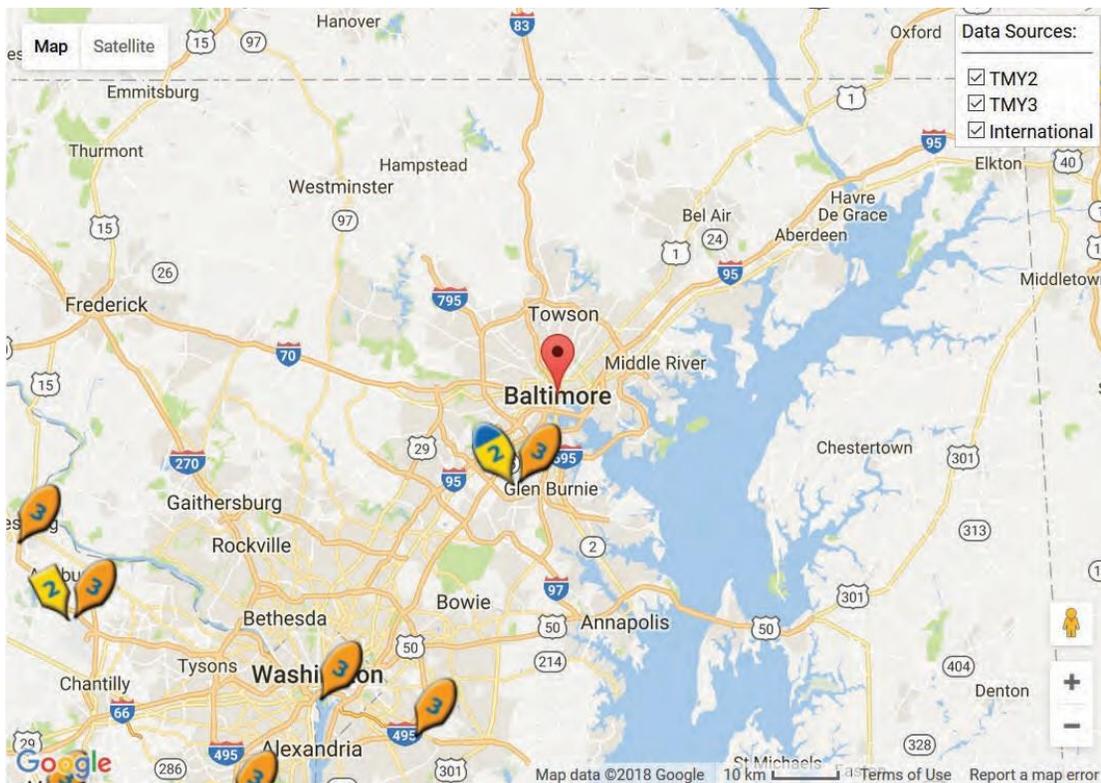
²¹ Go to website: pvwatts.nrel.gov/

FIGURE 7 *PVWatts Location Screen*



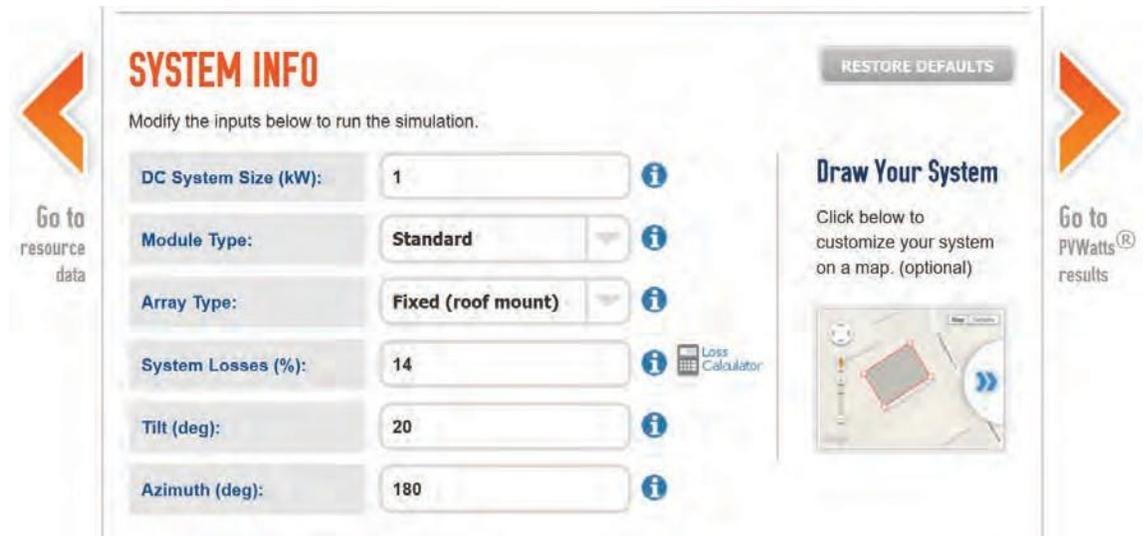
Click on “GO>>” when the location has been entered.

FIGURE 8 *PVWatts Solar Resource Data Screen*



Look at the weather station selected by the program. Normally it is the closest and best station to use. Click on the orange arrow that says, “Go to system info.”

FIGURE 9 *PVWatts System Info Screen*



Select a DC System Size of “1”. Assume the use of a Standard Module Type unless you know that you are using thin film solar panels or premium solar panels. Set the array type to Fixed (roof mount) unless the array is ground mounted (in which case used Fixed—open rack), or use one of the tracking system options that are selectable. Input the roof tilt (or in the case of ground mounted system, the tilt of the array),²² and the orientation of the array (the direction the array will point). If in doubt of these values, use the system default values.

Select the right arrow “Go to PVWatts results.”

²² If the roof tilt is not known, the use of the default 20 degree value is acceptable. If the array orientation is approximately south (+/- 30 degrees), use of the default 180 degree azimuth heading is acceptable.

FIGURE 10 *PVWatts Results Screen*



The next screen will say something like: “1,310 kWh/Year*. System output may range from 1,252 to 1,360 kWh per year near this location.” The Results page will also show the anticipated amount of kWh production each month of the year.

To calculate the required solar size simply divide annual energy used by the average annual energy production per year per kilowatt as provided by PVWATTS.

Using the example provided above, the homeowner decides to generate 100 percent of the energy used in 2016 (12,000 kWh). PVWATTS indicates that a single kW of solar panels will produce 1,310 kWh in a year. The solar system should be sized at approximately

$$12,000 \text{ kWh} / 1,310 \text{ kWh per 1 kW} = 9.16 \text{ kW}^{23}$$

²³ In this example, the electricity use of your home and the electricity generated from a solar panel are both described in kWh AC. The panels are described in kW DC.

The amount of electricity that any solar system produces will also vary from year to year, based on the weather and the amount of sunshine. Many people prefer to install a slightly smaller system than the size they find using PVWatts, in order to account for fluctuations in electric use and for fluctuations in electricity production by the panels. Under Maryland's net metering rules, any excess electricity at the end of the net metering year (in April) is compensated at a much lower rate than the regular net metering rate. By installing a slightly smaller system—perhaps only big enough to generate 80 percent of household electric use in a typical year—a homeowner saves money on installation costs, and reduces the likelihood of ending up with low-value excess electricity in April at the end of the net metering year.

Constraints

The size of the solar system can be constrained by roof size, roof load and wind load, or system cost. Modern solar panels used in residential applications take up about 17.6 sq. ft. for a 265-watt panel, or about 15 watts per square foot. If the roof has dimensions 44' X 11' (484 sq. ft.), then the maximum number of whole solar panels that can be placed on the roof are 26 panels in 13 columns and 2 rows. In total, the system would add up to 6.890 kW, so a roof this size could not support enough solar panels to meet the entire annual need. Potentially the home could use premium solar cells to increase the energy output, but these panels would come at a higher per unit cost.

A typical residential 265-watt solar panel weighs about 40 lbs. Mounting rails and racking add a bit to this weight. While most residential roofs can handle the added weight, the new roof configuration must also be able to handle wind and snow loading for the region. In some cases, additional structural support will be required, or potentially the roof must be tied down to the house frame to keep it on in a high wind. An engineer must normally sign off on the installation design for all roof-mounted systems.

Residential solar installation normally costs between \$2/watt and \$5/watt. (See the Financing section on p. 22 for some options that can reduce the upfront cost.) Performing energy efficiency FIRST will reduce the size of the required system, saving money.

Summary

The decision of solar system size is greatly tied to the question of your goals for the system. Once goals are established, a reasonable estimate of system size can be calculated. However, there are additional issues of roofing size, structural support, system cost and payback economics that may also influence the final size of the system. Only you can make decisions concerning your solar energy goals and your willingness to pay. With these answers in mind, the system designer and installer should be able to propose a system to meet your needs.

A Maryland Consumer's
GUIDE TO SOLAR



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Energy
Administration

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