

A Vermonter's Guide to Residential Solar



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About the SunShot Initiative

The U.S. Department of Energy SunShot Initiative is a collaborative national effort that aggressively drives innovation to make solar energy fully cost-competitive with traditional energy sources before the end of the decade. Through SunShot, the Energy Department supports efforts by private companies, universities, and national laboratories to drive down the cost of solar electricity to \$0.06 per kilowatt-hour. Learn more at www.energy.gov/sunshot.



About the Vermont Public Service Department Clean Energy Development Fund (CEDF)

The CEDF, at the Vermont Public Service Department (PSD), offers a portfolio of funding opportunities to accelerate the development and production of renewable energy in Vermont including: grants, direct incentive payments, credit enhancements for renewable energy lenders, contracts for specific products or services, and other offerings as may be authorized by the Vermont General Assembly and subject to approval of the PSD. Since its inception, the CEDF has awarded over \$64 million in federal and state resources for renewable energy and energy efficiency in Vermont, leveraging total investments of more than \$258 million in the state's clean energy infrastructure. Learn more at http://publicservice.vermont.gov/renewable_energy/cedf.



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.

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HOW TO USE THIS GUIDE

There are many ways to build and finance a solar PV system. ***A Vermonter's Guide to Residential Solar*** can help you decide whether it makes sense for you to go solar and, if so, how.

You do not necessarily have to read the guide from cover to cover, or all at once. It is divided into sections so that you can refer to relevant information at different points in the decision making and installation process. Although there is a lot to consider, keep in mind that hundreds of thousands of Americans who are not energy experts have happily and successfully installed solar on their homes or invested in group solar projects.

The guide provides information in the following sections:

- SECTION 1:** Reasons Vermonters 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:** After your system is installed

It also includes several appendices that cover:

- Questions to Ask a Solar Contractor
- PV Project Checklist
- Resources
- Glossary
- Calculating Net Savings for Systems Purchased with a Loan (EXAMPLE)

Solar panels are a big investment, whether you buy them outright or finance them over decades. Take some time to learn about solar, so you can be confident that your investment is a good one.



10 KEY THINGS TO REMEMBER

If You're Thinking about Solar

1. *Solar is a significant investment.*

Deciding to “go solar” is comparable to buying a car or making other major home improvements. Make sure you think it through carefully.

2. *Consider energy efficiency.*

If your home is not already highly energy efficient, you can do even more good—for your wallet and for the environment—by including efficiency with solar. See “Efficiency” on p. 16.

3. *Financing options are available.*

There are four main ways to pay for a solar system, each with its own advantages and disadvantages. See “Financing Your Solar PV System” on p. 21.

- Paying cash up front
- Financing a system through a loan
- Signing a solar lease
- Signing a net metering credit purchase agreement

4. *Net metering is key.*

Through net metering, utility customers who generate their own power can feed electricity produced back into the electricity grid and get credit for that power. Net metering figures into the calculations for solar savings and solar financing. See “Net Metering” on p. 26.

5. Group net metering is possible.

Perhaps you don't own your own home or there isn't a viable location on your property for solar; there may still be a solar option for you. A renter or a homeowner can participate in a group net-metering project, an offsite solar array that serves multiple customers. See "Group Net Metering" on p. 18.

6. Federal incentives are available.

The federal government provides an investment tax credit (ITC) that is worth 30 percent of the total cost of a residential solar system for those who are eligible. See "Federal Tax Credit" on p. 25.

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. 28.

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 "Comparing Bids" on p. 30.

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 page 30.

10. Know what you are signing.

Make sure you have read and fully understand your solar contract before you sign it. See "Contract Provisions" on p. 22 as well as "Signing a Contract" on p. 30.

Reasons Vermonters Choose to Go Solar

There are many good reasons to go solar. The price of solar PV systems has come down significantly in recent years, the technology has proven to be reliable, and there are more ways to pay for it. Below are several key reasons why Vermonters have decided to get their electricity from renewable solar resources.

Financial

Many Vermonters have been able to save money with solar panels. The cost of panels has fallen dramatically over the past decade. Net metering allows customers to get credit from their utilities for electricity generated by their panels. Innovative financing options, including leases and net metering credit purchase agreement,¹ enable consumers to pay for solar panels with a monthly charge spread out over many years rather than upfront in a lump sum. Many solar consumers' total electricity costs, even accounting for the cost of the panels, are reduced after installing solar panels.

Environmental

Most of the electricity produced in New England comes from burning fossil fuels, mainly natural gas. This produces emissions that contribute to air pollution, including carbon dioxide, which causes global warming. Solar panels have no emissions and can reduce the need for fossil fuels.



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¹ A Note on Terminology: A net metering credit purchase agreement is an arrangement in which a third party owns a solar system and a customer receives credit from the utility for the electricity the solar panels generate. This arrangement is often referred to as a power purchase agreement (PPA) in other states.

Local Economic Development

Solar installations in Vermont give rise to solar jobs in Vermont. According to the Vermont Clean Energy Industry report, more than 2,100 Vermonters were employed in the solar electric generation sector in 2016, and solar employment was 13 percent higher than in 2015.² Installing solar panels helps to sustain these jobs and to expand this sector of Vermont's economy.

Community

Solar can help bring people together around a common goal or project. Some Vermont municipalities have adopted specific energy targets and have banded together to help achieve them. Many Vermont cities and towns have started municipal energy committees to help transition toward clean energy at the local level. In some cases, people have united around specific group net-metering projects or been brought together through “Solarize,” a community-focused solar group purchasing campaign. The structure of Solarize, with volunteer-driven outreach and increasing discounts as more people sign up to go solar, encourages peer-to-peer interaction and community building.

Solar can help bring people together around a common goal or project.

Many Vermont cities and towns have started municipal energy committees to help transition toward clean energy at the local level.

Energy Independence and Resilience

Some Vermonters choose solar because they want to be more independent and produce their own power. To be completely independent of the grid requires investing in a stand-alone energy system and installing battery storage. Most people who go solar don't choose an off-grid system. A grid-tied 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” (disconnect from the grid). (See p. 14 for more discussion of these options.) But even a simple grid-connected system still provides some independence in the sense of being insulated from utility rate fluctuations and producing a portion of the power used.

² Vermont Clean Energy Industry Report, http://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/VCEIR%202016%20Final.pdf.

What Is a Solar PV System?

Photovoltaic (PV) systems convert sunlight into electricity. Sunlight strikes the panel material and frees electrons, and electricity is created. (See Figure 1.)

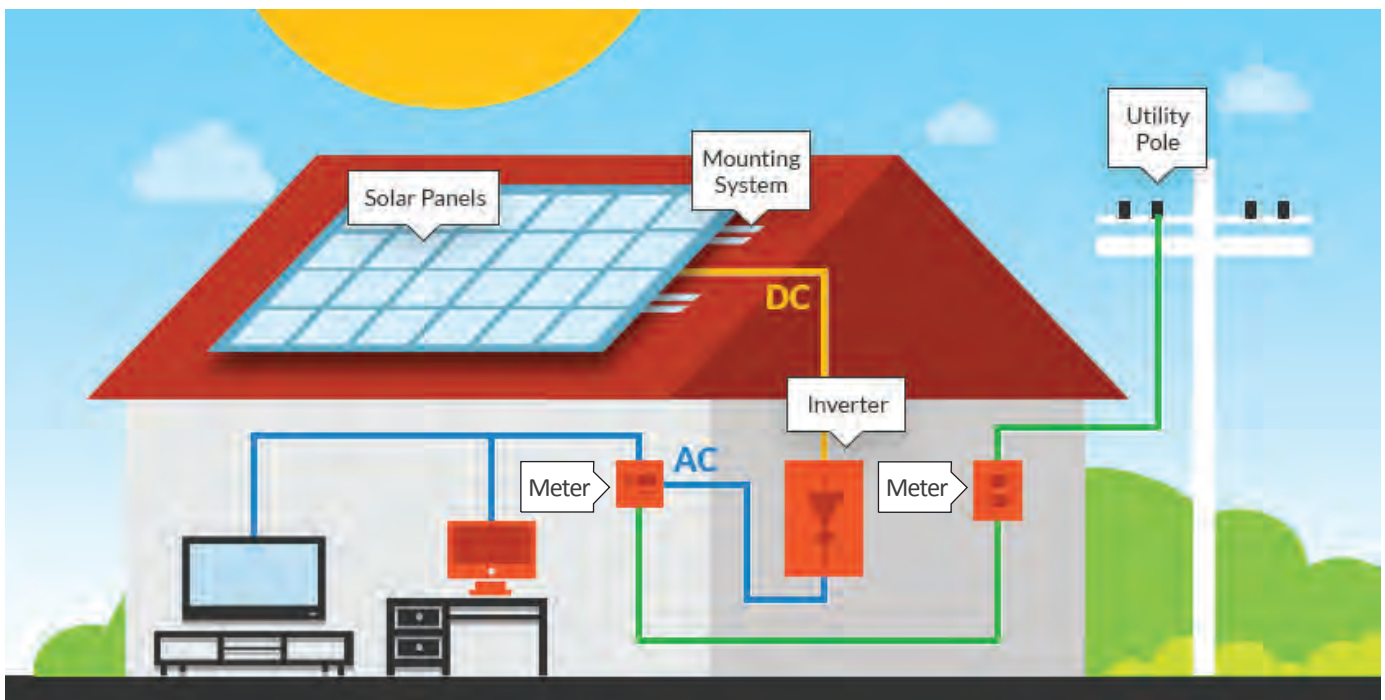
The electricity produced in a PV system is direct current (DC). Other than some off-grid homes and specialized appliances, homes use alternating current (AC). The PV system changes the DC into AC, through the use of an inverter. The AC power from the inverter is then connected to the home's electrical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

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

The Solar Cell and Panel

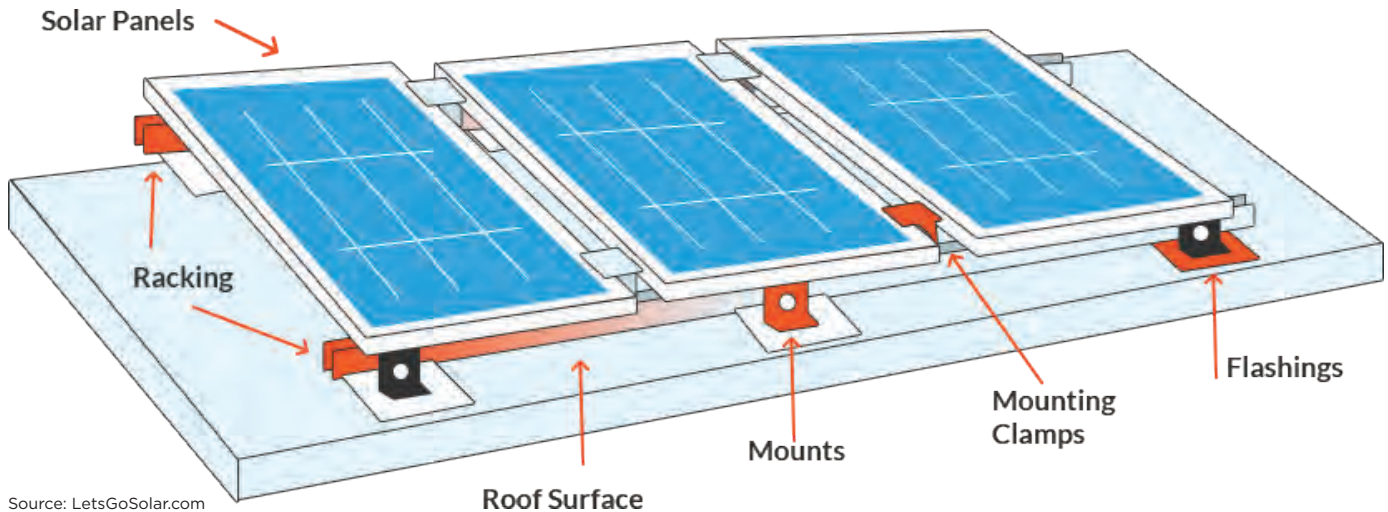
The basic electricity producing structure is the solar cell, which is comprised of silicon and electrodes. Cells are strung together in a panel (also referred to as a module). A series of panels connected together electrically and fed into the inverter is known as a string. The term often used to refer to all the panels in a system is an array. The output of a panel is measured in DC-watts. The nameplate output of a panel represents the amount of power produced in optimal conditions. Modern full-sized panels can reach up to 350 watts per panel and can be comprised of 80 cells working together. These panels are usually rectangular or square and measure around 20 square feet for the 350 watt panels. 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

FIGURE 1 *How a PV System Works*



Source: LetsGoSolar.com

FIGURE 2 *Traditional Rooftop Mounting System*



location. It could also depend on other factors, as Vermont solar vendors offer different types of panels. There are different ranges of power output and efficiency depending on the brand of the solar panels.

Racking and Mounting

Racking and mounting systems secure solar panels together and attach them to the structure or to the ground, usually as part of the system's electrical grounding. (See Figure 2.) Proper grounding is required by electric codes and ensures safe 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 as long without corrosion or other degradation, and can withstand wind, ice, and snow loads.

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 water-proofing 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 penetrations and flashing. Roofing material, age and quality can affect the choice of racking and mounts. (See Roofing Material, Roof Age, and Roof Condition on p. 17.)

In some cases, a ground or pole-mounted system is a better option than a roof-mounted system. Some roofs may not be sufficient to carry the extra weight of the panels; orientation or shading may limit the output of a rooftop system; or aesthetic concerns may lead you to examine these other options. Solar arrays can be mounted directly to the ground using racking systems

manufactured for this purpose. Systems may also be mounted on the side or top of a pole. These installations can increase costs due to additional construction and the distance to connect to the electricity panel, but provide greater flexibility in location. It is critical to ensure the mounting solution matches the site's soil bearing capacity and is secured at a sufficient depth to prevent frost heaving. For ground mounted systems, remember that snow sliding down from the panels can build up quickly and block the lower level of the panels. In Vermont, it is good practice to ensure that the lower edge of the solar panel is at least three feet off the ground.

Ground mount 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.

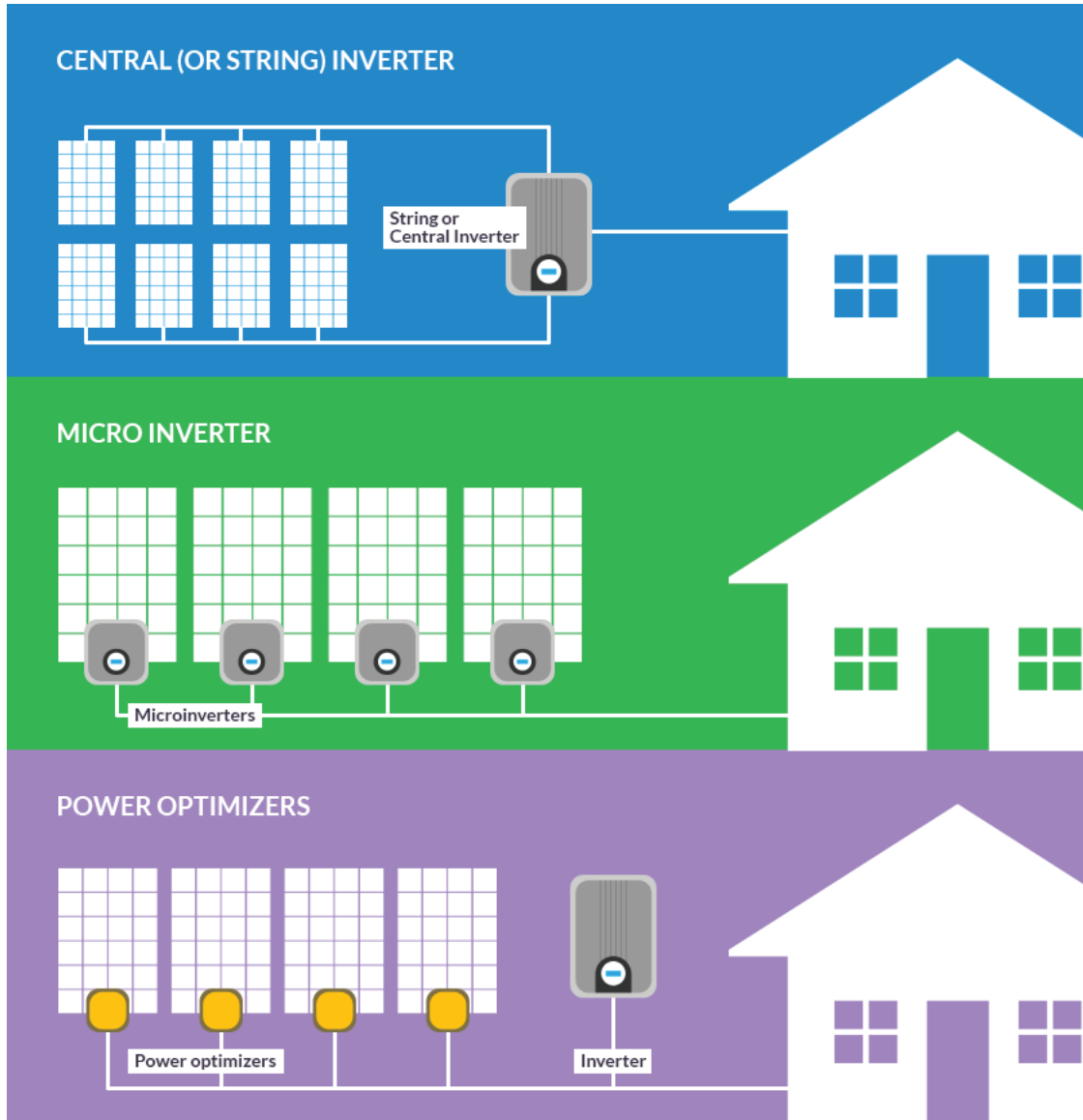
Trackers

Some pole-mounted systems use trackers to keep the panels pointed toward the sun throughout the day. Trackers are either single or dual 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 have additional maintenance requirements. Consumers should carefully weigh the benefits and costs of such systems when deciding what type of system is best for their needs.



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FIGURE 3 *Types of Solar Inverters*



Source: LetsGoSolar.com

Inverters

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

The three primary types of inverters are **central inverters**, **micro-inverters**, and **optimized inverters**. (See Figure 3.) Central inverters manage a string of panels that are wired together. Because the panels are wired together 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. This means that shading of individual panels will not affect the entire array's output. Individual panel output can also be monitored through micro-inverters. Optimized inverters are central inverters with an optimizer on each panel. If your system will be impacted by partial shading, it may make sense to consider micro-inverters. Ask your solar contractor if using micro-inverters is worthwhile given your specific installation conditions.

Inverters may fail and need to be replaced during the life of a solar system. Micro-inverters may last longer than central inverters.

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. The wiring must last a long time and should be enclosed in conduit when necessary to protect it from the elements and from rodents. 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.

Meter

Electric meters are provided by the utility to measure electricity usage and provide reliable service. When you install a PV system, the utility will usually need to install a second meter in order to measure your solar power output. The utility may charge you for the installation and use of this second meter, but it remains the property of the utility. All Vermont utilities are now installing "smart meters," which can accommodate more billing options and provide more data on electricity usage.



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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 security, especially 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.

There are several new battery systems that 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 no longer require electrolyte levels to be checked.

Some utilities offer homeowners battery storage systems that can be coupled with PV systems and include different financing arrangements. New battery and storage technologies are expected in the coming years. Some of these technologies will allow for the batteries to be installed safely after your system is in place and operational.

If you are interested in having storage, you should work with a system designer/installer that specializes in storage-based systems.

Solar Photovoltaics vs. Solar Thermal

This guide focuses on using sunlight to make electricity with PV panels. Sunlight can also be used to heat water for household 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 save consumers money by reducing water heating bills. Some installers have experience with both PV and solar hot water panels.

Both Efficiency Vermont and the Vermont Clean Energy Development Fund offer incentives for solar hot water systems. Follow these links to view the incentive programs:

- Efficiency Vermont rebate for solar hot water systems
<https://www.encyvermont.com/rebates/list/solar-water-heaters>
- Clean Energy Development Fund rebate for solar hot water systems
<http://publicservice.vermont.gov/content/funding-opportunities-projects>

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.

Your Goals

When considering going solar, it's useful to think about what your own goals are. 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 in the opportunity to achieve greater independence from your utility?

As you learn more about solar power, do your reasons for going solar still make sense? Make sure you know what you want your solar system to do for you, and make sure you choose a system that will accomplish your goals.

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 want. Once you've made your home more energy efficient, your electricity needs will be reduced. Thus, a smaller, less expensive PV system will meet your electricity needs.

Start by contacting Efficiency Vermont at www.encyvermont.com or 888-921-5990 (or, if you live in Burlington, the Burlington Electric Department at www.burlingtonelectric.com or 802-865-7300). They'll help you figure out the most sensible way to make your home more efficient. Every home is different, but Efficiency Vermont or the Burlington Electric Department can help you with an energy assessment that will tell you how *your* home can be made more efficient.

Renter or Owner

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

Electric Bill

The higher your electric bill, the more money you can potentially save by going solar. If your electric bill is very low (under \$50–\$60 per month), then the savings from solar will be relatively small, and some solar financing companies might not be interested in working with you.

Residential electric bills in Vermont consist mostly of a customer charge, an energy charge, and an energy efficiency charge. The customer charge is an amount that is the same no matter how much electricity you use. It is generally between \$8 and \$18 per month, depending on the utility and the rate you have signed up for.



The energy charge varies depending on how much electricity you use. The amount of electricity you use is measured in kilowatt-hours (kWh). For instance, the line item for your energy charge might say, “1,000 total kWh @ \$0.15 = \$150.”

The energy efficiency charge also varies. Depending on how much electricity you use, it may be smaller or larger than the customer charge.

The difference between customer charge, energy charge, and energy efficiency charge is important because these charges can be treated differently under Vermont’s net-metering rules.

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, including standing seam, are good candidates for solar panels. Installing solar panels on slate roofs is generally not recommended, due to the potential for damage to the slate.

Solar panels are usually warrantied to last 25 years, but they may last longer. Asphalt shingles are generally expected to last 20–30 years. It may not make financial sense to install panels on a roof that will need to be replaced in the next 15 years. Have your roof professionally evaluated before your panels are installed. Metal roofs last longer than asphalt, but you should still determine the condition of your roof before you install solar panels so you know how long it’s likely to last.

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 panels, getting ground-mounted solar panels, or participating in a group net metering project. It is also 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.

Orientation, Tilt, and Shading

The amount of direct sunlight your PV panels will receive is affected by orientation, tilt, and shading.



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Orientation refers to the compass direction your roof faces. The best orientation for solar panels is solar south, but southeast or southwest might also work. In Vermont, solar south is about 14 degrees west of magnetic south (where a compass points).

Tilt refers to the slope of your roof. The best roof tilt for solar panels in Vermont is 30–35 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 seriously reduce the energy output of the panels, especially if a system uses central inverters. Full sun in the middle hours of the day (10 am to 2 pm, or 11 am to 3 pm daylight savings time) is especially important.

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

Group Net Metering (Off-site Solar)

Group net metering allows electric customers to gain the economic benefits of solar without having an array located on their own home or property. Group net-metering projects typically allocate the electrical generation from a jointly owned or third-party-owned PV array to offset many customers' electricity consumption. A group net metering system can be structured in a variety of ways. It

could be administered by a utility, a solar developer, a nonprofit organization, or a group of electric customers. A project could be designed to offer customers the option to buy, lease, or subscribe to particular panels in an array or to provide the customers with an interest in a jointly owned array. Alternatively, a project could be designed to give customers the opportunity to buy a portion of the electrical generation from an array (See p. 21 for an explanation of lease.)

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

This guide includes what you need to know if you're thinking about signing an agreement with a group net-metering project that someone else is developing. If you're interested in developing your own group net-metering solar project, then you'll need to explore issues that are beyond the scope of this guide. A good place to start is the Vermont Energy and Climate Action Network (VECAN) at www.vecan.net.

What is Community Solar?

“Community solar” is a term that means different things to different people. Some people use the term “community solar” to mean the same thing as group net metering. Others use the term “community solar” to refer specifically to group net-metering projects that are owned by the participating customers. Still other people use the term “community solar” to refer to a utility program in which consumers can choose to pay extra for renewable power. Be sure that you understand what exactly someone is referring to when they say “community solar.”

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

What happens when you move to a new home depends on whether you own the solar panels or have signed a lease or net metering credit purchase agreement with a third-party owner. (See Financing on p. 21.) It also depends on whether your solar system is located at your home or off-site at a group net-metering facility.

If you own panels at your home, then solar panels can increase the resale value of your home. 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.”³ But remember that there are no guarantees, and that home prices depend on market conditions and the preferences of individual buyers.

If the panels do not belong to you, the situation is different. If you sign a lease or net metering credit purchase agreement, the panels on your property will be owned by someone else. You should carefully read the part of your contract that describes what happens if you sell your home. In some cases, the new owner, if interested, may be able to take over the lease or net metering credit purchase agreement. In other cases, it may be necessary for you to buy out the lease or net metering credit purchase agreement in order to sell your home. You may have to remove a fixture filing if one was attached to your property. (See Fixture Filings on p. 24.) Find out from your solar financing company what buying out your lease or net metering credit purchase agreement would involve.

If you're thinking of participating in a group net-metering system, you should read carefully the part of your contract that discusses what happens if you move to a new home. If your new

³ 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/sites/all/files/selling-into-the-sun-jan12.pdf>

FIGURE 4 *PVWatts Calculator (NREL)*



Source: NREL

home is served by the same utility as your old home, it may be possible to continue participating in the same group net-metering system. But if you move out of the utility service territory, you may no longer be able to participate, depending on your solar company's practices. Check what is required to terminate your group net-metering agreement or to sell your interest in the system if you move out of the utility service territory.

Online Solar Calculators

Online solar calculators are tools to help you predict how much energy you could generate with solar panels and how much money you can save. These calculators ask you to enter information such as your address, your utility electric rates, and how large a system you want to install. They then estimate whether you could benefit from solar.

The PVWatts online calculator from the National Renewable Energy Laboratory (pvwatts.nrel.gov) is easy to use and understand. (See Figure 4.) It asks the user to input an address, system specifications, and electric utility rates. It then returns a month-by-month estimate of kWh generated and the value of the electricity generated.

There are dozens of other solar calculators online. Be careful about which you use. Many of them 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.

Financing Your Solar PV System

With the soaring popularity of solar in Vermont and around the country, a number of 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.

1. DIRECT OWNERSHIP

Purchasing your system outright, whether through a loan or in cash, has its own set of benefits. As the owner, you receive any tax benefits. All savings on your electrical bill will be 100 percent yours.

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 asset if you default on the loan. On the other hand, secured loans often have lower interest rates, and that interest can be tax deductible in some cases. Unsecured loans may have higher interest rates, and the interest is generally not tax deductible.

Market Rate vs. Credit Enhanced

Market rate programs offer loans at the usual rates offered on the financial market. Credit enhanced programs offer favorable rates for solar consumers and are sometimes specifically designed to help consumers with low-to-moderate credit scores. Credit enhancements are not widely available but may be available to some consumers in some circumstances. Check with your local financial institutions for options that may be available in your territory.

Residential PACE

PACE (Property Assessed Clean Energy) is an arrangement in which a solar loan (or an efficiency loan) is paid back through an additional assessment on your local property tax bill. If your property is sold, then the loan transfers to the new owner. PACE is available in about 40 cities and towns in Vermont. Information on PACE can be found at Efficiency Vermont:

- <https://efficiencyvermont.com/services/financing/homes>

2. THIRD-PARTY OWNERSHIP

Within this broad category, consumers can choose between a lease and a net metering credit purchase agreement. As with any financial obligation, signing a lease or a net metering credit purchase agreement 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 owns solar panels located at your home, and you lease the panels from the owner. A solar lease generally involves a monthly payment from you to the owner over the term of the lease, which is usually 20 years. There may be no up-front

cost. You save money as long as the value of the electricity from the panels is more 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 owner, the company is also responsible for maintaining and monitoring the system. Be sure to read the section covering lease and net metering credit purchase agreement contract provisions, below, before you sign a lease contract; your monthly payment amount could be subject to change under the terms of the contract.

Net Metering Credit Purchase Agreements

A net metering credit purchase agreement (also frequently known as a power purchase agreement, or PPA) is another arrangement in which somebody else owns solar panels located at your home. In this case, 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. As with a lease, there may be no up-front cost, and you may be able to begin saving money immediately. As with a lease, the company, and not you, is eligible for the federal tax credit. Be sure to read the section below covering lease and net metering credit 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 Net Metering Credit Purchase Agreements

Leases and net metering credit purchase agreements involve many of the same issues:

- **System Performance:** 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? Will your payments be reduced in the meantime? Is there an annual "true-up" that adjusts your payments to match the actual output received?
- **Payment:** You 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 net metering credit 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 considerably smaller than your current utility bill.
- **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. The 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 net metering credit purchase agreement power rate over time. In theory, this escalation should match or be lower than the increase in utility power prices. If the contract payment accelerates faster than the price of power, then you will save less and less each year. It is impossible to predict what future utility prices will be, so there is inevitably some financial risk involved in signing a solar lease or net metering credit 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 payment increases compound over time and can add up to a lot. Ask your contractor for a complete schedule of**



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payment amounts or per kilowatt-hour charges over the entire term of the lease or net metering credit purchase agreement.

- **Read the Contract:** Ask questions and read the contract to ensure you understand the terms, especially including 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. These 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, 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.

Fixture Filings

If you've signed a lease or net metering credit 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 tax credit.

Sample Language

There are several places you can view model language on solar leases and net metering credit purchase agreements. The Solar Energy Industry Association (SEIA) has sample language here:

- www.seia.org/research-resources/model-leases-ppas

The National Renewable Energy Laboratory also has model language here:

- https://financere.nrel.gov/finance/solar_securitization_public_capital_finance



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How Solar Can Save You Money

Tax incentives, net-metering credits, and Renewable Energy Certificates can help make a solar system a good investment for you. 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 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.) The residential Investment Tax Credit (ITC) is worth 30 percent of the total cost of the system. In other words, if your system costs \$20,000, then the credit is worth \$6,000. You receive 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. According to the Tax Policy Center, 45 percent of American households pay no federal income tax.⁴ 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. So make sure you know whether or not you would normally be paying sufficient federal income tax to use 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 to future tax years and secure the full benefit of reducing the cost of the system 30 percent.

The ITC will decline in coming years. The 30 percent credit is 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.

The ITC is only available if you're buying a system. If you're leasing or signing a net metering credit 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 net metering credit purchase agreement before you sign it.

Eligibility of group net-metering customers for the 30 percent ITC is particularly complicated. Consult a tax professional before assuming you are eligible for any tax credits.

Renewable Energy Certificates (RECs)

RECs are created whenever solar panels (or other renewable sources, like wind turbines) generate electricity; one megawatt-hour of generation equals one REC. They represent the environmental value of solar power, and they can be bought and sold. Whoever owns the RECs has the legal right to say that they used that solar power. This right is valuable to utilities that are required

If you don't pay any federal income tax, you won't benefit from the solar Investment Tax Credit (ITC). According to the Tax Policy Center, 45 percent of American households pay no federal income tax.

⁴ See New Estimates of How Many Households Pay No Federal Income Tax. Tax Policy Center, 2015. www.taxpolicycenter.org/taxvox/new-estimates-how-many-households-pay-no-federal-income-tax.

to supply a certain amount of their power from renewable resources. It is also valuable to businesses that want to be able to say they use renewable electricity.

If you don't own the RECs that go with your solar 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.

In many cases, a customer's net-metering contract will designate the utility as the owner of the RECs. In other cases, the homeowner, third-party owner, or someone else may own the RECs. If one of your goals in getting solar panels is to personally be using solar power, then you will probably want to keep your RECs. But because RECs have value, you can probably make more money by selling the RECs, or assigning them to someone else like the utility or the third-party owner. If you're working with a third-party owner, or a group net-metering developer, they may not give you the option of keeping the RECs.

If you own your system, and you want to keep your RECs, you will need to make that choice at the beginning of the process. When you apply for your permit from the Vermont Public Service Board, you can indicate on the permit form that you want to keep your RECs. If you don't specifically indicate that you're keeping the RECs, then they will go to the utility. ***This choice is irrevocable.***

Renewable Energy Certificates (RECs)

RECs are important but can be tricky to understand. For more discussion of RECs, see the following:

1. The Center for Resource Solutions has a short animated video titled, "What is a Renewable Energy Certificate?" See <https://youtube.com/watch?v=opJMrzNauFQ>
2. The Vermont Attorney General has issued guidance to solar developers about the significance of RECs and what developers may say to consumers about whether their power is renewable. See <http://ago.vermont.gov/assets/files/Environmental/Guidance%20on%20Renewable%20Marketing.pdf>

Net Metering

Net metering is an electricity billing arrangement that credits solar customers for the electricity they add to the grid beyond the amount they consume during a particular billing period. Net metering enables customers to use their own solar generation to offset their electricity consumption and send excess on-site solar generation back to the grid for credit. They use the net-metering credits they receive to offset electricity consumption when they're using more power than they're generating.

During the summer, customers with solar panels often generate more electricity than they use and build up credits. During the winter, when there is less sunshine, customers use the credits they acquired during the summer to offset their winter electric bills. Under Vermont's net-metering rules, credits expire a year after they're generated.

As this is written, in the summer of 2016, Vermont's net-metering rules are being revised. Readers are encouraged to return to this section in 2017 to review the new requirements issued under a revised rule, or to visit the Public Service Board website at <http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/netmetering> for future updates.

The net-metering rules could be revised again 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.

Businesses and other non-residential electricity customers are also able to put up solar panels and participate in net metering. The special issues they might face when installing solar panels are beyond the scope of this guide.



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Solar Adder and Adjustors

In Vermont, the value that net-metering customers receive for the electricity they generate is not exactly the same as the retail price they pay for electricity. Under Vermont's pre-2017 net-metering rules, solar customers who participate in net metering receive a premium from the utilities for all of the electricity they generate. This premium, called the "solar adder," varies between utilities, but for most customers is worth roughly 5 cents for every kilowatt-hour generated. Under the new rules, the solar adder is likely to be replaced with a series of adjustors.

Check with your utility before you sign a solar contract, and confirm what net-metering price you will be credited for the electricity generated by your panels. This is important whether you're buying the panels or you're signing a lease or a net-metering credit purchase agreement. In all cases, the net-metering transaction happens between you and the utility, not between you and the solar financing company, and not between the utility and the financing company.

Vermont Property Tax and Vermont Sales Tax

In Vermont, solar systems under 50 kW are exempt from both state and local property taxes. (This applies to the equipment itself, not to the land.) Systems over 50 kW are subject to state property taxes of \$4/kW (based on the AC rating of the system). Systems over 50 kW may or may not be subject to local property taxes, depending on the municipality. Solar systems are also exempt from state sales tax.

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 lot 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. Understand the difference between buying, leasing, and signing a net metering credit purchase agreement. Understand how net metering works, what the federal tax credit is, and what RECs are. 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, ask them who they worked with, and whether they were pleased with the process and with the final result. Look at the work that was done.

Renewable Energy Vermont (REV) has created a list of installers at www.revermont.org/vrebl. It includes information on how long companies has been in business, what credentials they have, and how many systems they've installed. REV has verified that all of the companies on the list have liability insurance of at least \$1 million.

Be cautious if you receive cold calls from solar installers and financing companies. You have no obligation to listen to or 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.

There are several certification programs for solar installers, but no certification is currently required in Vermont to install a solar system. Some Vermont solar installers have certification from the North American Board of Certified Energy Practitioners (NABCEP), the most widely recognized certification organization for solar installation professionals. While some installers have electrician's licenses, not all licensed electricians have experience installing solar panels.

Where to Check for Complaints

Check with the Better Business Bureau at www.bbb.org/boston or 508-652-4800 to see if there have been any complaints filed about a particular installer.

Get Multiple Bids

As with any major project, you should ideally get bids from at least three different contractors before you make a decision.

What Bids Should Include

At a minimum, bids should include: total installation cost, including equipment and labor; system specifications, including system size in kilowatts; and estimated annual energy output, 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 net metering credit purchase agreement, the bid should include the price per kWh, how that price 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. Again, ask the contractor to include a copy of the calculations for net financial savings. (See Appendix 5 for a sample net financial savings calculation.)

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



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that you decide not to get solar panels after all, or perhaps you will be pleasantly surprised by how much money you can save.

Make sure you understand the assumptions contractors made when they prepared their bids. For example, if you received a bid to buy a system, is the total cost provided before or after you take the federal tax credit? If you received a bid for a lease or net metering credit purchase agreement, does the bid assume that the solar financing company will take possession of the RECs?

Understanding Utility Rate Increase Impacts

When contractors estimate how much money a solar system will save you, they 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, ask them all to use a standard utility power escalation rate, perhaps 2.5 percent annually. But keep in mind that utility rate changes vary widely in different years and for different utilities. Some Vermont utilities have had rate decreases in some years.

Comparing Bids

You may receive bids for two systems of slightly different sizes. How do you compare the prices in that case? 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). Under Vermont law, the legal size of a system is measured in kilowatts AC. This means the 15 kW limit for a small system means a system with a maximum inverter size of 15 kW but the DC array size could be 20 kW or more depending on the design. For calculation of pricing and estimated production, the DC kilowatt size should be used since this tracks much more closely with equipment cost and production. Make sure to understand when system size in kilowatts AC or kilowatts DC is being used.

Remember that different panels operate at different efficiencies, meaning that panels with the same kilowatt rating may produce different amounts of energy (measured in kilowatt-hours). So in addition to comparing cost per kilowatt, you may want to compare cost per kilowatt-hour.

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.

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.



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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. Different parts of the system (like panels, inverters, and mounting equipment) may be warrantied for different amounts of time. Typically, the performance of the panels is warrantied for 25 years. Panel performance will degrade over time, but they should still be producing at least 80 percent of their original production after 25 years. (See Warranties on p. 38 for more information.)
- **Payment schedule:** If the contractor will be paid in full when the project is built, the schedule may depend on construction milestones. If the contractor is involved in financing the project, the payment schedule may involve monthly payments over the life of the system.
- **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. 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 and other expenses.



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- **List of subcontractors:** 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.
- **Who is responsible for getting and paying for permits:** Because your contractor should have experience with system permitting, it will generally be best for your contractor to take care of this. This should be spelled out in the contract. Make sure that all costs associated with permitting are allocated to either you or the contractor in the contract. Among the costs that should be accounted for are any utility charges involved in setting up a net-metering account, including any costs for installing an additional meter.

If your contract is for a lease or net metering credit purchase agreement, it should include many other provisions. See “Questions to Ask” on p. 41 for a full list. Among these are:

- What is the length of lease or net metering credit purchase agreement?
- What happens at the end of the lease or net metering credit 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?

Permitting

In Vermont, connecting your home PV system to the grid requires a Certificate of Public Good (CPG) from the Public Service Board (PSB). In some cities and towns, local permits may also be required. Understanding how permitting works is important but, in most cases, Vermont solar vendors manage the permitting process for you.

This guide addresses permitting for solar systems under 15 kW AC. Almost all home systems are under 15 kW. Permitting for systems over 15 kW can be significantly more complicated and is beyond the scope of this guide.

Municipal Permits

Some cities and towns require PV systems to have local permits, in order to address issues such as municipal codes. In some cases, these local permits include requirements for inspection of the system after installation and before connecting the system to the grid. Consult your local government to find out about local requirements.

Certificate of Public Good (CPG)

PV systems that will be connected to the grid require a CPG from the Public Service Board. Off-grid systems do not need one.



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For systems under 15 kW AC, there is a streamlined process, sometimes referred to as “registration,” for securing a CPG. This simplified process originally covered systems 5 kW and under, was changed to 10 kW and under, and is now at the current size of 15 kW or less. Older state forms may refer to a 5 kW or 10 kW threshold for the registration process, but the current threshold is 15 kW. The Public Service Board provides its own guidance for the procedure. (Note: the header on this form states “Ten kilowatts AC or less”—the procedure is correct; the title is outdated.) The Registration Procedure Guide can be found at:

- <http://psb.vermont.gov/sites/psb/files/orders/2012/2012-4/2012-5/2012%20219a%20Registration%20Procedure.pdf>

Registration

To register your PV system under 15 kW AC, use the form available at:

- <http://psb.vermont.gov/sites/psb/files/NMRegistrationForm2016%20For%20Distribution.pdf>

The form must be filled out completely. Your installer can likely complete the form or provide support. The completed form must be filed with the Public Service Board, the Public Service Department and your utility. The utility has 10 days to respond with concerns or objections. If no objections are presented, the Certificate is deemed to be issued on the 11th day following filing. The rules count the day after filing as day one.

In order to complete the form, you will need your account information with your utility. You will also need information on the installer, system capacity, output, manufacturer and model of equipment.

As you (or your installer) fill out the form, there will be an opportunity to indicate if you plan to keep the RECs from your system (see p. 25). If you don’t specifically indicate that you plan to keep the RECs, they will go to the utility. **This decision is irrevocable.**

If you sell your home and transfer the PV system, you must transfer the CPG. This can be done with a very simple one-page form found here:

- <http://psb.vermont.gov/sites/psb/files/forms/NMtransferapp.pdf>

Proposed Changes to Final Rules on Net Metering

The Public Service Board is in the final stages of changing the net-metering rules. Changes to net-metering rules could affect permitting. Refer to the Net Metering section on p. 26 for more information. See also the Public Service Board website at <http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/netmetering> for updates.

After the System is Installed

The goals you have set for your PV system will be best realized through a responsible but relatively low-intensity operations and maintenance effort focused on monitoring output and occasional physical inspections.

Good maintenance will help ensure that the system operates correctly and safely. System monitoring and maintenance starts upon the completion of your system installation. At that time, there may be an inspection by the local community official and/or the utility to ensure safe operation and code-compliant installation. (See also Permitting, p. 33.) Regardless, your installer should provide you with a written commissioning report indicating that all system components are operational and online. Such a report should also include all system documentation and warranties.

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

System Maintenance

The primary maintenance task is physically inspecting the components of your system. Periodically check your system for physical damage to panels, wiring, and other external components. (Rodents or birds can sometimes invade areas where wiring is located.) 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 cracks or fractures can appear. 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.

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 5 percent or more. Since Vermont has fairly regular monthly 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 reduction in output. Since winter time is our cloudiest time of year, however, the impact of snow is not all that significant on annual production. If solar panels are accessible, many 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:** Rain helps clean the panels and depending on how much 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. Schedule your cleaning following the times of year with the most dust and pollen.

Most homeowners take on cleaning themselves on an as needed, infrequent basis.

Monitoring Your System

You should ask your installer to provide you with an expected 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 separate device that can track the output of the system. Most monitoring systems are now



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web-based, allowing easy access to system data from any computer or smartphone. Many of these service providers have an initial period of free service 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 that employs micro-inverters, you can access panel-by-panel data. (See Inverters on p. 13.) Although central inverters cannot provide data on individual panels, they can provide the system's output, voltage, carbon offsets, financial information, 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.

Aside from basic information, most monitoring systems, with simple inputs, can provide information on customized monetary savings as well as environmental benefits (usually expressed as carbon offset, trees planted, or cars removed from the road). 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 system is working properly.

A complete failure is easy to spot—no 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. 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 below about warranties.)

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 more 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, consider cleaning the surfaces after a physical inspection to see if there is buildup.
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. Growing plants and other obstructions can appear over time and must be managed if you want to preserve output goals.
5. **Damage to cells/panels:** Although it is rare, panels and cells can sometimes become damaged. It can be hard to spot. A qualified technician may be necessary to diagnose such impacts and assist with any warranty claims or repairs.

Sometimes installers offer a period of maintenance and inspection following an installation. If you're able to, follow the technicians during one of these visits and learn what they are looking for and how they check for system performance. Many installers and solar companies can continue to

provide maintenance for you for a fee beyond any initial free maintenance period.

Some homeowners are interested in reaching Net Zero status with their homes. For these homeowners, solar monitoring systems can provide the necessary information about electricity production from their systems.

System Safety

It is critical to ensure that all safety measures are correctly installed and that all components meet the requirements of the electric code and the utility. If system safety measures aren't followed, back-feeding power into the grid could seriously harm utility workers working on lines to restore power to the electric grid in the event of a power outage.

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

Proper grounding of the system protects you and your property. A qualified installer or an electrician should be able to 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.

Solar systems include electrical wiring, and electrical wiring of any kind has the potential to start fires, especially if it's not properly installed. Make sure your 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.

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

Insurance

If you own your home and have homeowner's insurance, you should notify your insurer of the installation. This ensures that if there is any damage to the 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 on installing a system.

If your system is owned by a third party, they may be responsible for insuring it.

Warranties

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

If you are selling your home, check to make sure you complete any of the required change-of-ownership forms for your system so that the warranty properly transfers. 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,



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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, their warranty coverage may cease to exist. Below are the warranties you should have.

Panels

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 guarantees. Currently, these warranties stretch from 20 to 25 or even 30 years, and protect against significant declines in output. Most companies will insure 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 who will inspect the panel 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 10 years, but longer warranties are often available to purchase at an extra cost. In most cases, you may purchase additional warranty coverage directly through the manufacturer. Inverters are the most complicated component in the system and the most critical point in your system for failure, so an inverter

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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 be more 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 meters belong to the utility, and the utility is responsible for maintaining them. 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 meters is the system owner's responsibility. Warranties for meters are generally two years in length.

How to Address a Problem with a Solar Company

Occasionally, consumers are not satisfied with the work performed by a solar company. Perhaps the system is not producing the amount of electricity expected. Perhaps the work has not been completed in a timely fashion. Or perhaps the roof or other property was damaged during installation.

The first step is 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 Vermont is in Boston, and can be reached at www.bbb.org/boston or 508-652-4800. 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 Vermont Attorney General's office at <https://uvm.edu/consumer/?Page=complaint.html> or at 1-800-649-2424. 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 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 net metering credit 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.

APPENDIX 1

Questions to Ask a Solar Contractor

1. How much experience do you have installing residential solar systems? How many systems have you installed?
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?
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?
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?
12. What's the upfront cost?
13. What will my monthly payment be?
14. What will my net savings be? Can I see your calculations?
15. Who gets the RECs 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 Net Metering Credit Purchase Agreement

1. What is the length of the lease or net metering credit 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?
7. Who do I notify if there's a problem with my system?
8. Does the contract include production guarantees? What happens if the guarantee isn't met? How will I be compensated?

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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?
 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?
 13. What happens to the system if the owner of the system goes out of business?


Additional Questions that Only Apply to a Group Net-Metered System

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?

APPENDIX 2

PV Project Checklist

- Have you thought about your goals?
- Have you consulted with Efficiency Vermont or the Burlington Electric Department about energy efficiency?
- Have you looked at your electric bills from the last 12 months and considered 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 how soon it will need to be replaced?
- 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, and signing a net metering credit purchase agreement?
- 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?
- Do you understand how net metering works?
- Do you know the price you'll receive from your utility for the electricity you generate?
- Have you talked to your 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 increases 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?
- 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 Renewable Energy Certificates (RECs) 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?
- Have you considered what assumptions your contractor is making about future utility price increases? What is the basis for these assumptions?

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- Have you read your contract thoroughly before signing?
 - If you're getting a lease or net metering credit purchase agreement, do you know what your responsibilities are for maintaining the system?
 - If you're getting a lease or net metering credit 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 net metering credit purchase agreement, do you know what happens if you want to sell your home?



APPENDIX 3

Resources

Official Information on Net Metering in Vermont

- From the Vermont Public Service Board, <http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/netmetering>
- From the Vermont Public Service Department, http://publicservice.vermont.gov/renewable_energy/net_metering

Vermont Organizations

- Clean Energy Development Fund (CEDF). A fund established by the State of Vermont to promote the development of renewable energy. http://publicservice.vermont.gov/renewable_energy/cedf
- Renewable Energy Vermont (REV). A trade association of renewable energy companies doing business in Vermont, www.revermont.org
- Vermont Energy and Climate Action Network (VECAN). A network of town energy committees in Vermont, administered by the Vermont Natural Resources Council (VNRC), www.vecan.net
- Vital Communities. A regional organization in the Upper Valley of Vermont and New Hampshire that has organized Solarize campaigns, <http://vitalcommunities.org>

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>
- LetsGoSolar.com: Consumer Guide to Home Solar Panels, www.letsgosolar.com

APPENDIX 4

Glossary

CPG (Certificate of Public Good): A permit issued by the Vermont Public Service Board. A CPG is required for any electricity generator in Vermont that is connected to the grid, including solar systems. See “Permitting” on p. 33.

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.

Group net metering: A system in which enough solar panels to serve multiple customers are grouped together in one location. Participating households or businesses receive net-metering credit for their portion of the output. See “Group Net Metering” on p. 18.

Kilowatt (kW): A unit of power. The generation capacity of solar panels and solar systems is described in terms of kilowatts.

Kilowatt-hour (kWh): A unit of energy. Kilowatt-hours are kilowatts over an amount of time. If you use one kilowatt for an hour, you’ve used one kilowatt-hour. The output 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 solar panels and you lease the panels from the owner. The panels that you lease may be at your home or they 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 p. 26.

Net Metering Credit 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. A net metering credit purchase agreement is also sometimes referred to as a power purchase agreement, or PPA.

Orientation, tilt, and shading: *Orientation* refers to what compass direction a roof faces. *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 “Orientation, Tilt, and Shading” on p. 17.

Renewable Energy Certificate (REC): A tradeable commodity representing the environmental attributes of renewable energy. See “Renewable Energy Certificates, or RECs” on p. 25.

Tax credit: A tax credit is an amount that you deduct from the income tax that you owe. There is a federal solar tax credit available for 30 percent of the cost of installing a home solar system. Not everyone is able to take advantage of this. See “Federal Tax Credit” on p. 25.

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

APPENDIX 5

Calculating Net Savings

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. This calculation is only an illustration and is not intended to be used for purposes of comparison. (See Table 1, p. 48.)

Net savings calculations can be performed for any type of financing, including cash purchase, loan, lease, or net metering credit purchase agreement. The example provided involves financing a system through a loan. Systems financed in other ways will require slightly different calculations. If you are entering a lease or net metering credit purchase agreement, then the financing company should be able to help you perform net savings calculations. Systems owned by a third party frequently include escalator clauses, which should be included in the calculations. If you have a lease, then the monthly payment will simply be the amount named in the contract. If you sign a net metering credit purchase agreement, then your monthly payment will vary based on how much energy the system generates, but the system owner should be able to provide you with an estimate, based on expected monthly generation.

If you are paying for your system in cash, then there obviously is no monthly payment. Net savings will simply be gross savings per year times the number of years, minus the original cost of the system (after the tax credit, if you're eligible for that).

Example Net Savings Calculation for a System Purchased with a Loan

In this scenario, a homeowner with an initial electric bill of \$100 a month installs a 5-kW system that generates an average of 475 kilowatt hours per month. The homeowner takes out a 20-year



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TABLE 1 *Net Savings Calculation Example*

EXAMPLE	How to find the value	Our example, including a \$14,000 20-year loan at 3.5%
What you start with		
Monthly electric bill before panels installed	Your average monthly electric bill over the last year	\$100
Average household electricity usage per month	Your average monthly electric usage over the last year (monthly usage is included on every bill)	540 kilowatt hours
What you install		
Size of system installed	Choose a system size that will match your needs	5 kilowatts
Average system generation per month	Initial estimates can be made using PVWatts. Later in the process, your contractor can give you more accurate numbers.	475 kilowatt hours
What it costs to install		
Total cost of system installed	Costs vary widely based on site factors and system design. Your contractor can give you accurate numbers.	\$20,000
Federal tax credit	30% of total cost	\$6,000
Cost after tax credit	Total cost minus amount of tax credit	\$14,000
Monthly payment (for 20 years)	Online loan calculators can predict what the monthly payment will be for a loan of a given amount, term, and interest rate.	\$81.19
What you get for it		
Average monthly value of electricity generated	System generation (in kilowatt hours) times your utility's retail rate	\$70
Value of solar adder	System generation (in kilowatt hours) times value of solar adder	\$23.75
Gross savings per month	Monthly value of electricity generated plus value of solar adder	\$93.75
Gross savings per year	Gross savings per month times 12 months in a year	\$1,125
Net Savings		
Net savings per month for the first 20 years	Gross savings per month minus monthly payment	\$12.56
Net savings over 20 years	Net savings per month times 12 months in a year times 20 years	\$3,014
Net savings over 25 years	Net savings over 20 years plus net savings over the final 5 years. Net savings over the final 5 years (after the loan is paid off) equal gross savings per year times 5 years.	\$8,639



loan at 3.5 percent to cover the upfront cost of buying the system. The total cost of the system is \$20,000, and the homeowner receives \$6,000 from the federal tax credit, so the cost after the tax credit is \$14,000. This assumes that the homeowner will be able to take full advantage of the federal tax credit.

This calculation is based on Vermont's net metering rules in effect in the summer of 2016, including the 5¢/kWh solar adder. Net metering rules will change on January 1, 2017.

In order to keep it simple, this calculation does not include consideration of future utility rate increases, nor does it account for degradation of panel output. It also does not include consideration of discount rates, which economists use when comparing future values to present values. Including these considerations would alter the results.

Please remember that the information contained in Table 1 is only an example, and each person's circumstances will be different. It is very important that you perform your own calculations using actual figures from your own home. The solar adder is likely to be replaced with a different mechanism on January 1, 2017.

A Vermonter's Guide to Residential Solar

