CALIFORNIA
ENERGY
COMMISSION

Buying a PHOTOVOLTAIC SOLAR ELECTRIC SYSTEM

A Consumer Guide

HANDBOOK

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Gray Davis, *Governor*

Buying a Photovoltaic Solar Electric System
A Consumer Guide

California Energy Commission
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John L. Geesman, *Commissioner*

Bob Therkelsen, *Executive Director*

Technology Systems Division
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Technology Management Development Office
Jim Hoffsis, *Manager*

Renewable Energy Program
Tim Tutt, *Technical Director*

Project Manager and Principal Author
Kate Zocchetti

Technical Advisor
Tony Brasil

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What is a solar electric or photovoltaic system?

Buying a Photovoltaic Solar Electric System: A Consumer Guide discusses the basic technical, economic and regulatory information you should know before buying a photovoltaic (PV) solar electric generation system.

This *Guide* is not a comprehensive technical or economic guide on photovoltaic systems. For that information, see the "Getting Help" section or consult an experienced photovoltaic system designer, retailer or supplier.

Unlike a solar hot water system that uses the sun's energy to heat water, solar electric or photovoltaic technology uses the sun's energy to make electricity. Learning from the word itself, the prefix "photo" means "produced by light," and the suffix "voltaic" refers to "electricity produced by a chemical reaction." PV technology produces electricity directly from the electrons freed by the interaction of sunlight with certain semiconductor materials, such as silicon, in the PV module. The electrons are collected to form a direct current (DC) of electricity.

The basic building block of PV technology is the solar "cell." Many cells may be wired together to produce a PV "module," and many modules are linked together to form a PV "array." PV modules sold commercially range in power output from about 10 watts to 300 watts, and produce a direct current like that from a car's battery.

A complete PV system usually consists of one or more modules connected to an inverter that changes the PV's DC electricity to alternating current (AC) electricity to power your electrical devices and to be compatible with the electric grid.[1] Batteries are sometimes included in a system to provide back-up power in case of utility power outages.

PV cells can be made from several processes or technologies. They all do the same job — produce electricity from sunlight.

The basic types of inverters include:

- True sine wave inverter. If you plan to take advantage of net metering (see "What is Net Metering?") and feed electricity into the transmission grid, then you must have this type of inverter.

  Most households use alternating current in their electric circuits, with power supplied from the utility at 120 volts and 60 cycles per second. A true sine wave inverter transforms the direct current from the PV modules to alternating current of 120 volts and 60 cycles per second. This transformation may also synchronize your system with the utility's system.

- Modified sine wave inverter. Similar to a true sine wave inverter, a modified inverter does not provide the same quality of 60 cycle-current that can be fed

back to the utility grid. This quality of power, however, can be used at your home or business to power many AC loads.

PV systems produce power intermittently because they work only when the sun is shining. More electricity is produced on a clear, sunny day with more intense sunlight and with a more direct light angle, as when the sun is perpendicular to the surface of the PV modules. Cloudy days can significantly reduce output, and of course no power is produced at night. PV systems work best during summer months when the sun is higher in the sky and the days are longer. Because of these variations, it is difficult for PV systems to furnish all the power you need, and are typically used in conjunction with utility-supplied electricity.

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

First consider how much sunlight your site receives. Your property should have clear, unobstructed access to the sun for most of the day, and throughout the year. In California, the sun is always in the southern half of the sky and is higher in the summer and lower in the winter.

Generally speaking, the southern part of the state will produce more PV electricity than in the north. Also, inland regions have more sunny days and can potentially produce more electricity than coastal areas. (See “How much electricity will a PV system produce?”)

The best orientation for a PV system is on a south-facing roof; however, roofs that face east or west may also be acceptable. Flat, horizontally-oriented roofs also work well for solar systems because the PV array can be mounted either on the roof facing the sky or on frames tilted toward the south at an optimal angle.

If a rooftop cannot be used, a PV array can also be placed on the ground, either in a tracking mount that follows the sun and orients the PV array to maximize the amount of electricity it generates, or in a fixed mount.

Other options include mounting structures that do double-duty by creating covered parking areas, window awnings or roofed patios.

If your location looks promising, a PV retailer can trace the sun’s path for you and determine whether your home or business would benefit from a PV system. Other considerations for a good PV site follow.

Is my site free from shading?

To make the best use of your PV system, you need most or all of the sun’s path to be clear and not shaded by trees, roof gables, chimneys, buildings, or other features of your home and the surrounding landscape.

Shading will substantially reduce the amount of electricity that your system can produce. Should you be in a

situation where neighboring trees are shading your roof, keep in mind that existing California law establishes your rights to receive sunlight on your property (California Civil Code Section 801.5 and California Public Resources Code sections 25980, et. seq.).

Do I have enough area?

The amount of roof space needed to roof-mount a solar system is based on the size or "generating capacity" or "rating" of the system you purchase. Most residential systems require as little as 50 square feet of mounting area for a small "starter" system, or as much as 500-1,000 square feet for a PV array capable of meeting all of a homeowner's needs. Commercial systems are typically much larger than residential systems.

Discuss the size of your system with your retailer. A rule of thumb is that a square foot of single- or poly-crystalline PV module area produces 10 watts of power in bright sunlight. Therefore, a 1000-watt system requires about 100 to 200 square feet of roof area, depending on the type of PV module.

The amount of roof area needed also depends on the PV module's efficiency in converting sunlight to electricity. Table 1 provides approximate roof area requirements as a function of PV efficiency (percent) and rating (watts).

Table 1: Roof Area Needed for Various Sizes of PV Systems

PV module efficiency (percent)*	*PV capacity rating (watts)*							
	100	*250*	*500*	*1000*	*2000*	*4000*	*10000*	*100000*
	Roof area needed in square feet							
4	30	75	150	300	600	1200	3000	30000
8	15	38	75	150	300	600	1500	15000
12	10	25	50	100	200	400	1000	10000
16	8	20	40	80	160	320	800	8000

*Although the efficiency (percent of sunlight converted to electricity) varies with different types of PV modules, higher-efficiency modules typically cost more.

Do I have a good roof?

While a PV system can be installed on any type of roof, some types of roofs are simpler and cheaper to work with than other types.

Typically, composition shingle roofs are the easiest to work with, and slate roofs are the most difficult. Between these are shake roofs, flat concrete tiles and mission tile roofs. In any case, an experienced PV installer will know how to work on all roof types and should use roofing techniques that eliminate any possibility of leaks.

Solar electric roofing tiles are relatively new PV products on the market. These tiles, similar in appearance to slate, are

used instead of regular roofing materials, and can be used on both new construction or re-roofing. Solar electric roofing tiles can be sized to fit a conventional roof layout, or customized for different roof configurations.

Ask your PV provider if installing a PV system impacts your roof warranty. If your roof is older and needs to be replaced in the very near future, you may want to replace it at the time the PV system is installed and avoid the later cost of removing and reinstalling your system. If, however, your roof must be replaced after the system has been installed, some roofers will insist on a type of mounting system that uses common roof flashing techniques to ensure a watertight seal.

How big should my PV system be?

Several factors will influence the size of the PV system you select. As a starting point, consider what your present electricity needs are.

The usable energy a typical house in California gets from sunshine in one year is enough to satisfy eight times its total annual electricity needs!

One way to do this is by examining past electric bills. You could also contact your utility and request the total electricity demand, measured in kilowatt-hours (kWh), for your household or business over the last 12 months. Ask your PV provider how much electricity your PV system would produce on an annual basis (also measured in kilowatt-hours) and compare it to your annual electricity demand. This will also give you an idea of how much money you will save on your electricity bill once your PV system is installed and generating.

If you want to meet 50 percent of your electricity needs with your PV system, you would choose a system sized to produce about half of your usual electricity demand.

What features should my PV system have?

Some PV systems use batteries to provide back-up power to your home or business in case of utility grid outages. While batteries certainly add value to your system, they also add cost and maintenance. Keep in mind that batteries and other electricity storage devices are not covered under most incentives.

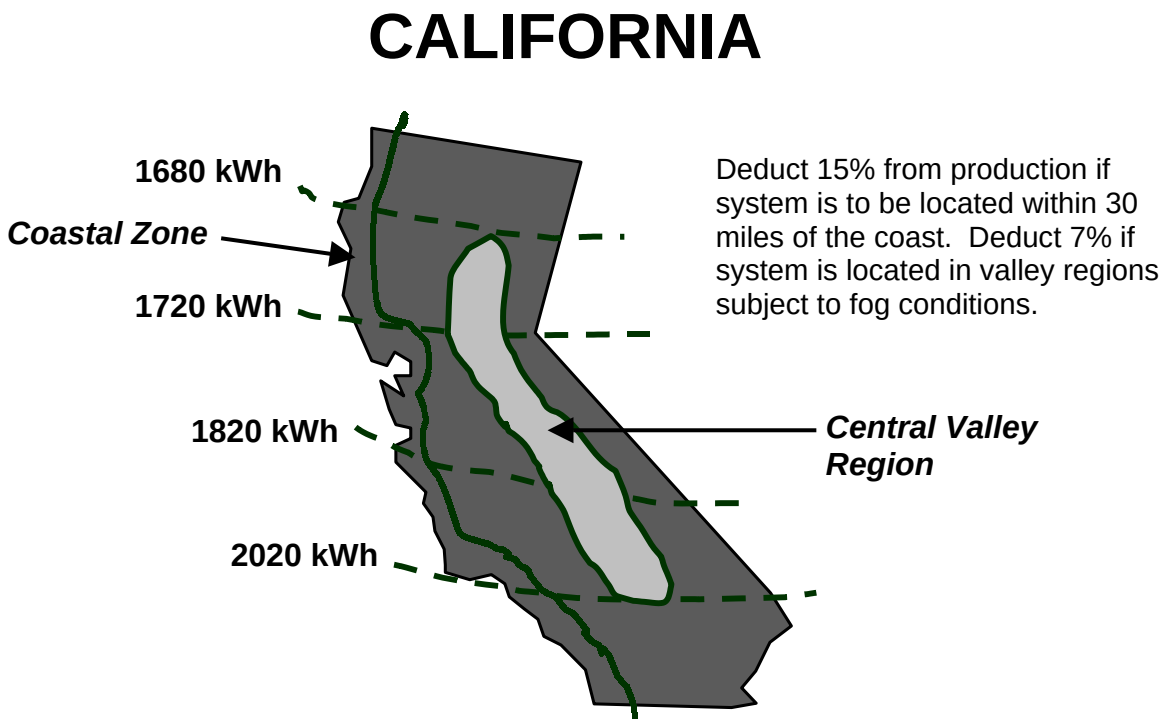
You should also consider the "economies of scale" associated with your system, which means that a larger system costs less per kilowatt-hour generated, even though it costs more overall. For example, many inverters are sized to accommodate systems up to four to five kilowatts. If your PV array is smaller (say three kilowatts) you may still end up buying the same inverter. Similarly, your PV provider is likely to offer you a better price to install a two-kilowatt system all at once than one-kilowatt this year and one-kilowatt next year, because multiple orders and multiple site visits are more expensive. On the other hand, putting a system together in this "modular" fashion may be more attractive financially, as it allows a pay-as-you-go approach.

How much electricity will a PV system produce?

PV systems produce the most electricity from spring through fall when the sun is shining. Energy production will vary, of course, depending on geography and climate. The following map provides *very approximate* statewide production estimates for a 2-kW rooftop PV system facing due south at a 20-degree tilt.

In California, the "average" residential customer uses 6,500 kWh per year. As the map shows, a two-kilowatt system would supply about 62 percent of the average customer's total demand. A one-kilowatt system would probably supply about one-third of a customer's load, while a three-kilowatt system might supply almost all of an average customer's needs. Naturally these estimates vary depending on the customer's electricity load, the geographic location, whether tracking devices are used, weather conditions, and so on.

Figure 1: Maximum PV System Production in kilowatt-hours (1 kW system)



Source: Energy Commission staff estimates derived from Pacific Energy Group estimates.

Is PV electricity expensive?

PV-generated electricity is still more expensive than conventional utility-supplied electricity when amortized over the life of the system. Although improved manufacturing has substantially reduced the cost since the 1970s, PV electricity can still cost about 18 cents or more per kWh, depending on the installed cost of the system.

Most of PV electricity's cost comes from the expense of initially purchasing the system. This investment is like paying for years of electricity bills all at once. You will appreciate the reduction in your monthly electricity bills, and the electricity your system generates after the system has paid for itself is free; nevertheless, the initial investment can be substantial.

Incentives can reduce this up-front cost, making PV systems a more affordable investment. Like any investment, you should research your options before you make a decision. This guide is intended to help you make an informed decision about investing in a PV system for your home or business.

Electricity production and savings example

As discussed earlier, a number of factors affect system performance. A typical fixed-mount PV system would produce less electricity than shown in Figure 1, usually about 80 percent of its maximum output. An ideal 1-kW rooftop PV system in an inland area of Los Angeles would produce about 2,424 kWh of electricity annually.

The formula below uses this example and a 16 cents per kWh utility rate to estimate what your average monthly savings might be.

2,424 kWh x 16¢/kWh = $388/year, or about $32/month on average

Check your local utility rates to estimate the value of the electricity your system would produce.

Remember that actual energy production will vary, depending on your specific geographic location, the system's angle and orientation, and the quality of the system's components and installation.

Be sure to discuss these issues with your PV provider and consider asking for a written estimate of the average annual energy production from the system. An estimate can be accurate for an average year, but actual electricity production will fluctuate from year to year, based on natural weather and climate variations.

Reminder: If electricity rates increase in future years, savings will also increase. Conversely, if electric rates decline, savings from the PV system will go down.

Investing in a PV system

How much does a PV system cost?

The cost of your PV system will depend on many factors: the system's configuration, equipment options, and labor costs. Prices vary depending on other factors as well, such as whether or not your home is new, and if the PV is integrated into the roof or mounted on top of the existing roof. The cost also scales somewhat with the system size or rating, and the amount of electricity it produces.

As shown in Table 2, a small, single-PV panel system with a built-in inverter that produces about 100 watts may cost about $900 installed; $9 per watt. However, such a small system would offset only a small fraction of your electricity bill.

A two-kilowatt system may cost $13,000 to $20,000 installed, or $6.50 to $10 per watt, and offset about half an average home's electricity needs. At the other extreme, a five-kilowatt system that will completely offset the electricity needs of many conventional homes may cost $30,000 to $40,000 installed, or $6 to $8 per watt. (All above costs are **before** deducting incentives.)

Table 2: PV System Cost Estimates (before rebate)

Watts	*Cost per Watt (dollars)*	*Total System Cost (dollars)*
100	$9	$900
2,000	6 – 10	13,000 – 20,000
5,000	6 – 8	30,000 – 40,000

Prescription for a Least-Cost PV System

1. Obtain at least three bids.
2. Select a standardized PV system (offered by some retailers).
3. Have an easy-to-install system mounted on a composition roof or the ground.
4. Buy as a group to get volume discounts.
5. Above all, shop around.

Are incentives available to help reduce my costs?

Yes! Reducing your cost is the primary feature of the California Energy Commission's Emerging Renewables Program. Tax incentives and net metering also help make buying a PV system more affordable.

What is the Emerging Renewables Program?

The California Legislature set aside funds to reduce the up-front price consumers pay to purchase and install emerging renewable energy technologies, such as solar photovoltaic. Among other criteria, rebate amounts are based on the generating capacity of the system, measured in watts.

What are the eligibility requirements for the rebate?

Visit the Energy Commission's website or call the toll free Energy Call Center to learn more about the current eligibility requirements and available funds. (See *For More Information*.)

Additional questions you should consider before making your final purchase decision follow.

What would my monthly payments be?

Earlier we estimated the cost of a 2 kW PV system at $13,000 to $20,000, before rebates. In this example we assume that an installed 2 kW AC system[2] costs $15,000 before rebates.

If you receive a rebate of $4 per watt from the Energy Commission, your net costs after rebate would be $7,000 ($4/watt x 2000 watts = $8,000 rebate). Table 3 shows your estimated net system cost and monthly payments, based on a two-kilowatt, $15,000 system. In a similar way, you can calculate your monthly loan payments and estimate your possible net system cost -- assuming a system is financed through a bank, savings and loan or credit union (more about financing later).

Table 4 summarizes the electricity savings, loan costs, and tax deductions for a two-kilowatt system costing $15,000.

Table 3: Estimated Net System Cost and Monthly Payments (2 kW AC system)

Total System Cost	***$16,235***
Rebate ($4/watt x 2,000 watts)	$8,000
Tax Credit	$1,235
Net cost/loan amount	$7,000
Loan period	20 years
Interest rate	7 percent
Annual payments	$660/year
Approximate monthly payments*	$55/month

Table 4: Estimated Monthly Costs/Savings (2 kW AC system)

Monthly Costs/Savings	
Monthly electricity savings	$32.00
Minus loan payments	-55.00
Income tax deduction[3]	17.00
Net cost*	-6.00

*Tables 3 and 4 assume a loan of $7,000 for a two-kilowatt system financed over a 20-year period at a seven percent interest rate (typical of the terms of many home equity loans).

> **Note:** The low-end estimate of $13,000 is used in these examples because it represents the approximate the "break-even" investment cost you should be aware of when pricing systems. To break even, the cost of owning and operating a PV system (including electricity savings, loan payments and tax considerations) must equal your present electric costs with your local electric utility. The net costs of a more expensive system will probably be higher than the anticipated savings, making it more economical to purchase electricity from your utility.

To estimate the value of installing a PV system at your home or business, visit the Energy Commission's website to use an interactive tool, the CleanPower Estimator©. The Estimator provides personalized estimates for PV systems you are considering, including electricity production, emissions reductions, and monthly savings on your electricity bill. See the *Getting Help* section.

Are there other incentive programs?

Yes. Even if you do not qualify for the Emerging Renewables Program rebate, you may be eligible for other incentives. Most utilities — including the state's largest municipal utilities, LADWP and SMUD — offer programs to help their customers obtain PV systems for their homes or businesses. Contact your local utility for more information.

Are tax incentives available?

Yes, the U.S. government provides financial support for developing PV technology — through an investment tax credit for commercial uses of solar energy. This incentive provides business taxpayers (but not individuals or utilities) with a ten percent tax credit and a five-year accelerated depreciation for the cost of equipment used to generate electricity using solar technologies.

The State of California offers a state income tax credit on the purchase and installation of PV systems for both residents and commercial business owners. Contact the Energy Commission or the Franchise Tax Board for current information.

How do I finance my PV system?

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 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 from your federal taxes. If you buy the PV system at the

same time that you build, buy, or refinance the house on which the system will be installed—adding the cost of the PV system to your mortgage is simple and may avoid additional loan application forms or fees.

If mortgage financing is not available, look for other sources of financing, such as conventional bank loans. PV systems purchased for business applications are probably best financed through a company's existing sources of funds for capital purchases—usually Small Business Administration loans or conventional bank loans. Because your PV system is a long-term investment, the PV financing terms and conditions are likely to be important factors in determining the effective price of your PV-generated electricity. Contact the Energy Commission for a list of lenders who are familiar with financing PV systems.

Will a PV system increase my property taxes?

No. All PV systems installed from 1999 until 2006 will not be subject to property taxes (Revenue and Taxation Code, section 73).

Connecting your PV system to the utility grid

All utilities in the state must offer the option of interconnecting on a net metering basis to residential and small commercial customers with PV or small wind systems one megawatt or less (California Public Utilities Code section 2827).

What is net metering?

As an eligible customer with a PV or small wind system, net metering allows you to interconnect with your utility and feed your surplus electricity to the utility grid. You can use an equivalent amount of electricity later without additional cost to you.

Net metering allows your electricity meter to spin forward when electricity flows from the utility into your building, and backward when your system produces surplus electricity that is not immediately used. Your excess electricity is "banked" on the utility grid.

Under federal law, utilities must give you credit for any excess electricity you generate beyond what you use in your home or business, but they are not required to carry over your credit from year to year. At least once a year, you are charged for the net energy consumed over the previous 12 months.[4]

Most utilities have established simplified agreements for customers that qualify; be sure to ask your PV provider or your utility for a net-metering agreement.

Do I need a special meter?

At a residence, net metering can usually be accomplished by using your existing electricity meter. Utilities usually require business customers without net-metering agreements 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. For large commercial and industrial customers who generate their own power, this "dual metering" arrangement is still the norm.

What is an interconnection agreement?

Interconnecting your PV system to the utility transmission grid will require you to enter into an interconnection agreement, and a purchase and sale agreement. Most California utilities have developed standardized interconnection agreements for small-scale PV systems as part of their implementation of California's net metering law. These agreements may be a single contract with your local utility or separate contracts with your utility and your electrical service provider.

The interconnection agreement defines the terms and conditions under which your system will be connected to the utility grid, including the technical requirements necessary to ensure safety and power quality. Other items in the agreement include your obligation to obtain all necessary permits for the system, maintain the system in good working order, and generally be responsible for the system's safe operation.

The interconnection agreement also specifies the metering arrangements (usually net metering for residential customers, dual metering for commercial and industrial customers), and any other related issues.

Most utilities have established simplified interconnection agreements; be sure to ask your provider or utility. The language in these agreements should be simple and straightforward. If you are unclear about your obligations, you should contact your utility or electric service provider for clarification. If your questions are not adequately addressed, contact one of the "Getting help" listings at the end of this *Guide*.

What should I know about Utility Interconnection Standards?

Recent progress has been made in developing nationally recognized standards for utility interconnection of PV systems. Although these standards are not necessarily binding on utilities, many utilities are adopting them rather than developing their own.

The most important standard focuses on inverters. Traditionally, inverters simply converted the DC electricity generated by PV arrays into AC electricity that is used in your home. 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.

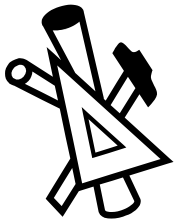
Two of these standards are particularly relevant:

1. 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 (1988, with revision being finalized in 1999).

2. 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 do not necessarily need to know about these standards, but your PV provider and utility should. It is your obligation to ensure that your PV provider uses equipment that complies with these or other relevant standards.

What should I know about permits and codes?



In most locations, you will need to obtain various permits from your city or county building department before adding a PV system. You will likely need to purchase a building permit, an electrical permit, or both to legally begin installation. Typically, your PV provider will take care of this task, rolling the price of permits into the overall system price. In some cases, however, your PV provider may not know how much time or money will be involved in obtaining a permit. In that case, permitting may be priced on a "time and materials" basis. Make sure that permitting costs and responsibilities are addressed with your PV provider at the start of your project.

Code requirements for PV systems vary somewhat from one jurisdiction to the next, but most requirements are based on the National Electrical Code. NEC Article 690 carefully spells out requirements for designing and installing safe, reliable, code-compliant PV systems. Because many 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 among the first people in your community to install a grid-connected PV system, your local government may never have permitted one of these systems, and the building inspector may have never seen one. If this is the case, you and your PV provider can speed the process along by working closely and cooperatively with your local building officials to help educate them about the technology and its characteristics.

You may live in a location where you must gain installation approval from an architectural committee or homeowners' association to comply with the "Covenants, Codes and Restrictions" applicable to your home. If so, you or your PV provider may need to seek agreement from your neighbors and submit your system plans to a homeowner committee before you install a system. Complying with "CC&Rs" is a very important step that you should undertake *before* you begin installing your PV system. If this process becomes an obstacle, contact one of the "Getting help" listings at the end of this *Guide*.

How do I get the utility and inspection signoff?

After your new PV system is installed, your local permitting agency, usually a building or electrical inspector, and your utility will probably need to inspect and sign off on your system. Depending on the inspection, your PV provider may

have to make corrections to your system to satisfy the inspector's requirements. Corrections are fairly common in the construction business, so don't be alarmed if they are requested of you and your provider.

A copy of the building permit showing final inspection signoff, and a recent utility statement showing electrical service at the installation location, are required to obtain a rebate from the Emerging Renewables Program.

What do I need to know about the system warranty?

You are required to obtain a minimum five-year full-system warranty against defective parts, workmanship, or unusual degradation of output (performance) to qualify for an Emerging Renewables Program rebate. The equipment warranty must cover the full cost of repair or replacement of defective components. If the system is professionally installed, rather than self-installed, the warranty must also include the labor of removing and reinstalling any defective components and shipping costs. Ask yourself, "Will this company stand behind the full-system warranty for the next five years?"

If a qualified contractor installs the equipment and the installation price is included in the overall system price on which the rebate amount is based, then the required warranty should cover repairs for five years.

On the other hand, if you install the system, you will have to bear the costs of replacing defective equipment. To be eligible for a rebate from the Energy Commission, you must provide major system component warranties from the manufacturer. You should consider these warranty implications in deciding whether to install the system yourself.

The Emerging Renewables Program's five-year warranty requirement supercedes any other warranty limitations. In other words, if the manufacturer's own warranty on a particular component is less than five years, the retailer or installing contractor must still provide you with a five-year warranty to be eligible for a rebate.

The warranty may have certain exclusions. These exclusions may include, but are not limited to, failure to properly operate and maintain the system, failure to comply with applicable building codes and utility requirements, mishandling, neglect, vandalism, or acts of God.

The warranty may also contain exclusions for systems that are not installed by either you or an appropriately licensed California contractor, and for systems that are not installed in accordance with applicable safety and building codes and local utility requirements. Be sure to carefully read the warranty and review the terms and conditions with your retailer to avoid later misunderstandings.

How do I insure my PV system?

As described earlier, your electric utility will require you to enter into an interconnection agreement. One or more provisions of this agreement may specify minimum insurance requirements that you must keep in force.

If you are buying a PV system for your home, your standard homeowner's insurance policy may be adequate to meet the utility's requirements. California law, however, does not allow a utility to require that you purchase additional insurance [California Public Utilities Code section 2827 (F)].

If insurance coverage becomes an issue, contact one of the "Getting help" listings at the end of this *Guide*.

Selecting a PV retailer

While some retailers offer equipment only with no installation, many retailers can provide completely installed systems. In some locations, finding a PV provider can be as simple as looking in the telephone directory under "Solar Energy Equipment and Systems —Dealers."

Many of those listings, however, are for companies experienced in solar water heating system installations, not in PV system design or installation. Similarly, many electrical contractors, although proficient in typical electrical contracting work, may not have expertise in working with PV systems or with residential roof mounting techniques.

For sources of PV system retailers:

- Contact the Energy Commission to get a list of retailers participating in the Emerging Renewables Program. The list can be found at the Energy Commission's Web site at <www.energy.ca.gov/programs> or by calling (800) 555-7794.

- Contact either the *California Solar Energy Industries Association* at (800) 225-7799 or by fax at (949) 837-7430; or the *Independent Power Providers* at (209) 841-7001. Both organizations maintain a list of PV retailers.

- Conduct an Internet search for retailers in your area.

  Reminder: If you purchase equipment from an out-of-state retailer, you will still be responsible for paying use tax on the purchase to the State Board of Equalization (BOE). Check with the retailer on use tax withholding or call the BOE at (800) 400-7115 for more information.

Once you have identified several companies, investigate further by asking the questions outlined below.

How do I choose among PV retailers?

Once you have compiled a list of providers, the next step is to call and ask them questions. When contacting any company, consider its location relative to yours. Try to locate a PV provider who is relatively close to where the system will be installed and who meets the other criteria outlined below.

When contacting companies, you might ask some of the following questions:

1. **Has the company installed any grid-connected PV systems?**

Experience installing grid-connected systems is valuable because some elements of the installation—particularly interconnection with the local utility—are unique to these systems. If the company does not have this experience, has it installed off-grid systems?

Although grid-connected work differs from off-grid work, a competent company with experience on photovoltaic systems should not be eliminated just because they have not installed grid-connected PV systems.

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

This issue speaks for itself: a company or contractor that has been in business a long time has demonstrated an ability to work with customers and to compete effectively with other firms.

3. Is the company properly licensed?

The Emerging Renewables Program requires PV systems to be installed by an appropriately licensed California contractor. For PV systems, this requirement means either an "A" (general engineering), B or C-10 (electrical) or C-46 (solar) contractor's license.

Although using a properly licensed contractor is highly recommended, individuals who have adequate electrical and construction experience are not prohibited from installing their own system and qualifying for a rebate from the Emerging Renewables Program. A decision to do so, however, should be carefully considered and only attempted with a clear understanding of the complexities of the job, the difference in the rebate amount, and the potential effects on the system warranty.

4. Does the company have any pending or active judgements or liens against it?

As with any project that necessitates hiring a contractor, due diligence is recommended. The California Contractor's State License Board maintains records of the work history of contractors. These records can be accessed at (800) 321-2752, or in the Sacramento area at (916) 255-3900. Records can also be found on the Board's website at <http://www.cslb.ca.gov>.

5. How do I obtain and choose among competing bids?

You should get more than one bid for your system installation, making sure that the bids are made on the same basis. Comparing a bid for a ground-mounted system to a bid for a roof-mounted system, for example, would not result in a fair comparison. Similarly, there are different types of PV panels, some of which generate more electricity per square foot than others.

Bids should clearly state the quantity, make and model of the equipment, including details about where it will be installed and the maximum generating capacity of the system, measured in watts or kilowatts. If possible, the bids should

specify the system capacity in "AC watts" as defined by the Emerging Renewables Program. Bids should also include estimates of the system's annual energy production, measured in kilowatt-hours.

Bids should also include the total cost of getting the PV system up and running, including hardware, installation, connecting to the grid, permitting, sales tax, and warranty.

6. Is the lowest price the "best deal"?

It might not be. You must decide how much you wish to pay for your PV system, but price should not be your only consideration.

Getting help

Many details about the Emerging Renewables Program are not addressed here, but your qualified PV provider should be able to guide you through the process.

You can also contact the California Energy Commission. Obtain a copy of the *Guidebook for the Emerging Renewables Program* (CEC publication number P500-03-001F). The *Guidebook* contains more detailed program information and all necessary forms needed to reserve a rebate, and to request payment after your system is installed and operating. Request a printed copy of the *Guidebook* from the Energy Commission's Call Center, or download it from the Energy Commission's website.

Other helpful information can be found on the Energy Commission's website, including lists of PV retailers, equipment that is eligible for the Emerging Renewables Program rebate, and contacts for technical assistance and financing options. To use the interactive web tool, the CleanPower Estimator©, visit the Energy Commission's website at www.consumerenergycenter.org.

Contacts

California Energy Commission
Call Center
(800) 555-7794 (toll free)
(916) 654-4058 (outside California)
Fax: (916) 653-2543
www.consumer**energy**center.org
renewable@energy.state.ca.us

California Public Utilities Commission
San Francisco Office (Headquarters)
(415) 703-2782
Utility complaints: (800) 649-7570
www.cpuc.ca.gov

California Solar Energy Industries Association (CalSEIA)
(949) 709-8043
www.calseia.org

Northern California Solar Energy Association (NCSEA)
(510) 869-2759
www.norcalsolar.org
info@norcalsolar.org

Pacific Gas & Electric Company (PG&E)
(415) 973-7000
(800) 743-5000 toll free
www.pge.com

San Diego Gas & Electric Company (SDG&E)
(800) 411-7343
www.sdge.com

San Diego Regional Energy Office
866-SDENERGY (733-6374) toll free
www.sdenergy.org

Southern California Edison Company (SCE)
(800) 655-4555
www.sce.com

Definitions

Alternating current (AC) – The flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

Ampere (Amp) - The unit of measure that indicates how much electricity flows through a conductor. It is like using cubic feet per second to measure the flow of water. For example, a 1,200-watt, 120-volt hair dryer pulls 10 amperes of electricity current. (amps = watts/volts)

Average Demand - The energy demand for a given location over a period of time. For example, the number of kilowatt-hours used in a 24-hour period, divided by 24, tells the average demand for that location in that time period.

Avoided Cost - The amount of money an electric utility would need to spend for the next increment of electric generation to produce or purchase.

Battery - Batteries are often sold with a PV system. The primary purpose is to store the electricity not immediately used, which could be used at some later time. With net metering, the value of batteries is less because the utility grid basically acts as a storage facility. For a reliable generation system that can function independent of the utility grid, however, batteries may be a viable component to the total system. Back-up generators may be included in a system to provide power when the PV system is not operating, and are generally included when systems are not grid connected. Neither batteries nor generators are eligible for rebate money.

Circuit – One or more conductors through which electricity flows.

Converter – An apparatus that changes the quantity or quality of electrical energy.

Customer load - The amount of power your site uses. Load may be expressed in kilowatts (capacity) or kilowatt-hours (energy). A site's peak kilowatts generally refer to when electric demand requirements are highest.

Demand - The level at which electricity (or natural gas) is delivered to end-users at a given point in time. Electric demand is measured in kilowatts.

Direct current (DC) – The flow of electricity that flows continuously in one direction.

Frequency - The number of cycles through which an alternating current moves in each second. Standard electric utility frequency in the United States is 60 cycles per second, or 60 hertz.

Definitions

Grid - The electricity transmission and distribution system that links power plants to customers through high-power transmission line service.

Hertz - The unit of electromagnetic wave frequency that is equal to one cycle per second.

Interconnection - The linkage of transmission lines between two utilities, or between a utility and an end-user, enabling power to be moved in either direction.

Inverter - Device used to change direct current electricity to alternating current electricity.

Kilowatt (kW) –1000 watts. A unit of measure of the amount of electricity needed to operate given equipment. For example, one kW is enough power to illuminate 10 light bulbs at 100 watts each. (volts x amps = watts)

Kilowatt-hour (kWh) – the amount of kW produced over a period of time, or one kilowatt of electricity supplied for one hour. For example, a one kW system, if operating at full capacity for 5 hours will produce 5 kWh of electricity.

Megawatt – One thousand kilowatts or one million watts. One megawatt is enough to power 1,000 average California homes per day.

Meter – A device that measures levels and volumes of customers' electricity and gas use.

Mounting equipment - Equipment/apparatus used to fasten PV modules to the roof.

Peak load - The highest electrical demand within a particular period of time.

Photovoltaic cell – A device that produces an electric reaction to light, producing electricity.

Solar Energy – Heat and light radiated from the sun.

Solar Thermal - The process of concentrating sunlight to create high temperatures that are needed to vaporize fluid to drive a turbine for electric power generation.

Storage - Storage refers to saving surplus electricity produced by a PV system. Generally batteries are used as storage devices.

Tracking equipment - Structure that houses PV modules and that can automatically follow the sun across the sky throughout the day to maximize output.

Definitions

Utility grid - The interconnection of electricity generation plants through the transmission and distribution lines to customers. The grid also refers to the interconnection of utilities through the electric transmission and distribution systems.

Volt - The amount of force required to drive a steady current of one ampere through a resistance of one ohm. Electrical systems of most homes and offices use 120 volts. (Volts = watts/amps)

Watt (W) –Electric measurement of power at one point in time, as capacity or demand. For example, light bulbs are classified by wattage. (1000 watts = 1 kilowatt)

Acknowledgements

About this Guidebook

Buying a Photovoltaic Solar Electric System: A Consumer Guide is based on a similar buying guide, *Consumer's Guide to Buying a Solar Electric System*, authored by Thomas Starrs and Howard Wenger, and funded by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL). With the express permission of NREL, California Energy Commission staff updated NREL's *Consumer Guide,* making the new *Guide* specific to California.

We appreciate the various retailers of photovoltaic solar electric systems who offered comments and suggestions on this *Guide*. We apologize for any errors or omissions, and welcome suggestions to consider for future editions of this *Guide*

About the Renewable Energy Program

The Energy Commission has long been an advocate for clean, sustainable energy, demonstrating its commitment most recently by developing and implementing this innovative program that fosters the growth of the renewable energy market in California. With the long-term goal of a fully competitive, diverse and sustainable renewable energy supply in the state, the Renewable Energy Program has vigorously pursued investments in renewable resources since its inception in 1998.

Disclaimer

References in *Buying a Photovoltaic Solar Electric System: A Consumer Guide* to any resources, products, companies, or services are provided as a public service, and are not an endorsement, recommendation, or favoring of same by the California Energy Commission. The State of California and the California Energy Commission and its employees make no warranties, express or implied, and assume no legal liability for the information included in this *Consumer Guide*.

Endnotes

1. PV systems do not necessarily have to use an inverter in order to produce usable power. For example, many "off-grid" systems use DC power to operate lights and motors. On-grid systems can also use DC power but the DC circuits in the home must then be separately connected to the rest of the home's electric system through the use of a charge controller.

2. The AC system rating for the Energy Commission's Emerging Renewables Program is determined by multiplying the PTC rating of the module array by the inverter efficiency.

3. Assumes interest is deductible from a home equity loan, and assumes your combined state and federal income tax rate at 30 percent.

4. You are permitted to pay for net energy consumed on a monthly basis as well.