A Consumer's Guide

Get Your Power from the Sun

U.S. Department of Energy

Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Solar energy has advanced greatly since 2003, when "A Consumer's Guide: Get Your Power from the Sun" was written. The price for solar systems has dropped by more than a factor of ten, and solar cell efficiency continues to improve. The payback has decreased, making solar energy much more attractive now than in 2003. Although this guide still contains valuable information about how solar energy works, please consult recent publications if you need pricing or product maturity metrics. For example, here are some 2016 postings:

- Homeowner's Guide to Going Solar (U.S. Department of Energy)
- EnergySage—Explore Solar (EnergySage)
- Residential Consumer Guide to Solar Power (Solar Energy Industries Association)

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Cover photo: This PV system, integrated into an awning over the back porch of a home in California, generates electricity while shading the family's outdoor activities. (Courtesy of AstroPower/PIX12345)

Photo opposite: These PV modules are light and flexible, which makes them suitable for roofing shingles.

This Consumer's Guide is based on a state-specific guide written by Tom Starrs and Howard Wenger for the California Energy Commission, which was supported, in part, by the National Renewable Energy Laboratory in Golden, Colorado.

Get Your Power from the Sun

Are you thinking about buying a solar electric system for your home or business? If so, this booklet provides some basic information that can help you.

Solar electric systems, which are also called photovoltaic or PV systems, are reliable and pollution-free. They make use of a renewable source of energy—the sun. And PV systems for homes and businesses are becoming more affordable all the time.

PV works best in an energy-efficient building. So, adding insulation and energy-efficient lighting, appliances, and windows is a good idea, to reduce your home's overall electricity use before you install a PV system.

To make PV systems even more affordable, several states offer financial incentives through solar rebates and other programs. Some utilities have net metering programs, which further enhance the economics of PV. Net metering means that when your PV system generates more power than you need, the excess goes to the utility grid and the meter runs backward. This allows you to receive full retail value for the power that your PV system generates.

This booklet can guide you through the process of buying a solar electric system. It is not a technical guide to designing or installing a system—for that information, we recommend consulting an experienced PV system designer or supplier.

A PV system can be a substantial investment. As with any investment, careful planning will help you make the right decisions for your home or business.

Warren Gretz, NREL/PIX06283

Background

What is a solar electric or photovoltaic system?

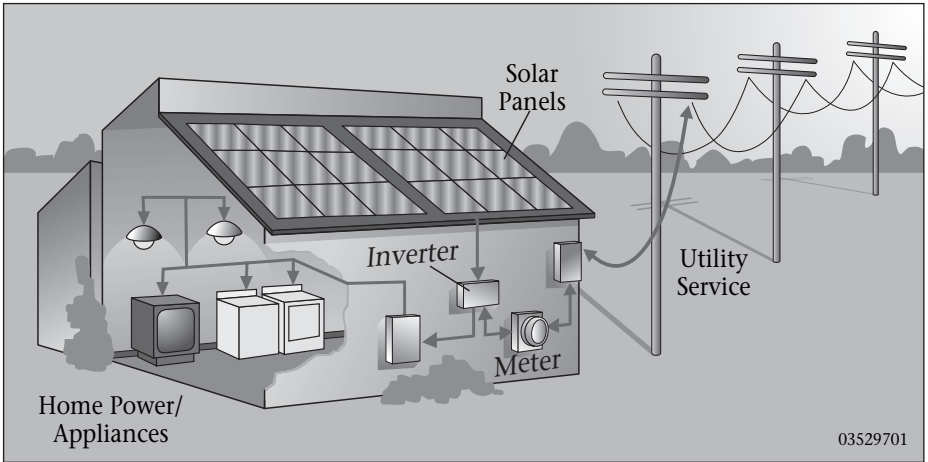
Photovoltaic (PV) systems convert sunlight directly to electricity. They work any time the sun is shining, but more electricity is produced when the sunlight is more intense and strikes the PV modules directly (as when rays of sunlight are perpendicular to the PV modules). Unlike solar thermal systems for heating water, PV does not use the sun's heat to make electricity. Instead, electrons freed by the interaction of sunlight with semiconductor materials in PV cells are captured in an electric current.

PV allows you to produce electricity—without noise or air pollution—from a clean, renewable resource. A PV system never runs out of fuel, and it won't increase U.S. oil imports. Many PV system components are manufactured right here in the United States. These characteristics could make PV technology the U.S. energy source of choice for the 21st century.

The basic building block of PV technology is the solar "cell." Multiple PV cells are connected to form a PV "module," the smallest PV component sold commercially. Modules range in power output from about 10 watts to 300 watts. A PV system connected or "tied" to the utility grid has these components:

- One or more PV modules, which are connected to an inverter
- The inverter, which converts the system's direct-current (DC) electricity to alternating current (AC)
- Batteries (optional) to provide energy storage or backup power in case of a power interruption or outage on the grid.

AC electricity is compatible with the utility grid. It powers our lights, appliances, computers, and televisions.



Residential grid-connected PV system

Special appliances that run directly on DC power are available, but they can be expensive.

Before you decide to buy a PV system, there are some things to consider:

First, PV produces power intermittently because it works only when the sun is shining. This is not a problem for PV systems connected to the utility grid, because any additional electricity required is automatically delivered to you by your utility. In the case of non-grid, or stand-alone, PV systems, batteries can be purchased to store energy for later use.

Second, if you live near existing power lines, PV-generated electricity is usually more expensive than conventional utility-supplied electricity. Although PV now costs less than 1% of what it did in the 1970s, the amortized price over the life of the system is still about 25 cents per kilowatt-hour. This is double to quadruple what most people pay for electricity from their utilities. A solar rebate program and net metering can help make PV more affordable, but they can't match today's price for utility electricity in most cases.

Finally, unlike the electricity you purchase monthly from a utility, PV power requires a high initial investment. This means that buying a PV system is like paying years of electric bills up front. Your monthly electric bills will go down, but the *initial* expense of PV may be significant. By financing your PV system, you can spread the cost over many years, and rebates can also lighten your financial load.

Are incentives available to help reduce the cost?

Yes, many states offer incentives. For specific information, call one of the contacts listed under "Getting Help" at the end of this booklet. Another excellent source is the National Database of State Incentives for Renewable Energy (DSIRE). Prepared by the North Carolina Solar Center, this database contains information on financial and regulatory incentives that promote renewable energy technologies.

Net Metering—In more than 35 states, customers who own PV systems can benefit from laws and regulations that require "net" electric meter reading. The customer is billed for the net electricity purchased from the utility over the entire billing period—that is, the difference between the electricity coming from the power grid and the electricity generated by the PV system. Through net metering, the customer obtains the full retail electricity rate—rather than the much lower wholesale rate—for kilowatt-hours of PV-produced electricity sent to the utility power grid. The benefits of net metering to consumers are especially significant in areas such as Hawaii and New York, which have high retail electric rates. Utilities also benefit because the solar-generated energy often coincides with their periods of "peak" demand for electricity.

Property and Sales Tax—Tax incentives may include a sales tax exemption on the PV system purchase, a property tax exemption, or state personal income-tax credits,

PV awnings such as this one in California provide both electricity and shade.

AstroPower/PIX12346

all of which provide an economic benefit to consumers by lowering high capital costs. The U.S. government also provides financial support for PV technology through a tax credit for commercial uses of solar energy. This energy investment credit provides businesses (but not individuals or utilities) with a 10% tax credit and 5-year accelerated depreciation for the cost of equipment used to generate solar electricity.

Buy-Down—Rebates and buy-downs, typically based on the rated power of the system, help to defray high capital costs and to create competitive, sustainable market growth. In the United States, the U.S. Department of Energy has been involved in a program known as TEAM-UP, or Technology Experience to Accelerate Markets in Utility Photovoltaics. Through this program, some 80 utilities in 40 states have installed more than 7 megawatts of grid-connected PV; supplier buy-downs and consumer rebates range between $2 and $4 per watt.

Residential Energy Rate—This is the average retail residential rate for energy from utilities, in cents per kilowatt-hour. Check your utility bill for your *actual* rate.

Investing in a PV system

Why should you buy a PV system?

People decide to buy PV systems for a variety of reasons. Some people want to help preserve the Earth's finite fossil-fuel resources and reduce air pollution. Others want to invest in an energy-producing improvement to their property. Some people like the security of reducing the amount of electricity they buy from their utility because it makes them less vulnerable to future price increases. And some people just appreciate the independence that a PV system provides.

If you plan to build a home away from an established utility service, inquire about the cost of installing a utility line. Often, the cost of extending conventional power to your residence is higher than the cost of a solar option.

Whatever your reason, solar energy is widely thought to be the energy source of choice for the future, and you may be able to take advantage of a state-sponsored program to help make it your energy choice for today and tomorrow.

Is your home or business a good place for a PV system?

Can you locate your system so it works well?

A well-designed PV system needs clear and unobstructed access to the sun's rays for most or all of the day, throughout the year. You can make an initial assessment yourself. If the location looks promising, your PV provider can determine whether your home or business can effectively use a PV system.

The orientation of your PV system (the compass direction that your system faces) affects its performance. In the United States, the sun is always in the southern half of the sky but is higher in the summer and lower in the winter. Usually, the best location for a PV system is a south-facing roof, but roofs that face east or west may also be acceptable. Flat roofs also work well for solar electric systems, because PV modules can be mounted flat on the roof facing the sky or bolted on frames tilted toward the south at an optimal angle. They can also be attached directly to the roof as “PV shingles.”

If a rooftop can't be used, your solar modules can also be placed on the ground, either on a fixed mount or a “tracking” mount that follows the sun to orient the PV modules. Other options (often used in multifamily or commercial applications) include mounting structures that create covered parking, or that provide shade as window awnings.

Is your site free from shading by trees, nearby buildings, or other obstructions?

To make the best use of your PV system, the PV modules must have a clear “view” of the sun for most or all of the day—unobstructed by trees, roof gables, chimneys, buildings, and other features of your home and the

surrounding landscape. Some potential sites for your PV system may be bright and sunny during certain times of the day, but shaded during other times. Such shading may substantially reduce the amount of electricity that your system will produce. To be eligible for some rebates, your system must be unshaded between certain hours during certain times of the year. Some states have laws that establish your right to protect your solar access through the creation of a "solar easement." Your PV provider can help you determine whether your site is suitable for a solar electric system.

Does your roof or property contain a large enough area for the PV system?

The amount of space that a PV system needs depends on the size of the system you purchase. Some residential systems require as little as 50 square feet (for a small "starter" system), but others could need as much as 1,000 square feet. Commercial systems are typically even larger. If your location limits the size of your system, you may want to install one that uses more efficient PV modules. Greater efficiency means that the module needs less surface area to convert sunlight into a given amount of electric power. PV modules are available in a range of types, and some offer more efficiency per square foot than others do (see table on the next page). Although the efficiency (percent of sunlight converted to electricity) varies with the different types of PV modules available today, higher efficiency modules typically cost more. System sizing, discussed later in this booklet, should also be discussed with your PV provider.

What kind of roof do you have, and what is its condition?

Some types of roofs are simpler and cheaper to work with, but a PV system can be installed on any type. Typically, roofs with composition shingles are the easiest to work with, and those with slate are the most difficult. In any case, an experienced solar installer will know how to work on all types and can use roofing techniques that eliminate any possibility of leaks. Ask your PV provider how the PV system affects your roof warranty.

If your roof is older and needs to be replaced in the near future, you may want to replace it at the time the PV system is installed to avoid the cost of removing and reinstalling your PV system. PV panels often can be integrated into the roof itself, and some modules are actually designed as three-tab shingles or raised-seam metal roof sections. One benefit of these systems is their ability to offset the cost of roof materials.

How big should your PV system be, and what features should it have?

To begin, consider what portion of your current electricity needs you would like your PV system to meet. For example, suppose that you would like to meet 50% of your electricity needs with your PV system. You could work with your PV provider to examine past electric bills and

determine the size of the PV system needed to achieve that goal.

You can contact your utility and request the total electricity usage, measured in kilowatt-hours, for your household or business over the past 12 months (or consult your electric bills if you save them). Ask your PV provider how much your new PV system will produce per year (also measured in kilowatt-hours) and compare that number to your annual electricity usage (called demand) to get an idea of how much you will save. In the next section, we'll provide more information on estimating how much you will save.

Some solar rebate programs are capped at a certain dollar amount. Therefore, a solar electric system that matches this cap maximizes the benefit of the solar rebate.

To qualify for net metering in some service territories, your PV system must have a peak generating capacity that is typically not more 10 kilowatts (10,000 watts), although this peak may differ from state to state. Also, utilities have different provisions for buying excess electricity produced by your system on an annual basis (see the section on net metering). Finally, customers eligible for net metering vary from utility to utility; for example, net metering could be allowed for residential customers only, commercial customers only, or both.

One optional feature to consider is a battery system to provide energy storage (for stand-alone systems) or backup power in case of a utility power outage (for grid-connected systems). Batteries add value to your system, but at an increased price.

As a rule, the cost per kilowatt-hour goes down as you increase the size of the system. For example, many inverters are sized for systems up to 5 kilowatts, so even if your PV array is smaller (say, 3 kilowatts), you may have to buy the same size of inverter. Labor costs for a small system may be nearly as much as those for a large system, so you are likely to get a better price for installing a 2-kilowatt system all at once, rather than installing 1 kilowatt each year for two years.

Roof Area Needed in Square Feet (shown in **Bold Type**)

PV Module Efficiency (%)	PV Capacity Rating (Watts)						
	100	250	500	1,000	2,000	4,000	10,000
4	**30**	**75**	**150**	**300**	**600**	**1,200**	**3,000**
8	**15**	**38**	**75**	**150**	**300**	**600**	**1,500**
12	**10**	**25**	**50**	**100**	**200**	**400**	**1,000**
16	**8**	**20**	**40**	**80**	**160**	**320**	**800**

For example, to generate 2,000 watts from a 12%-efficient system, you need 200 square feet of roof area.

How much will you save with your PV system?

The value of your PV system's electricity depends on how much you pay for electricity now and how much your utility will pay you for any excess power that you generate. If your utility offers net metering (and so pays the full retail price for your excess electricity), you and your utility will pay the same price for each other's electricity. You can use the calculation box on the next page to roughly estimate how much electricity your PV system will produce and how much that electricity will be worth. Actual energy production from your PV system will vary by up to 20% from these figures, depending on your geographic location, the angle and orientation of your system, the quality of the components, and the quality of the installation.

Also, you may not get full retail value for excess electricity produced by your system on an annual basis, even if your utility does offer net metering. Be sure to discuss these issues with your PV provider. Request a written estimate of the average annual energy production from the PV system. However, even if an estimate is accurate for an average year, actual electricity production will fluctuate from year to year because of natural variations in weather and climate.

If your utility does not offer net metering, you can still use the calculation box to determine the amount of electricity your system will produce. However, this is not as straightforward, because the excess electricity will not be worth as much as the electricity you actually use. You may earn only 2 cents per kilowatt-hour—or less than half the retail rate—for your excess power.

PV systems produce most of their electricity during the middle of the day, when residential electric loads tend to be small. If your utility does not offer net metering, you may want to size your system to avoid generating electricity significantly beyond your actual needs.

How much does a PV system cost?

No single answer applies in every case. But a solar rebate and other incentives can always reduce the cost. Your price depends on a number of factors, including whether your home is under construction and whether PV is integrated into the roof or mounted on top of an existing roof. The price also depends on the PV system rating, manufacturer, retailer, and installer.

The size of your system may be the most significant factor in any measurement of costs versus benefits. Small, single-PV-panel systems with built-in inverters that produce about 75 watts may cost around $900 installed, or $12 per watt. These small systems offset only a small fraction of your electricity bill. A 2-kilowatt system that meets nearly all the needs of a very energy-efficient home could cost $16,000 to $20,000 installed, or $8 to $10 per watt. At the high end, a 5-kilowatt system that completely meets the energy needs of many conventional

Calculating Electricity Bill Savings for a Net-Metered PV System

- Determine the system's size in kilowatts (kW). A reasonable range is from 1 to 5 kW. This value is the "kW of PV" input for the equations below.
- Based on your geographic location, select the energy production factor from the map below for the "kWh/kW-year" input for the equations.

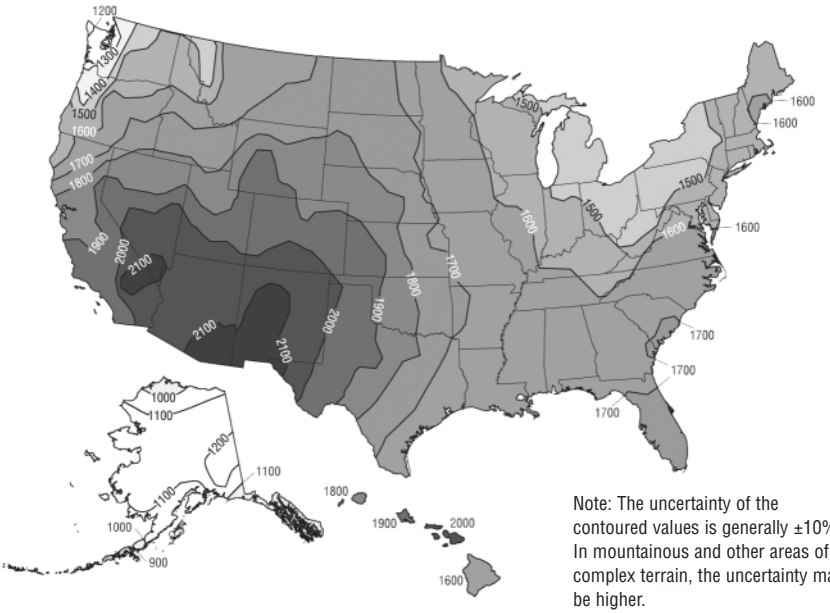
Energy from the PV system = (kW of PV) x (kWh/kW-year) = kWh/year

Divide this number by 12 if you want to determine your monthly energy reduction.

Energy bills savings = (kWh/year) x (Residential Rate)/ 100 = $/year saved

(Residential Rate in this above equation should be in dollars per kWh; for example, a rate of 10 cents per kWh is input as $0.10/kWh.)

For example, a 2-kW system in Denver, CO, at a residential energy rate of $0.07/kWh will save about $266 per year: 1,900 kWh/kW-year x $0.07/kWh x 2 kW = $266/year.



Note: The uncertainty of the contoured values is generally ±10%. In mountainous and other areas of complex terrain, the uncertainty may be higher.

homes can cost $30,000 to $40,000 installed, or $6 to $8 per watt. These prices are rough estimates; your costs depend on your system's configuration, your equipment options, and other factors. Your local PV providers can give you more accurate estimates or bids.

How can you finance the cost of your PV system?

When it comes to financing the cost of purchasing and installing your PV system, there are some special programs particular to financing solar and other renewable energy

Schott Applied Power Corp./PIX08808

This 20-kilowatt PV system produces electricity for the common areas of a shopping center in Cambridge, Massachusetts.

investments. But most of the options will be familiar to you.

The best way to finance PV systems for homes is through a mortgage loan. Mortgage financing options include your primary mortgage; a second mortgage, such as a U.S. Department of Housing and Urban Development (HUD) Title 1 loan; or a home-equity loan that is secured by your property. There are two advantages to mortgage financing. First, mortgage financing usually provides longer terms and lower interest rates than other loans, such as conventional bank loans. Second, the interest paid on a mortgage loan is generally deductible on your federal taxes (subject to certain conditions). If you buy the PV system for your home at the same time that you build, buy, or refinance the home, adding the cost of the PV system to your mortgage loan is likely to be relatively simple. It is also one way to avoid additional loan application forms and fees.

If mortgage financing is not available, look for other sources of financing, such as conventional bank loans. Seek the best possible combination of low rate and long term. This allows you to amortize your PV system as inexpensively as possible. Because your PV system is a long-term investment, the terms and conditions of your financing are likely to be the most important factor in determining the effective price of your PV-generated power.

PV systems for businesses are probably best financed through a company's existing sources of funds for capital purchases—such as Small Business Administration loans or conventional bank loans.

Selecting a PV provider

Who sells and installs PV systems?

In some areas, finding a PV provider can be as simple as picking up the telephone directory and looking under "Solar Energy Equipment and Systems—Dealers." However, many of the listings are solar water-heating companies and many companies might not be experienced in PV system design or installation. Similarly, many electrical contractors, although proficient in typical electrical contracting work, might not have expertise in PV or residential roof-mounting techniques. *How do you identify solar electric system providers?* Here are several suggestions.

- Check the Source Guide for renewable energy businesses (including PV) by name, product type, business type, and location: http://energy.sourceguides.com/index.shtml
- Contact the Solar Energy Industries Association (SEIA) at 202-628-7745 for a list of solar service providers.
- Contact your utility company to see which vendors it might recommend.
- Conduct a search on the Internet.

Reputable, professional contractors with experience in PV systems are the best choice for the actual installation.

How do you choose among PV providers?

Compile a list of prospective PV providers. (Those closest to you should have the lowest travel costs). Contact these providers and find out what products and services they offer. The following questions may give you a good sense of their capabilities:

Has the company installed grid-connected PV systems? If not, has it installed grid-independent (or stand-alone) PV systems?

Experience in installing grid-connected systems is valuable because some elements of the installation—particularly interconnection with the local utility—are unique to these systems. Because grid-connected systems are relatively uncommon, however, most contractors with PV experience have worked only on stand-alone systems. So, they have experience with all aspects of PV system installation *except* connection with the utility grid. However, a competent company with PV experience should not be eliminated just because it has not yet installed grid-connected PV. Experience with off-grid systems is valuable, because grid-independent systems are more technically complex than grid-tied systems.

How many years of experience does the company have installing PV systems?

This issue speaks for itself: A contractor who has been in business a long time probably understands how to work with customers and to compete effectively with other firms.

Is the company properly licensed?

PV systems should be installed by an appropriately licensed contractor. This usually means that either the installer or a subcontractor has an electrical contractor's license. Your State Electrical Board can tell you whether a contractor has a valid electrician's license. Local building departments might also require that the installer have a general contractor's license. Call the city or county you live in for additional information on licensing.

A solar rebate program may require that, in addition to being properly licensed, installers must demonstrate that they have special knowledge about installing PV systems. This special knowledge may be demonstrated in one of the following ways:

- Possession of a solar contractor specialty license, issued by a local building jurisdiction, that recognizes—through testing or other means—special knowledge of PV systems
- Certification in PV systems by a group such as the state chapter of SEIA
- A letter from the PV system manufacturer stating that the installer has the experience and training needed to install the system properly.

Does the company have any pending or active judgments or liens against it?

As with any project that requires a contractor, due diligence is recommended. Your state electrical board can tell you about any judgments or complaints against a state-licensed electrician. Consumers should call the city and county they live in for information on how to evaluate contractors. The Better Business Bureau is another source of information.

How do you choose among competing bids?

If you decide to get more than one bid for the installation of your PV system (always a good idea), make sure that all bids are made on the same basis. For example, a bid for a system mounted on the ground is usually very different from another bid for a rooftop system.

Similarly, some PV modules generate more electricity per square foot than others. Bids should clearly state the maximum generating capacity of the system (measured in watts or kilowatts). If possible, have the bids specify the system capacity in "AC watts" under a standard set of test conditions, or specify the output of the system at the inverter.

Also request an estimate of the amount of energy that the system will produce on an annual basis (measured in kilowatt-hours). Because the amount of energy depends on the amount of sunlight—which varies by location, season, and year to year—it's unlikely the contractor will quote a specific figure, but a range of ±20% is realistic. Bids also should include the total cost of getting the PV system up and running, including hardware, installation, connection to the grid, permitting, sales tax, and warranty.

Your warranty is a very important factor for evaluating bids. A solar rebate program may require that systems be covered by a two-year parts-and-labor written installation warranty, for example, in addition to any manufacturers' warranties on specific components. The installer may offer longer warranties. Also, ask yourself, "Will this company stand behind the full-system warranty for the next two years?"

Is the lowest price the "best deal"?

It might not be. You generally get what you pay for, and it's possible that a low price could be a sign of inexperience. Companies that plan to stay in business must charge enough for their products and services to cover their costs, plus a fair profit margin. Therefore, price should not be the only consideration, and quality should probably rank high on the list.

A home in the woods of New Hampshire had too much shade to use PV on the roof. The solution was installing a freestanding PV array.

Alan Ford/PIX09507

Before connecting a PV system to the grid

What should you know about permits?

If you live where a homeowners association must approve a solar electric system, you or your PV provider may need to submit your plans. You'll need approval before you begin installing your PV system. However, some state laws stipulate that you have the right to install a solar electric system on your home.

You will probably need to obtain permits from your city or county building department. These include a building permit, an electrical permit, or both. Typically, your PV provider will take care of this, rolling the price of the permits into the overall system price.

However, in some cases, your PV provider may not know how much time or money will be involved in "pulling" a permit. If so, this task may be priced on a time-and-materials basis, particularly if additional drawings or calculations must be provided to the permitting agency. In any case, make sure the permitting costs and responsibilities are addressed at the start with your PV provider before installation begins.

Code requirements for PV systems vary somewhat from one jurisdiction to the next, but most are based on the National Electrical Code (NEC). Article 690 in the NEC spells out requirements for designing and installing safe, reliable, code-compliant PV systems. Because most local requirements are based on the NEC, your building inspector is likely to rely on Article 690 for guidance in determining whether your PV system has been properly designed and installed. If you are one of the first people in your community to install a grid-connected PV system, your local building department may not have experience in approving one of these systems. If this is the case, you and your PV provider can speed the process by working closely with building officials to bring them up to speed on the technology.

What should you know about insurance?

For grid-connected PV systems, your electric utility will require that you enter into an interconnection agreement (see also the next section). Usually, these agreements set forth the minimum insurance requirements to keep in force. If you are buying a PV system for your home, your standard homeowner's insurance policy is usually adequate to meet the utility's requirements. However, if insurance coverage becomes an issue, contact one of the groups listed in the Getting Help section.

How do you get an interconnection agreement?

Connecting your PV system to the utility grid will require an interconnection agreement and a purchase and sale agreement. Federal law and some state public utility commission regulations require utilities to supply you with an interconnection agreement. Some utilities have developed

simplified, standardized interconnection agreements for small-scale PV systems.

The interconnection agreement specifies the terms and conditions under which your system will be connected to the utility grid. These include your obligation to obtain permits and insurance, maintain the system in good working order, and operate it safely. The purchase and sale agreement specifies the metering arrangements, the payment for any excess generation, and any other related issues.

The language in these contracts should be simple, straightforward, and easy to understand. If you are unclear about your obligations under these agreements, contact the utility or your electrical service provider for clarification. If your questions are not answered adequately, contact one of the groups in the Getting Help section.

National standards for utility interconnection of PV systems are being adopted by many local utilities. The most important of these standards focuses on inverters. Traditionally, inverters simply converted the DC electricity generated by PV modules to the AC electricity we use in our homes. More recently, inverters have evolved into remarkably sophisticated devices to manage and condition power. Many new inverters contain all the protective relays, disconnects, and other components necessary to meet the most stringent national standards. Two of these standards are particularly relevant:

- Institute of Electrical and Electronic Engineers, *P929: Recommended Practice for Utility Interface of Photovoltaic Systems*. Institute of Electrical and Electronic Engineers, Inc., New York, NY (1998).
- Underwriters Laboratories, *UL Subject 1741: Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems* (First Edition). Underwriters Laboratories, Inc., Northbrook, IL (December 1997).

You don't need to fully understand these standards, but your PV provider and utility should. It is your obligation to make sure that your PV provider uses equipment that complies with the relevant standards, however, so be sure to discuss this issue.

How do you get a net-metering agreement?

Some utilities offer customers with PV systems the option to net meter the excess power generated by the PV system. As noted, this means that when the PV system generates more power than the household can use, the utility pays the full retail price for this power in an even swap as the electric meter spins backward, and your PV power goes into the grid.

Net metering allows eligible customers with PV systems to connect to the grid with their existing single meter. Almost all standard utility meters can measure the flow of energy in either direction. The meter spins *forward* when electricity is flowing from the utility into the building and spins *backward* when power is flowing from the building to the utility.

For example, in one utility program, customers are billed monthly for the "net" energy consumed. If the customer's net consumption is negative in any month (i.e., the PV system produces more energy than the customer uses), the balance is credited to subsequent months. Once a year, on the anniversary of the effective date of the interconnection agreement, the utility pays the customer for any negative balance at its wholesale or "avoided cost" for energy, which may be quite small, perhaps less than 2 cents per kilowatt-hour.

Net metering allows customers to get more value from the energy they generate. It also simplifies both the metering process (by eliminating the need for a second meter) and the accounting process (by eliminating the need for monthly payments from your utility). Be sure to ask your utility about its policy regarding net metering.

Under the federal Public Utility Regulatory Policies Act (PURPA), utilities must allow you to interconnect your PV system. They must also buy any excess electricity you generate, beyond what you use in your home or business. If your utility does not offer net metering, it will probably require you to use two meters: one to measure the flow of electricity *into* the building, the other to measure the flow of electricity *out of* the building. If net metering is not available, the utility will pay you only a *wholesale* rate for your excess electricity. This provides a strong incentive to use all the electricity you generate so that it offsets electricity you would otherwise have to purchase at the higher *retail* rate. This may be a factor in how you optimize the system size, because you may want to limit generating excess electricity. Such a "dual metering" arrangement is the norm for industrial customers who generate their own power.

What should you know about utility and inspection sign-off?

After your new PV system is installed, it must be inspected and "signed off" by the local permitting agency (usually a building or electrical inspector) and most likely by the electric utility with which you entered into an interconnection agreement. Inspectors may require your PV provider to make corrections (which is fairly common in the construction business). A copy of the building permit showing the final inspection sign-off may be required to qualify for a solar rebate program.

What should you know about warranties?

Warranties are key to ensuring that your PV system will be repaired if something should malfunction during the warranty period. PV systems eligible for some solar rebate programs must carry a full (not "limited") two-year warranty, in addition to any manufacturers' warranties on specific components. This warranty should cover all parts and labor, including the cost of removing any defective component, shipping it to the manufacturer, and reinstalling the component after it is repaired or replaced. The rebate program's two-year warranty requirement supersedes any other warranty limitations. In other words, even if the manufacturer's warranty on a particular component is less than

two years, the system vendor must provide you with a two-year warranty. Similarly, even if the manufacturer's warranty is a limited warranty that does not include the cost of removing, shipping, and reinstalling defective components, the system vendor must cover these costs if the retailer/vendor also installed the system.

Be sure you know who is responsible for honoring the various warranties associated with your system—the installer, the dealer, or the manufacturer. The vendor should disclose the warranty responsibility of each party.

Know the financial arrangements, such as contractor's bonds, that ensure the warranty will be honored. (A warranty does not guarantee that the company will remain in business). Find out whom to contact if there is a problem. Under some solar rebate programs, vendors must provide documentation on system and component warranty coverage and claims procedures. To avoid any later misunderstandings, be sure to read the warranty carefully and review the terms and conditions with your retailer/vendor.

Getting Help

For more information on solar electric systems, please contact:

National Association of State Energy Officials (NASEO)
1414 Prince Street
Suite 200
Alexandria, Virginia 22314
Phone: 703-299-8800 • Fax: 703-299-6208
www.naseo.org/members/states.htm

Check the above Web site to find the contact for your state energy office, which typically promotes the development and use of renewable energy resources in your state. The office might offer technical assistance, sponsor workshops and forums, and provide general information to resident energy consumers on renewable energy resources and applications.

National Association of Regulatory and Utility Commissioners (NARUC)
1101 Vermont, N.W.
Suite 200
Washington, DC 20005
Phone: 202-898-2200 • Fax: 202-898-2213
www.naruc.org

This Web site has a listing of state Public Utility Commissions that you may contact.

Solar Energy Industries Association (SEIA)
1616 H Street, N.W., Suite 800
Washington, DC 20006
Phone: 202-628-7745 • Fax: 202-628-7779
www.seia.org

The Solar Energy Industries Association is the national trade association of the solar industry. Many states have a state chapter of the national SEIA organization, which can be found on SEIA's Web site.

Other helpful Web sites

Solar Energy Technologies Program: www.eere.energy.gov/solar

National Center for Photovoltaics: www.nrel.gov/ncpv

Million Solar Roofs: www.millionsolarroofs.com

Database of State Incentives for Renewable Energy (DSIRE): www.dsireusa.org

About the Office of Energy Efficiency and Renewable Energy

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as vital new "energy carriers."

The Opportunities

Biomass Program—Using domestic, plant-derived resources to meet our fuel, power, and chemical needs
Building Technologies Program—Homes, schools, and businesses that use less energy, cost less to operate, and, ultimately, generate as much power as they use
Distributed Energy & Electric Reliability Program—A more reliable energy infrastructure and reduced need for new power plants
Federal Energy Management Program—Leading by example, saving energy and taxpayer dollars in federal facilities
FreedomCAR & Vehicle Technologies Program—Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle
Geothermal Technologies Program—Tapping the Earth's energy to meet our heat and power needs
Hydrogen, Fuel Cells & Infrastructure Technologies Program—Paving the way toward a hydrogen economy and net-zero carbon energy future
Industrial Technologies Program—Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance
Solar Energy Technology Program—Utilizing the sun's natural energy to generate electricity and provide water and space heating
Weatherization & Intergovernmental Program—Accelerating the use of today's best energy-efficient and renewable technologies in homes, communities, and businesses
Wind & Hydropower Technologies Program—Harnessing America's abundant natural resources for clean power generation

To learn more, visit www.eere.energy.gov

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a DOE national laboratory, produced this Consumer's Guide for:

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