AEE Solar Packaged Solutions

Engineered Grid-Tie PV Systems

AEE Solar grid-tie PV power systems are designed for use on residential and small commercial buildings. They consist of high quality Evergreen or SolarWorld photovoltaic (PV) modules, a Fronius, SMA or Xantrex inverter, array wiring, DC and AC disconnects, UniRac mounting structures to secure modules on the roof, electrical drawings, data sheets, warranties and instructions.

Some Xantrex and SMA inverters have integrated DC disconnects. Systems that list “ST7000” as the inverter use the new SMA Sunny Tower 42 kW tower that consists of 6 SMA SB7000US inverters, pre-assembled on a stainless steel structure.

Packaged systems with Evergreen 190-watt modules (PTC = 168.8)

PV watts	Module quantity	Series x parallel	System CEC watts	Inverter model	Inverter watts	Output VAC	Item code	Price
1900	10	10 x 1	1544	SB1800	1800	120	10.6202	$14,167
4560	24	12 x 2	3889	SB4000US	4000	240	10.6208	$32,167
5700	30	15 x 2	4836	SB5000US	5000	240	10.6211	$40,684
6840	36	12 x 3	5803	SB6000US	6000	240	10.6214	$47,829
7980	42	14 x 3	6806	SB7000US	7000	240	10.6217	$55,059
47880	252	14 x 18	40836	ST7000	42000	240	10.622	$329,990
2280	12	12 x 1	1893	IG2000	2000	240	10.6223	$16,708
3040	16	8 x 2	2539	IG3000	2700	240	10.6226	$21,630
4560	24	12 x 2	3808	IG4000	4000	240	10.6229	$32,373
5250	30	10 x 3	4785	IG5100	5100	240	10.6232	$42,214
3040	16	16 x 1	2552	GT2800	2800	240	10.6235	$21,219
3800	20	10 x 2	3173	GT3300	3300	240	10.6238	$26,514
4560	24	12 x 2	3849	GT4000	4000	240	10.6241	$31,548
5700	30	15 x 2	4836	GT5000	5000	240	10.6244	$39,496

Packaged systems with SolarWorld 175-watt modules (PTC = 156.6)

PV watts	Module quantity	Series x parallel	System PTC watts	Inverter model	Inverter watts	Output VAC	Item code	Price
700	4	4 x 1	570.	SB700	700	120	10.6247	$6,427
2100	12	6 x 2	1719	SB1800	1800	120	10.6251	$16,247
3500	20	10 x 2	2991	SB3000US	3000	240	10.6255	$25,951
4200	24	8 x 3	3608	SB4000US	4000	240	10.6259	$30,743
5250	30	10 x 3	4487	SB5000US	5000	240	10.6263	$39,149
7000	40	10 x 4	5982	SB6000US	6000	240	10.6267	$50,256
7875	45	9 x 5	6765	SB7000US	7000	240	10.6271	$56,656
47250	270	9 x 30	40590	ST7000	42000	240	10.6275	$338,995
2100	12	6 x 2	1757	IG2000	2000	240	10.6279	$16,175
3150	18	9 x 2	2649	IG3000	3000	240	10.6283	$23,192
4200	24	8 x 3	3532	IG4000	4000	240	10.6287	$31,190
5600	32	8 x 4	4735	IG5100	5100	240	10.6291	$40,607
3150	18	9 x 2	2663	GT2800	2800	240	10.6295	$22,818
3500	20	10 x 2	2944	GT3300	3300	240	10.6299	$25,394
4200	24	8 x 3	3570	GT4000	4000	240	10.6303	$30,311
5250	30	10 x 3	4487	GT5000	5000	240	10.6307	$38,148

Wiring from the array to the DC disconnect, array ground wiring, and wiring from the AC disconnect to the main panel and all conduit must be supplied by professional installers (your specific installation or utility may require additional AC disconnects). Contact us to obtain these essential resources and expert advice on your system installation.

All components comply with the 2005 National Electrical Code (NEC-2005); IEEE Std 929-2000, Institute of Electrical and Electronics Engineers Recommended Practices for Utility Interface of Photovoltaic (PV) Systems; UL 1741-Underwriters Laboratories Standard for Safety; and the ICBO 2000 International Building Code. The arrays and inverters are matched for maximum efficiency.

These modular systems can be combined to form larger systems to meet your requirements. It is economical to put these systems together for use in 30 kilowatt or smaller systems. For larger systems, please ask us for a quote.

Select a pre-packaged system that meets your needs from the accompanying table. California Energy Commission bases rebates on the system CEC rating in column 4 of the table. CEC’s calculation takes into account module output in normal operating conditions and inverter efficiency.

Utility Grid-Tie System Design

Budget, roof dimensions and other site-specific factors often call for custom system design. If you are planning to mount your array on a roof, decide which module best fits into the available roof space, taking into consideration obstructions such as chimneys, plumbing vents and skylights. See Solar Power section, page 16, for dimensions of modules. A grid-connected PV system consists of PV modules, output cables, module mounting structures, AC and DC disconnect switches, inverter(s), grounding equipment and a metering system. This worksheet will help you decide what size PV array would be required to eliminate your electric bill. This will be the largest system that would be cost-effective to install. A smaller system can reduce part of your bill, or eliminate higher cost electricity in locations that have progressively increasing rates as consumption increases. Use this information and the amount of available space to get a rough idea of your PV array size.

PV Array Design Worksheet – Determine the array size for your grid-connected system.

Step 1 **Find your monthly average electricity usage from your electric bill.** ________

This will be in kilowatt-hours (kWh). Due to air conditioning, heating and other seasonal usage, it is a good idea to look at several bills. You can add the typical summer, fall, winter and spring bills and divide by four to find the average monthly usage.

Step 2 **Find your daily average electricity use.** ________

Divide the monthly average number of kWh use by 30 (days)

Step 3 **Find your location's average peak sun hours per day.** ________

See the chart and listings on pages 14 and 15, and/or the insolation maps beginning page 183. For example, the average for California is 5 peak sun hours

Step 4 **Calculate the system size (AC watts) to provide 100% of your electricity.** ________

Divide your daily average electricity use by average sun hours per day. For example, if the daily average electricity use is 30 kWh, and the site is in California, system size would be: 30 kWh / 5 h = 6 kW AC

Step 5 **Calculate the number of pv modules required for this system**. ________

Divide the system AC watts in Step 4 by the CEC watt rating of the modules to be used, then divide by the inverter efficiency, usually 0.94, and you get the total number of modules required. (Round this number up)

Use chart below (continued next page) to determine array size/inverter combinations

This chart shows inverter and module combinations for common modules used in grid connected systems. For a given inverter and module combination, the chart displays the acceptable number of series strings of modules and the number of modules per string for temperatures between 14ºF and 104ºF. Where the inverter will support more than one string of modules, the chart shows the number of modules that can be used with multiple strings. Sizing is accurate in locations where the maximum temperature is lower than 104ºF or the minimum temperature is higher than 14ºF. In locations where the minimum temperature is lower than 14ºF, the maximum number of modules per string may be lower.

In the chart on the next page, the line labeled CEC watts is the expected output of the modules at normal operating temperature, in full sun. The approximate power output of a system in full sun will be the number of modules times the CEC rating of the modules times the inverter efficiency from second column on the table. Other factors, such as high or low temperature, shading, array orientation, roof pitch and dirt on the modules, will affect the system's actual output.

Recommended number of modules per string						
Inverter		*Module >*	**SW165 mono**	**SW175 mono**	**ES-180-RL/SL**	**ES-190-RL/SL**
Brand and Model	CEC Efficiency	CEC	147.3	156.6	159.7	168.8
		Ratio	0.893	0.895	0.887	0.888
SB700U	91.5%	one string	3 to 5	3 to 5		
SWR1800U	91.5%	one string	6 to 8	5 to 8	8 to 10	8 to 10
		two strings	6	5 to 6		
SB3000US	95.5%	one string	8 to 10	8 to 10	10 to 13	10 to 13
		two strings	8 to 10	8 to 10	10 to 11	10
		three strings	8			

Recommended number of modules per string

Inverter		*Module >*	SW165 mono	SW175 mono	ES-180-RL/SL	ES-190-RL/SL
Brand and model	CEC Efficiency	CEC	147.3	156.6	159.7	168.8
		Ratio	0.893	0.895	0.887	0.888
SB4000US	96.0%	one string	9 to 12	9 to 12	11 to 16	11 to 16
		two strings	9 to 12	9 to 12	11 to 14	11 to 13
		three strings	9 to 10	9		
SB5000US	95.5%	one string	10 to 12	10 to 12	12 to 16	12 to 16
		two strings	10 to 12	10 to 12	12 to 16	12 to 16
		three strings	10 to 12	10 to 12		
SB6000US	95.5%	one string	10 to 12	10 to 12	12 to 16	12 to 16
		two strings	10 to 12	10 to 12	12 to 16	12 to 16
		three strings	10 to 12	10 to 12	12 to 14	12 to 13
		four strings	10 to 11	10		
SB7000US	96.0%	one string	10 to 12	10 to 12	12 to 16	12 to 16
		two strings	10 to 12	10 to 12	12 to 16	12 to 16
		three strings	10 to 12	10 to 12	12 to 16	12 to 15
		four strings	10 to 12	10 to 12	12	
		five strings	10	10		
GT 2.8	94.0% (est.)	one string	8 to 12	7 to 12	10 to 16	10 to 16
		two strings	8 to 10	7 to 9		
GT 3.3	94.5%	one string	8 to 12	7 to 12	10 to 16	10 to 16
		two strings	8 to 12	7 to 11	10 to 11	10 to 11
		three strings	8	7		
GT 4.0	95% (est.)	one string	8 to 12	7 to 12	10 to 16	10 to 16
		two strings	8 to 12	7 to 12	10 to 13	10 to 12
		three strings	8 to 9	7 to 8		
GT 5.0	95.5%	one string	9 to 12	9 to 12	12 to 16	12 to 16
		two strings	9 to 12	9 to 12	12 to 16	12 to 16
		three strings	9 to 11	9 to 10		
IG2000	93.5%	one string	5 to 8	5 to 8	8 to 13	8 to 13
		two strings	5 to 7	5 to 7		
		three strings	5			
IG3000	94.0%	one string			8 to 13	8 to 13
		two strings	5 to 8	5 to 8	8 to 9	8
		three strings	5 to 6	5 to 6		
		four strings	5			
IG4000	94.0%	one string			8 to 12	8 to 12
		two strings			8 to 12	8 to 12
		three strings	5 to 9	5 to 8	8	8
		four strings	5 to 6	5 to 6		
		five strings	5	5		
IG5100	94.5%	one string	5 to 9	5 to 9	8 to 13	8 to 13
		two strings	5 to 9	5 to 9	8 to 13	8 to 13
		three strings	5 to 9	5 to 9	8 to 11	8 to 10
		four strings	5 to 9	5 to 8	8	8
		five strings	5 to 9	5 to 6		
		six strings	5 to 6	5		

AEE Solar Engineered Grid-Tie Systems with Battery Backup

These full-service renewable energy systems give you all the benefits of utility interconnection and net metering *plus* energy independence. With these grid-tie systems, backup AC power is made available in the event of a utility outage, providing reliable power and peace of mind. An average conversion efficiency of 89% to 91% using the California Energy Commission (CEC) test protocol provides greater savings and a shorter time period for system payback than previous designs.

Battery-backup grid-tie systems come with modules, array wiring, combiner boxes, roof mounting structures, inverters/control systems with all required over-current protection and disconnects. (Your specific installation or utility may require additional AC disconnects, which we can supply as needed). They require a 48-volt battery bank to operate. The size of the battery determines the amount of backup power available during power failure. Use the worksheet on the next page to determine battery bank size. Battery backup systems qualify for the California Energy Commission incentives and the federal tax credit.

Grid-tie systems with inverters installed indoors (see table at bottom for batteries)

PV watts	Module Quantity	Module Brand & watts	System CEC watts	Inverter Model	Backup watts	Output VAC	Item code	Price
570	3	Evergreen 190	460	OutBack FLEXware system with one GVFX3648	3600	120	10.6724	$8,833
2850	15	Evergreen 190	2304	OutBack FLEXware system with one GVFX3648	3600	120	10.6728	$22,392
5700	30	Evergreen 190	4608	OutBack FLEXware system with two GVFX3648	7200	120/240	10.6732	$42,959

Grid-tie systems with NEMA 3R inverters for outdoor installation (see table below for batteries)

PV watts	Module Quantity	Module Brand & watts	System CEC watts	Inverter Model	Backup watts	Output VAC	Item code	Price
570	3	Evergreen 190	460	OutBack PS1 system with one GVFX3648	3000	120	10.6746	$8,946
2280	12	Evergreen 190	1843	OutBack PS1 system with one GVFX3648	3000	120	10.6750	$19,501
2850	15	Evergreen 190	2304	OutBack PS1 system with one GVFX3648	3000	120	10.6754	$23,116

Battery packs for systems above

watt-hours storage to 80% discharge	Battery quantity	System amp-hours	Battery model	Battery rack	NEMA 3R outdoor	Item code	Price
3750	4	98	MK S31-SLD-G	OutBack PS1 battery enclosure (w/ PS1 only)	Yes	10.6781	$1,586
7500	8	196	MK S31-SLD-G	OutBack PSR battery rack	No	10.6783	$2,889
7500	8	196	MK S31-SLD-G	OutBack PSR battery rack w/ 3RK cover	Yes	10.6785	$3,038
11250	12	294	MK S31-SLD-G	OutBack PSR battery rack	No	10.6787	$4,017
11250	12	294	MK S31-SLD-G	OutBack PSR battery rack w/ 3RK cover	Yes	10.6789	$4,166

Grid-tie systems with battery backup are configured differently and are much more complex than standard grid-tie systems without batteries. They need to be custom designed. If you need a backup system, consult with us to determine all the system components that you will need. .

Inverters for Grid-Tie with Battery Backup

The OutBack PS1-3048 is a 3000-watt complete system for grid-tie with battery backup. These inverters are ready to use with the addition of a PV array and a 48-volt battery bank.

OutBack also makes inverters and switchgear that can be assembled into larger grid-tie w/ battery backup systems.

The new Xantrex XW series of inverters offers grid-tie inverters with battery backup capability in 6000-watt increments. Several can be stacked for 12kW or 18kW battery backup systems.

You can use the following steps to determine the dual-function inverter size and the battery capacity that your system will require. Follow steps 1-5 on the PV Array Design Worksheet on page 8 to determine the size of the array required to provide the desired percentage of total power. Then calculate the inverter size and battery capacity needed using the worksheet below.

Worksheet: Inverter and Batteries for Grid-Tie w/ Backup System

Step 1 **Find the power requirements (watts) for the appliances you need to power during a black-out.** ________

Make a list of the loads and appliances that you absolutely need to power during an outage. Only list the essential items since the system size (and cost) will vary widely with power needed. The wattage of individual appliances can usually be found on the back of the appliance or in the owners manual. You can use a Kill-a-Watt meter for better measurements (page 107). If an appliance is rated in amps, multiply amps by the operating voltage (120 or 240) to find watts. Add up the wattage of all the items on your list to arrive at the total amount of watts that you need to run all at the same time. This will determine the size of the dual-function inverter that you will need.

Step 2 **Decide the blackout duration you want to be prepared for.** ________

Power outages last from a portion of an hour to a day (or more). Again, this decision will greatly affect the system size and cost, so it is more cost effective to stay on the conservative side.

Step 3 **Find the amount of stored power required.** ________

Multiply the power requirements (in step 1) by duration in hours (in step 2). The result will be in watt-hours. For instance, if you need to power 1000 watts of appliances for 2 hours, you would need to have 2000 watt-hours (or 2 kWh) of stored power.

Step 4 **Calculate the power storage needed.** ________

Multiply the figure arrived at in step 3 by 1.7. In the example, 2 kWh X 1.7 = 3.4 kWh of stored power needed.

Step 5 **Calculate battery capacity needed.** ________

Divide the power storage requirement needed from step 4 by the DC voltage of the system (usually 48V, but sometimes 24V) to get battery amp-hour (Ah) capacity. See the battery section on page 112 for more information on batteries. Most backup systems use sealed batteries due to their greatly reduced maintenance requirements, and because they can be more easily placed in enclosed battery compartments.

System Sizing Information

The size of a solar electric system depends on the amount of power that is required (watts), the amount of time it is used (hours) and the amount of energy available from the sun in a particular area (sun-hours per day). The user has control of the first two variables, while the third depends on the location.

Conservation

Conservation plays an important role in keeping down the cost of a photovoltaic system. The use of energy-efficient appliances and lighting, as well as non-electric alternatives wherever possible, can make solar electricity a cost-competitive alternative to gasoline generators and, in some cases, utility power.

Cooking, Heating and Cooling

Conventional electric cooking, space heating and water heating equipment use a prohibitive amount of electricity. Electric ranges use 1500 watts or more per burner, so bottled propane or natural gas is a popular alternative to electricity for cooking. A microwave oven has about the same power draw, but since food cooks more quickly, the amount of kilowatt hours used may not be large. Propane and wood are generally better alternatives for space heating. Good passive solar design and proper insulation can reduce the need for winter heating. Evaporative cooling is a more reasonable load than air conditioning and in locations with low humidity, the results are almost as good. One big plus for solar cooling: the largest amount of solar energy is available when the need for cooling is the greatest.

Lighting

Lighting requires the most study since many options exist in type, size, voltage and placement. The type of lighting that is best for one system may not be right for another. The first decision is whether your lights will be run on low voltage direct current (DC) or conventional 110 volt alternating current (AC). In a small home, an RV, or a boat, low voltage DC lighting is often the best choice. DC wiring runs can be kept short, allowing the use of fairly small gauge wire. Since an inverter is not required, the system cost is lower. When an inverter is part of the system, and the lights are powered directly by the battery, a home will not be dark if the inverter fails. In addition to conventional-size medium-base low voltage bulbs, the user can choose from a large selection of DC fluorescent lights, which have 3 to 4 times the light output per watt of power used compared with incandescent types. Halogen bulbs are 30% more efficient and actually seem almost twice as bright as similar wattage incandescents given the spectrum of light they produce. High quality fluorescent lights are available for 12 and 24 volt systems.

In a large installation or one with many lights, the use of an inverter to supply AC power for conventional lighting is cost effective. AC compact fluorescent lights will save a tremendous amount of energy. It is a good idea to have a DC-powered light in the room where the inverter and batteries are in case there is a problem. AC light dimmers will only function properly on AC power from inverters that have pure sine wave output.

Refrigeration

Gas powered absorption refrigerators are a good choice in small systems if bottled gas is available. Modern absorption refrigerators consume 5-10 gallons of LP gas/month. If an electric refrigerator will be used in a standalone system, it should be a high-efficiency type. Some high-efficiency conventional AC refrigerators use as little as 1200 watt-hours of electricity/day at a 70º average air temperature. A comparably sized Sun Frost refrigerator/freezer uses half that amount of energy and a SunDanzer refrigerator (without a freezer) uses less than 100 watt-hours per day. The higher cost of good quality DC refrigerators is offset by savings in the number of solar modules and batteries required.

Major Appliances

Standard AC electric motors in washing machines, larger shop machinery and tools, swamp coolers, pumps, etc. (usually 1/4 to 3/4 horsepower) require a large inverter. Often, a 2000 watt or larger inverter will be required. These electric motors are sometimes hard to start on inverter power, they consume relatively large amounts of electricity, and they are very wasteful compared to high-efficiency motors, which use 50% to 75% less electricity. A standard washing machine uses between 300 and 500 watt-hours per load, but new front-loading models use less than 1/2 as much power. If the appliance is used more than a few hours per week, it is often cheaper to pay more for a high-efficiency appliance rather than make your electrical system larger to support a low-efficiency load. Vacuum cleaners usually consume 600 to 1,000 watts, depending on how powerful they are, about twice what a washer uses, but most vacuum cleaners will operate on inverters larger than 1,000 watts since they have low-surge motors.

Small Appliances

Many small appliances such as irons, toasters and hair dryers consume a very large amount of power when they are used but by their nature require very short or infrequent use periods. If the system inverter and batteries are large enough, they will be usable. Electronic equipment, such as stereos, televisions, VCRs and computers have a fairly small power draw. Many of these are available in low voltage DC as well as conventional AC versions. In general, DC models use less power than their AC counterparts.

Off-Grid Load Worksheet

Determine the total energy in amp-hours per day used by all the AC and DC loads in your system.

Calculate your AC loads

If there are no AC loads, skip to Step 5

1. List all AC loads, wattage and hours of use per week in the spaces provided. Multiply watts by hours/week to get watt-hours per week (WH/Wk). Add up all the watt hours per week to determine AC watt-hours per week. Use a separate sheet of paper if you need to list more loads than the space below allows

NOTE: Wattage of appliances can usually be determined from tags on the back of the appliance or from the owner's manual. If an appliance is rated in amps, multiply amps by operating voltage (120 or 240) to find watts.

Description of AC loads run by inverter	watts	x	hours/week	=	watt-hours/week
	Total watt-hours/week				

2. Convert to DC watt-hours per week. Multiply line 1 by 1.15 to correct for inverter loss. _______________
3. Inverter DC input voltage; usually 12-, 24- or 48-volts. This is DC system voltage. _______________
4. Divide line 2 by line 3. This is total DC amp-hours per week used by AC loads. _______________

Calculate your DC loads

5. List all DC loads in the table below. If you have no DC loads, enter "0" in line 7 and proceed to line 8.
6. DC system voltage. Usually 12, 24, or 48 volts. _______________
7. Find total amp-hours per week used by DC loads: divide line 5 by line 6. _______________
8. Total amp-hours per week used by AC loads from line 4. _______________
9. Add lines 7 and 8. This is total amp-hours per week used by all loads. _______________
10. Divide line 9 by 7 days. This is total average amp-hours per day that needs to be supplied by the battery. _______________

Enter this number on line 1 on the Number-of-Modules Worksheet on page 14, and on line 1 of the Battery Sizing Worksheet on page 115.

Description of DC loads	watts	x	hours/week	=	watt-hours/week
	Total watt-hours / week				

Number of Modules Worksheet

Use this worksheet to calculate the total number of solar modules required for your system.

To find average sun-hours per day in your area (line 3), check local weather data, look at the map below or find a city on the next page that has similar weather to your location. If you want year- round autonomy, use the lower of the two figures. If you want 100% autonomy only in summer, use the higher figure. If you have a utility grid-tie system with net metering, use the yearly average figure. The peak amperage of the module you will be using can be found in the module specifications. You can also get close enough if you divide the module's rated wattage by the peak power point voltage, usually 17 to 17.5 for a 12-volt module or 34 to 35 volts for a 24-volt module.

Step 1 Total average amp-hours per day needed from the System Loads Worksheet, line 10 __________

Step 2 Multiply line 1 by 1.2 to compensate for loss from battery charge / discharge __________

Step 3 Average sun-hours per day in your area __________

Step 4 Divide line 2 by line 3. This is the total solar array amps required __________

Step 5 Optimum or peak amps of solar module used. See module specifications __________

Step 6 Total number of solar modules in parallel required. Divide line 4 by 5 __________

Step 7 Round off to the next highest whole number __________

Step 8 Number of modules in each series string to provide DC battery voltage – see table below __________

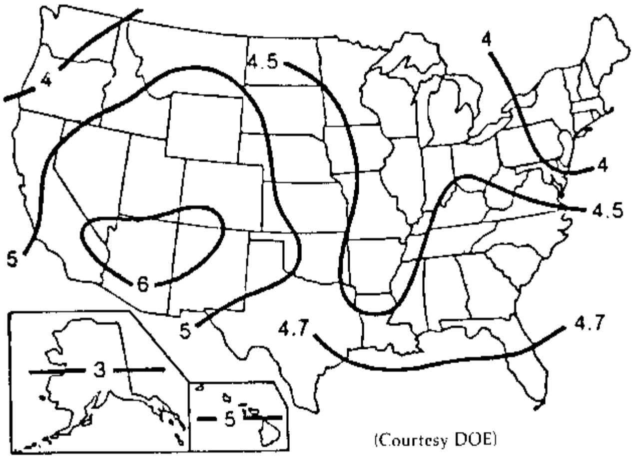
Step 9 Multiply line 7 by line 8 to get the total number of solar modules required. __________

Nominal system voltage	Number of series connected modules per string	
volts	12V module	24V module
12	1	N/A
24	2	1
48	4	2

The charts below show sun-hours per day for the U.S.

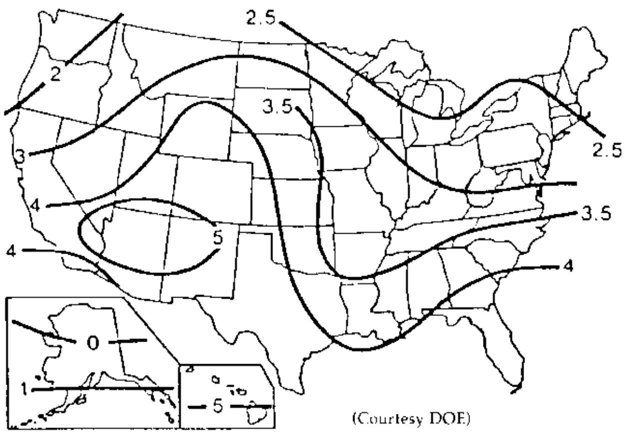
See world insolation maps (and a larger version of the USA map) beginning page 183.

Yearly Average



(Courtesy DOE)

Four-Week Average, 12/7-1/4



(Courtesy DOE)

Solar Insolation

This chart shows solar insolation in kilowatt-hours per square meter per day in many U.S. locations. For simplicity, we call this figure "sun-hours per day." To find average sun-hours per day in your area (line 3 on page 11), check local weather data, look at the map on the previous page or find a city in the table below that has similar weather to your location. If you want year-round autonomy, use the lowest of the two figures. If you want only 100% autonomy in summer, use the higher figure. If you want a utility grid-tie system, and you have net metering available in your state, use the average figures. World insolation maps are in the Reference section, beginning page 183

State	City	High	Low	Avg
AK	Fairbanks	5.87	2.12	3.99
AK	Matanuska	5.24	1.74	3.55
AL	Montgomery	4.69	3.37	4.23
AR	Bethel	6.29	2.37	3.81
AR	Little Rock	5.29	3.88	4.69
AZ	Tucson	7.42	6.01	6.57
AZ	Page	7.30	5.65	6.36
AZ	Phoenix	7.13	5.78	6.58
CA	Santa Maria	6.52	5.42	5.94
CA	Riverside	6.35	5.35	5.87
CA	Davis	6.09	3.31	5.10
CA	Fresno	6.19	3.42	5.38
CA	Los Angeles	6.14	5.03	5.62
CA	Soda Springs	6.47	4.40	5.60
CA	La Jolla	5.24	4.29	4.77
CA	Inyokern	8.70	6.87	7.66
CO	Grandby	7.47	5.15	5.69
CO	Grand Lake	5.86	3.56	5.08
CO	Grand Junction	6.34	5.23	5.85
CO	Boulder	5.72	4.44	4.87
DC	Washington	4.69	3.37	4.23
FL	Apalachicola	5.98	4.92	5.49
FL	Belie Is.	5.31	4.58	4.99
FL	Miami	6.26	5.05	5.62
FL	Gainsville	5.81	4.71	5.27
FL	Tampa	6.16	5.26	5.67
GA	Atlanta	5.16	4.09	4.74
GA	Griffin	5.41	4.26	4.99
HI	Honolulu	6.71	5.59	6.02
IA	Ames	4.80	3.73	4.40
ID	Boise	5.83	3.33	4.92
ID	Twin Falls	5.42	3.42	4.70
IL	Chicago	4.08	1.47	3.14
IN	Indianapolis	5.02	2.55	4.21
KS	Manhattan	5.08	3.62	4.57
KS	Dodge City	6.50	4.20	5.60
KY	Lexington	5.97	3.60	4.94
LA	Lake Charles	5.73	4.29	4.93
LA	New Orleans	5.71	3.63	4.92
LA	Shreveport	4.99	3.87	4.63
MA	E. Wareham	4.48	3.06	3.99
MA	Boston	4.27	2.99	3.84
MA	Blue Hill	4.38	3.33	4.05
MA	Natick	4.62	3.09	4.10
MA	Lynn	4.60	2.33	3.79
MD	Silver Hill	4.71	3.84	4.47
ME	Caribou	5.62	2.57	4.19
ME	Portland	5.23	3.56	4.51
MI	Sault Ste. Marie	4.83	2.33	4.20
MI	E. Lansing	4.71	2.70	4.00
MN	St. Cloud	5.43	3.53	4.53
MO	Columbia	5.50	3.97	4.73
MO	St. Louis	4.87	3.24	4.38
MS	Meridian	4.86	3.64	4.43
MT	Glasgow	5.97	4.09	5.15
MT	Great Falls	5.70	3.66	4.93
MT	Summit	5.17	2.36	3.99
NM	Albuquerque	7.16	6.21	6.77
NB	Lincoln	5.40	4.38	4.79
NB	N. Omaha	5.28	4.26	4.90
NC	Cape Hatteras	5.81	4.69	5.31
NC	Greensboro	5.05	4.00	4.71
ND	Bismarck	5.48	3.97	5.01
NJ	Sea Brook	4.76	3.20	4.21
NV	Las Vegas	7.13	5.84	6.41
NV	Ely	6.48	5.49	5.98
NY	Binghampton	3.93	1.62	3.16
NY	Ithaca	4.57	2.29	3.79
NY	Schenectady	3.92	2.53	3.55
NY	Rochester	4.22	1.58	3.31
NY	New York City	4.97	3.03	4.08
OH	Columbus	5.26	2.66	4.15
OH	Cleveland	4.79	2.69	3.94
OK	Stillwater	5.52.	4.22	4.99
OK	Oklahoma City	6.26	4.98	5.59
OR	Astoria	4.76	1.99	3.72
OR	Corvallis	5.71	1.90	4.03
OR	Medford	5.84	2.02	4.51
PA	Pittsburgh	4.19	1.45	3.28
PA	State College	4.44	2.79	3.91
RI	Newport	4.69	3.58	4.23
SC	Charleston	5.72	4.23	5.06
SD	Rapid City	5.91	4.56	5.23
TN	Nashville	5.20	3.14	4.45
TN	Oak Ridge	5.06	3.22	4.37
TX	San Antonio	5.88	4.65	5.30
TX	Brownsville	5.49	4.42	4.92
TX	El Paso	7.42	5.87	6.72
TX	Midland	6.33	5.23	5.83
TX	Fort Worth	6.00	4.80	5.43
UT	Salt Lake City	6.09	3.78	5.26
UT	Flaming Gorge	6.63	5.48	5.83
VA	Richmond	4.50	3.37	4.13
WA	Seattle	4.83	1.60	3.57
WA	Richland	6.13	2.01	4.44
WA	Pullman	6.07	2.90	4.73
WA	Spokane	5.53	1.16	4.48
WA	Prosser	6.21	3.06	5.03
WI	Madison	4.85	3.28	4.29
WV	Charleston	4.12	2.47	3.65
WY	Lander	6.81	5.50	6.06