www.ecowerc.com

ecoWERC

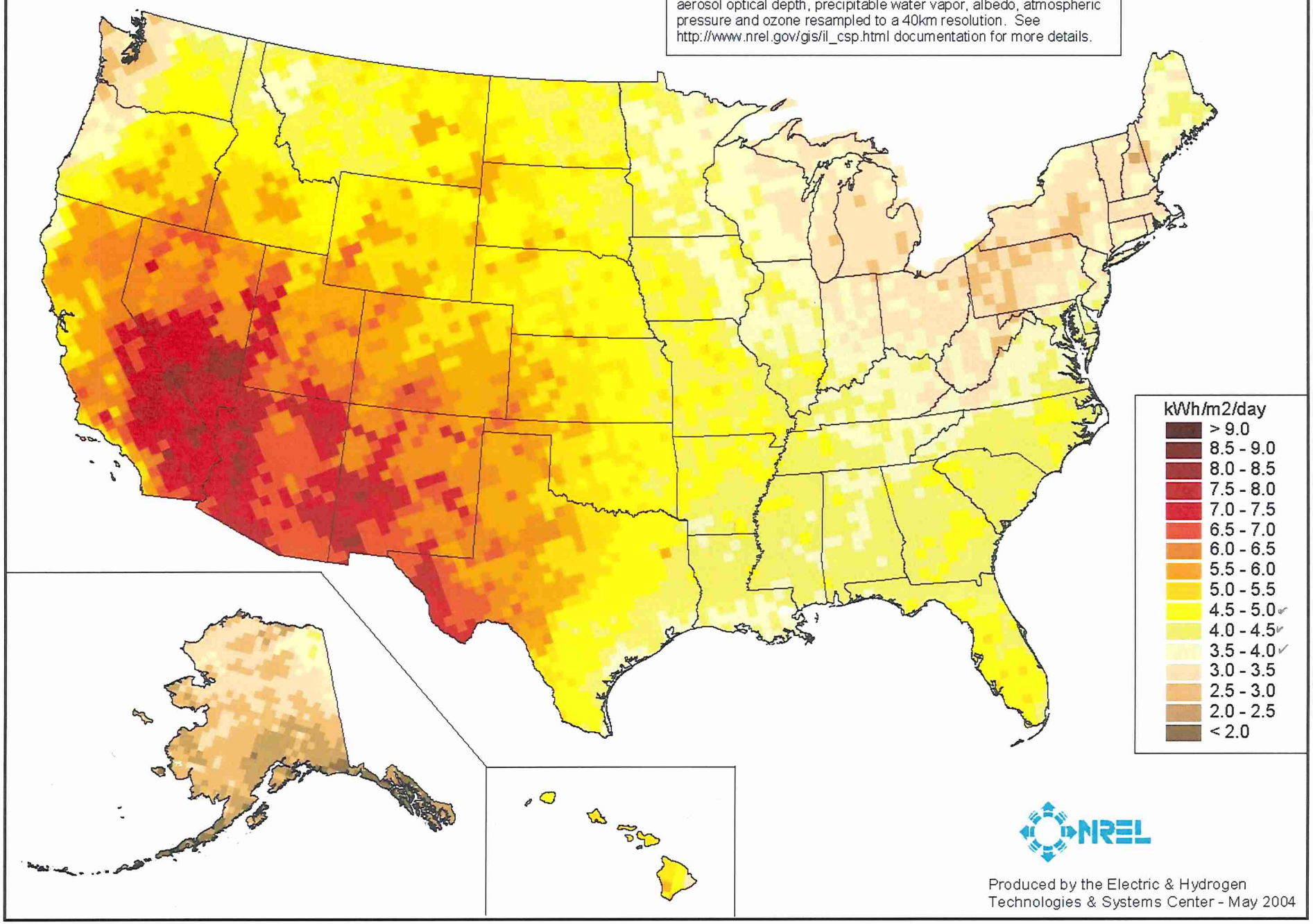
Winkelman's Environmentally Responsible Construction

SOLAR POWER SITE PLAN

Direct Normal Solar Radiation (Two-Axis Tracking Concentrator)

Annual

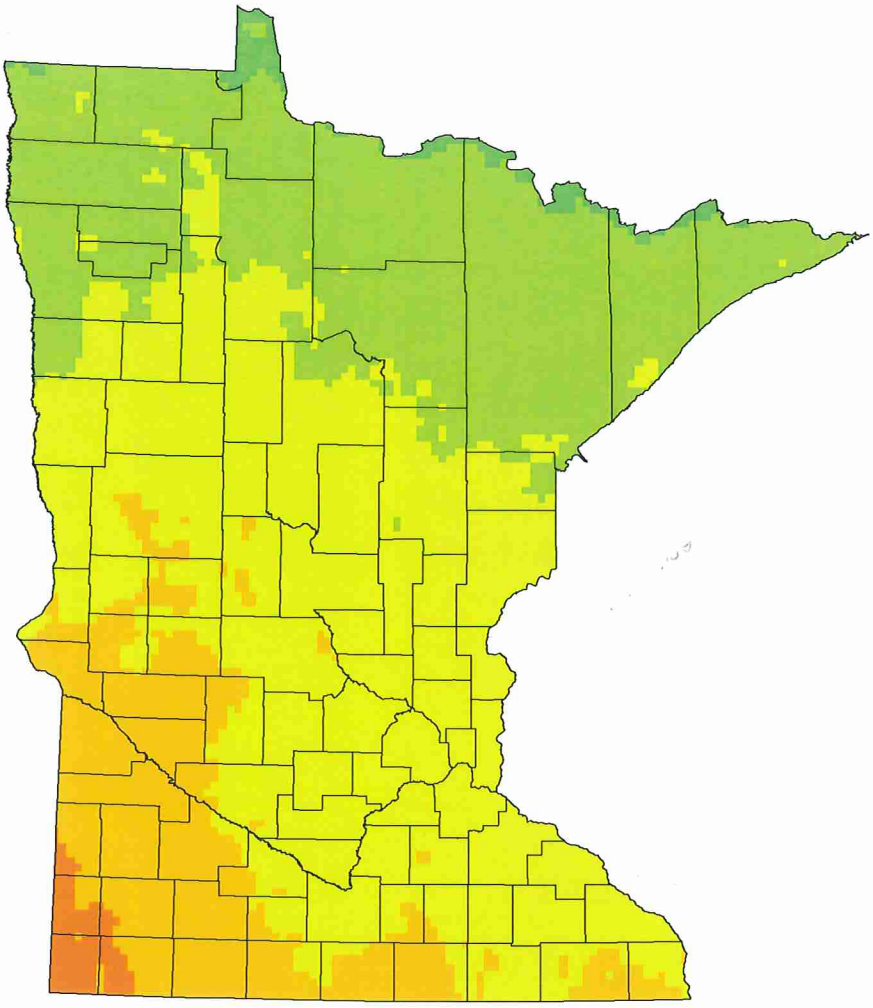
Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution. See http://www.nrel.gov/gis/il_csp.html documentation for more details.

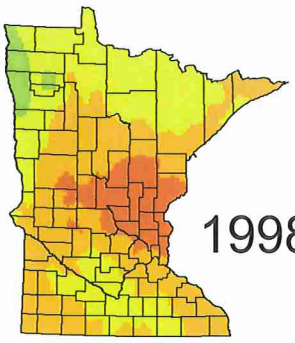


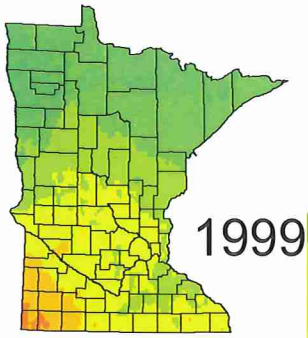
NREL

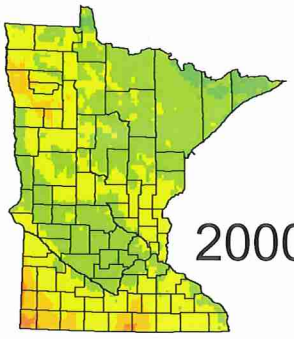
Produced by the Electric & Hydrogen Technologies & Systems Center - May 2004

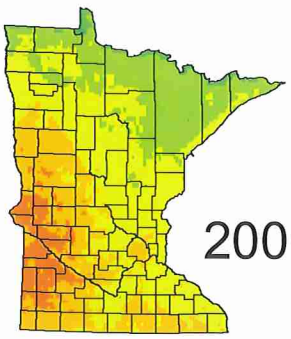
Average Solar Radiation in Minnesota, 1998-2002

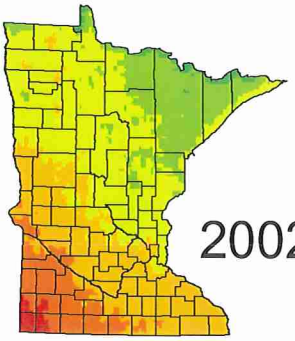












MINNESOTA
DEPARTMENT OF
COMMERCE

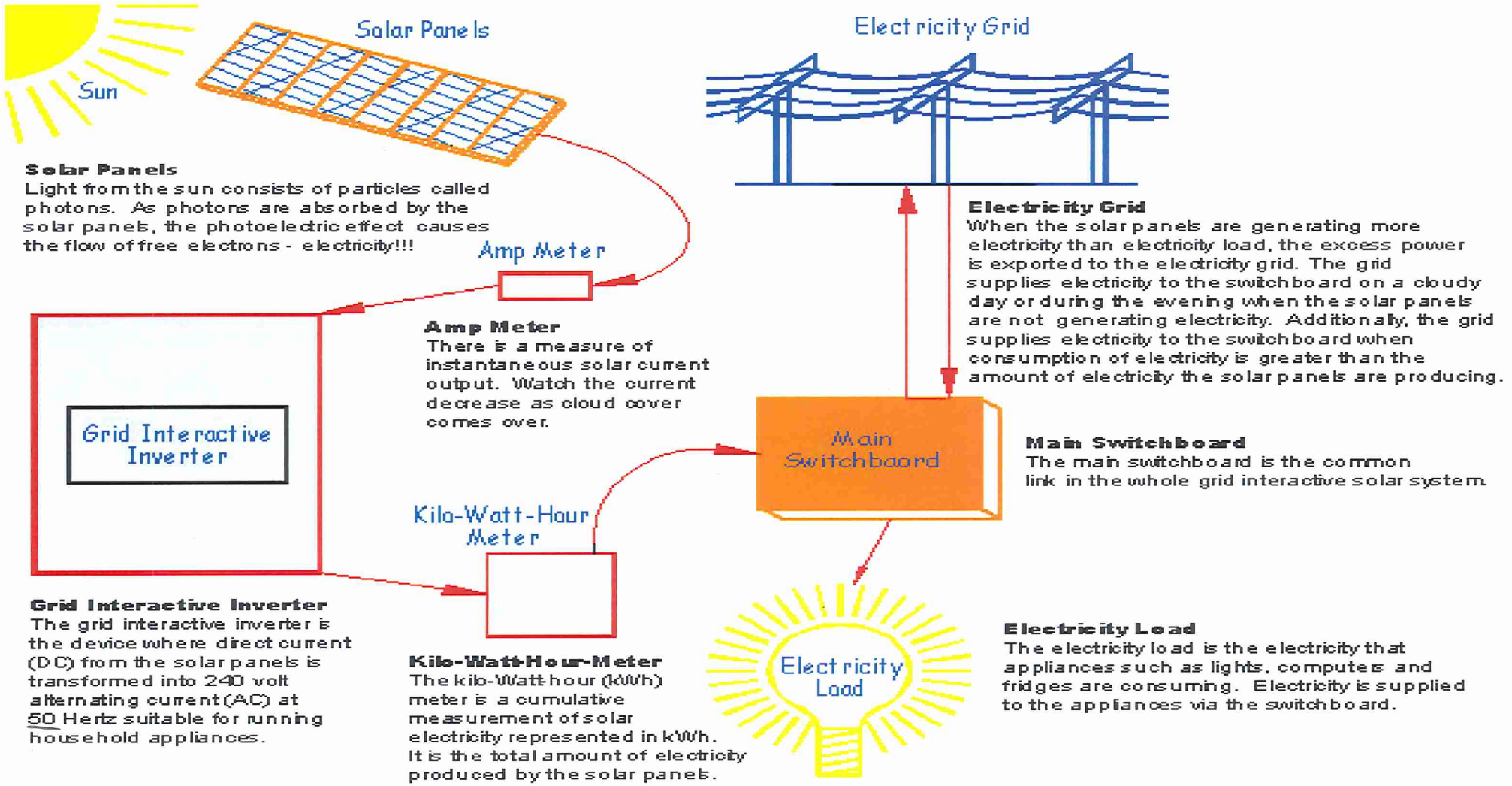
Watts / Square Meter

- 136.4 - 140
- 140.1 - 145
- 145.1 - 150
- 150.1 - 155
- 155.1 - 160
- 160.1 - 165
- 165.1 - 170

Note: Differences between high and low values are roughly 15%.

WWW.ECOWERC.COM
Winkelman's Environmentally Responsible Construction
9121 CR 23, BRAINERD, MN 56401 - PHONE: 218-764-2321 - E-MAIL: INFO@ECOWERC.COM

How Solar Panels Work



Solar Panels
Light from the sun consists of particles called photons. As photons are absorbed by the solar panels, the photoelectric effect causes the flow of free electrons - electricity!!!

Amp Meter
There is a measure of instantaneous solar current output. Watch the current decrease as cloud cover comes over.

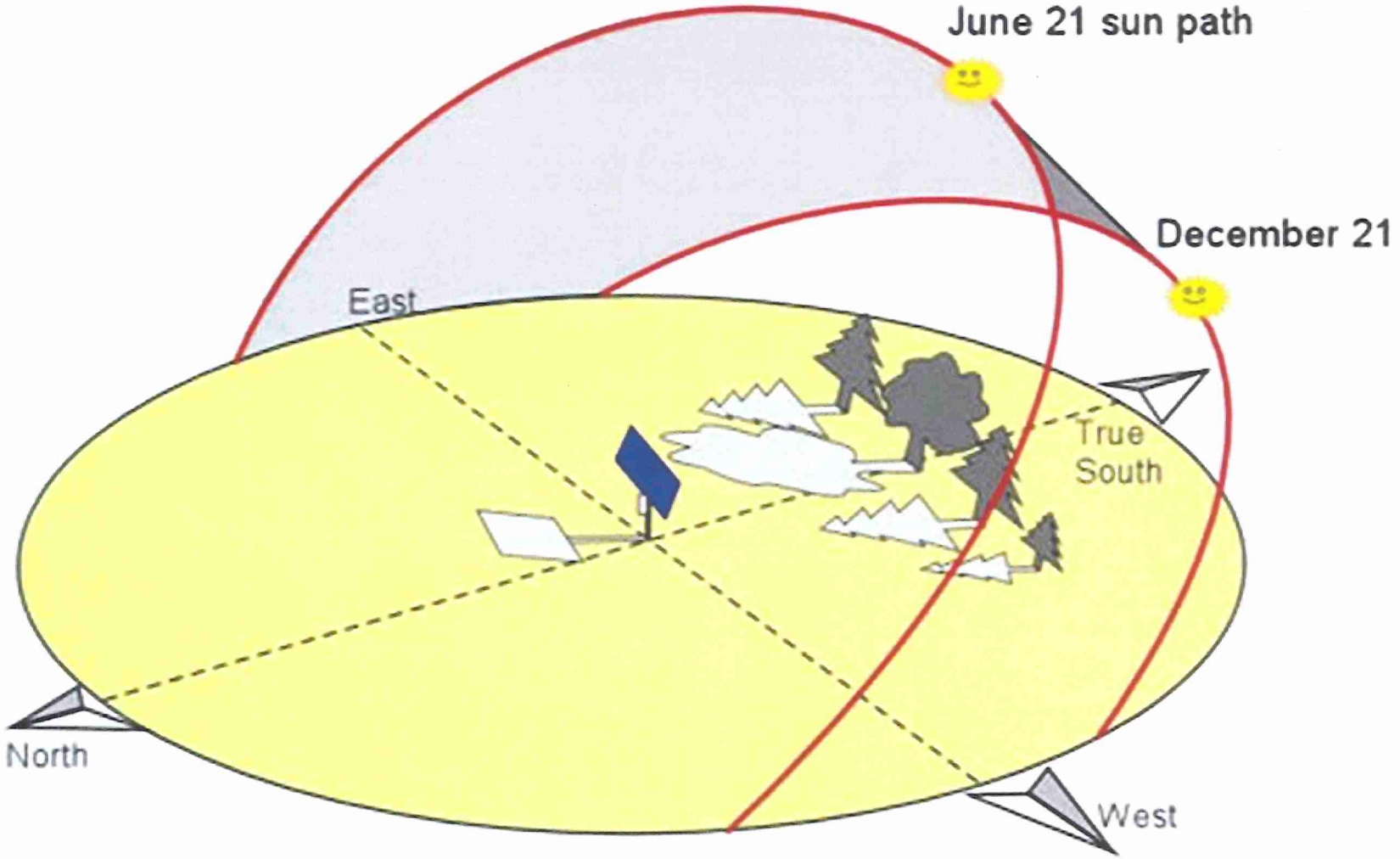
Electricity Grid
When the solar panels are generating more electricity than electricity load, the excess power is exported to the electricity grid. The grid supplies electricity to the switchboard on a cloudy day or during the evening when the solar panels are not generating electricity. Additionally, the grid supplies electricity to the switchboard when consumption of electricity is greater than the amount of electricity the solar panels are producing.

Main Switchboard
The main switchboard is the common link in the whole grid interactive solar system.

Grid Interactive Inverter
The grid interactive inverter is the device where direct current (DC) from the solar panels is transformed into 240 volt alternating current (AC) at 50 Hertz suitable for running household appliances.

Kilo-Watt-Hour-Meter
The kilo-Watt-hour (kWh) meter is a cumulative measurement of solar electricity represented in kWh. It is the total amount of electricity produced by the solar panels.

Electricity Load
The electricity load is the electricity that appliances such as lights, computers and fridges are consuming. Electricity is supplied to the appliances via the switchboard.


June 21 sun path
December 21
East
True
South
North
West

GARRISON, MN - MN/DOT SOLAR ARRAY


GARRISON, MN - MN/DOT SOLAR ARRAY

EarthTools™

Reset Map | Link here | How to Use
About the Data | Webservices | © and Disclaimer

46.2981°N 93.8272°W

-- Jump to country --

Home | Tools | My Places (0) | DONATE

Places | Sun | Time | Height | Location | Distance

Metres

384m

Feet

1259.8ft

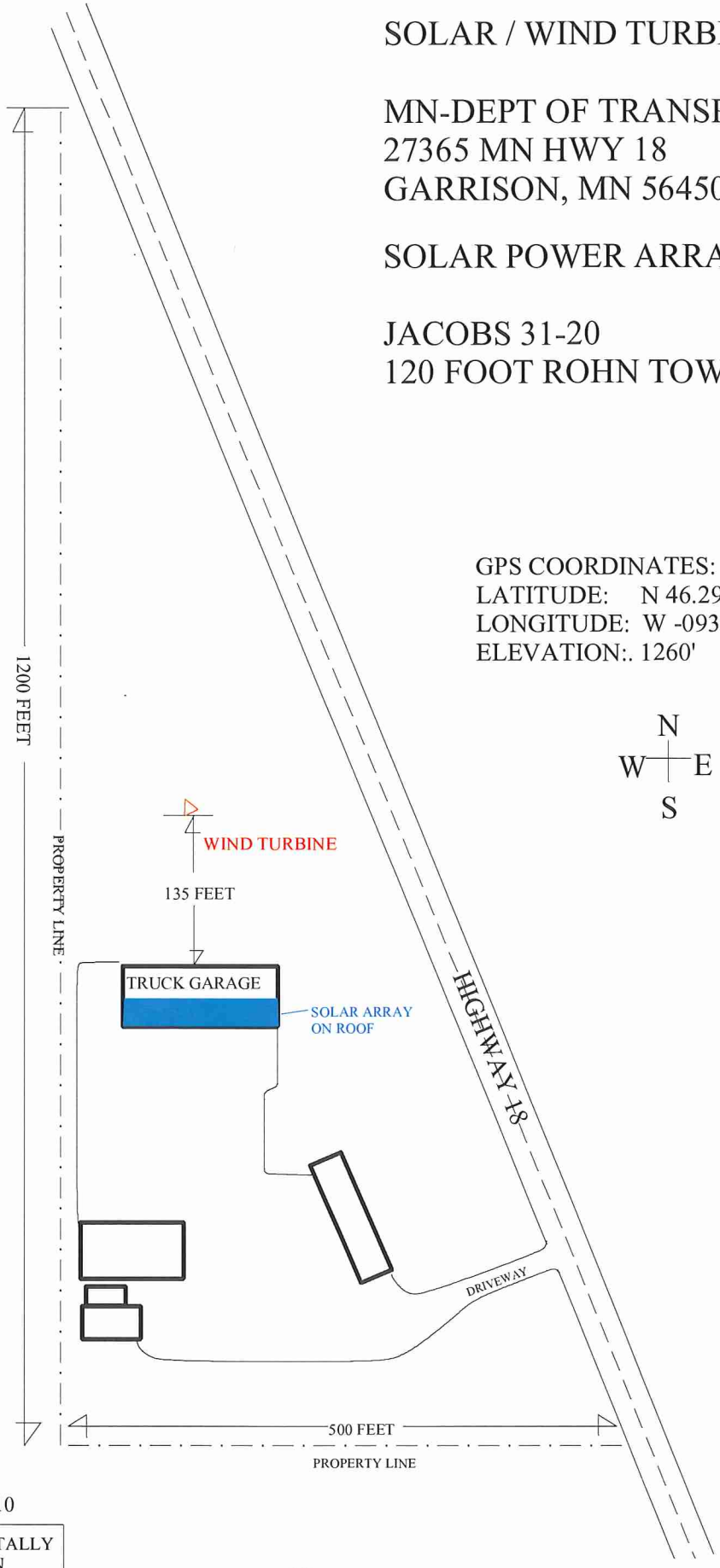
SOLAR / WIND TURBINE SITE

MN-DEPT OF TRANSPORTATION
27365 MN HWY 18
GARRISON, MN 56450

SOLAR POWER ARRAY

JACOBS 31-20
120 FOOT ROHN TOWER

GPS COORDINATES:
LATITUDE: N 46.2981
LONGITUDE: W -093.8272
ELEVATION:. 1260'



PREPARED MAY 25, 2010

WINKELMAN'S ENVIRONMENTALLY
RESPONSIBLE CONSTRUCTION
9121 CR 23, BRAINERD, MN 56401
218-764-2321 - WWW.ECOWERC.COM

www.ecowerc.com

Phone:218-764-2321
Fax: 218-764-3582

Price Valid To: 10/1/2010

SOLAR PHOTO-VOLTAIC COST - BENEFIT

Completely installed on roof

WINKELMAN'S ENVIRONMENTALLY RESPONSIBLE CONSTRUCTION (WERC)

Part of the Eco-Domes LLC, 9121 CR 23, Brainerd, MN 56401

This is an estimate only, prepared by: David Winkelman

Job Name:	**Garrison Truck Shop Solar PV Roof**
Client:	**Minnesota Department of Transportation**
Address:	**27365 HWY 18**
City, State Zip code:	**Garrison, MN 56450**
Telephone:	**218 828 5726**
Cell Phone:	
Email address:	Clarence.wroolie@state.mn.us
County:	**Mille Lacs**
Township:	**City of Garrison**
Elevation:	**1259.8 ft**
Soil Classification:	n/a
Grid Power Company:	**Mille Lacs Energy Cooperative**
Power Cost 2009:	**$ 0.0846 Per kWh**
Latitude:	**46.2981 Longitude: -93.8272**

Version One:

TIGER II Grant
Advertising/Sponsors
Green Credits
Finders Fees

Cost per watt, installed: $8.13

Payback Years: 5.1

COST BREAKDOWN OF PROJECT

85 each of the Sharp 230 Watt PV Panels	$ 97,750.00
85 Enphase Micro Inverters	$ 21,250.00
Mounting System: Racks, Rails, Anchors, Grounding, Connectors, Braces	$ 9,800.00
Site Plan	$ 500.00
Electrician Wiring Labor:	$ 17,000.00
Assemble and Erect Mounting System, PV Panels, Inverters	$ 6,000.00
Wiring, Conduit, Straps and Switches	$ 4,000.00
Grant Work, Permit Work-($75/hr., as needed)	$ 2,500.00
Interconnection with Mille Lacs Energy Coop	$ 750.00
Shipping/Handling	$ 950.00
Travel Expenses/Lodging	$ -
Contingencies	$ 2,000.00
TOTAL COST	$ 162,500.00

Solar Insolation Data from:
St Cloud
Duluth

State Solar Map from DOC

Power Production Projected Annually: 32,111 kWh

CO-2 Emissions Reduced tons / yr: 65,000

Grants

Project Cost	$ 162,500.00
Less: USDA Grant	
Less: TIGER II Grant	$ 81,945.00
Total Project Cost:	$ 80,555.00

BENEFITS - (inflation adjustment factor = 5%)		**1st year**	**2nd year**	**3rd year**	**4th year**	**5th year**	**6th year**	**7th year**	**8th year**	**9th year**	**10th year**
Federal Investment Tax Credit*	$ -	$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
MN Production Tax Credit	$ -	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Green Credits (REC in dollars)**	$ 0.02	$642.22	$674.33	$708.05	$743.45	$780.62	$819.65	$860.64	$903.67	$948.85	$996.29
2011 Electricity Rate (dollars):***	$ 0.11	$3,532.21	$3,708.82	$3,894.26	$4,088.97	$4,313.87	$4,529.56	$4,756.04	$4,993.84	$5,243.53	$4,756.04
Education & Sponsors (per yea	$ 1,200.00	$ 1,200.00	$ 1,260.00	$ 1,323.00	$ 1,389.15	$ 1,458.61	$ 1,531.54	$ 1,608.11	$ 1,688.52	$ 1,772.95	$ 1,608.11
State or Local Rebates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
TIGER II Grant	$ 121,875.00	$ 121,875.00		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Cost (per year):	$ 100.00	-$100.00	-$105.00	-$110.25	-$115.76	-$121.55	-$127.63	-$134.01	-$140.71	-$147.75	-$155.13
Insurance Cost (per year):	$ -	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
MACRS Tax Deduction:****	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
USDA or Other Grants	$ -	$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Finders Fees: *****	1.0% per unit	$1,620.00	$1,620.00	$2,440.00	$2,440.00	$2,440.00	$ -	$ -	$ -	$ -	$ -
Income Tax Rate Estimate:	0%										
Interest Cost:											
	Totals By Year:	**$128,769.43**	**$135,927.58**	**$144,182.64**	**$152,728.45**	**$161,600.00**	**$168,353.12**	**$175,443.91**	**$182,889.23**	**$190,706.81**	**$197,912.13**

* Federal ITC tax credit passed 2009-can be taken as a credit or receive cash grant from IRS.

** Green Credit Sales are negotiated with various vendors, 2 cents per KWH is used for estimates here

*** Grid power cost increase of 5% per year is used in these calculations (annual adjustment and inflation will vary)

**** Depreciation can be taken in several ways, see your tax advisor.

*****WERC will pay client a 1% finders fee for any referral that puchases a wind turbine.

Owner may qualify for USDA grant funding for a Wind Turbine installation (25% of cost up to $500,000).

Small Solar Electric Systems: A Minnesota Guide

Can I use solar energy to power my home? More and more Minnesotans are asking themselves this question as people look for affordable, clean and reliable sources of electricity.

Minnesota has better solar resources than what most people may think. In fact, average annual resources in Minneapolis are comparable to solar resources in Jacksonville, Fla. Minnesota's solar energy can produce electricity when demand is highest—during the summer months. Solar electric systems will even produce electricity on cloudy days, although generation is significantly reduced.

Small solar electric systems can make a significant contribution to meeting energy needs. A small solar electric system may be a good choice if:

- trees, buildings, or other structures do not shade the installation location,
- there is adequate roof, wall or yard space to permit a collector assembly installation,
- the desired electrical output can be achieved,
- there are few personal financial barriers for on-grid homes or
- the home or cabin is located off-grid, away from power lines.

Most people are interested in solar energy because it is a nonpolluting source of power. Solar electric systems are one of the most flexible home-based renewable energy systems available. The system can be moved from one location to another with far greater ease than other renewable energy systems and can be added to over an extended period of time, a few solar panels at a time.

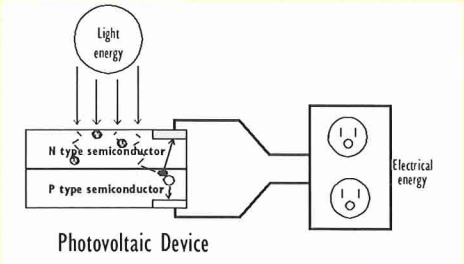
Depending on the solar resource availability and the home's electric energy consumption, a small solar electric system can lower electricity bills by 50 to 90 percent, prevent power interruptions and avoid the high costs of extending utility power lines to remote locations.

In small solar electric systems, PV cells are typically combined into panels that hold about 40 cells; multiple panels can be mounted together in an array that can measure up to several yards (meters) on a side. Panels come in sizes from a few watts to hundreds of watts—a small home system can use anywhere from 3 to 20 panels, depending on their size. Also available are solar roof shingles, which replace conventional roofing materials while providing electricity less expensively than standard solar panels.

The photovoltaic effect

French scientist Edmund Becquerel first reported the photovoltaic effect in 1839, when he observed a voltage between two electrodes in a beaker of electrolyte after the beaker was exposed to sunlight.

Solar electric or photovoltaic (PV) cells convert sunlight directly into electricity. PV cells are made of semi-conducting materials, similar to those used in computer chips. When exposed to sunlight, these materials absorb light energy and are "excited," causing electrons to flow through the material and produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic effect.



Photovoltaic Device

generally consume only 50 percent of the electricity used by a ten-year-old refrigerator. See the Home Energy Guide "Home Appliances."

- Replace all incandescent light bulbs with fluorescent and compact fluorescent light bulbs. Using fluorescent lighting can reduce lighting costs by up to 75 percent. See the Home Energy Guide "Home Lighting."
- When shopping for appliances, use the Energy Star® label as a minimum standard. Energy Star® appliances have been identified by the U.S. Environmental Protection Agency and U.S. Department of Energy as being the most energy-efficient products in their classes. For more information visit the web site www.energystar.gov

The "For More Information" section at the end of this guide lists additional resources about how to make homes and businesses energy efficient.

Making the decision

The following list can serve as a guide for deciding if a solar electric system is for you:

- the property has good solar resources,
- whether local zoning codes or covenants allow solar electric systems,
- long-term investments are a comfortable financial option,
- there is a commitment to decrease the impact on the environment, or
- the property is in a remote location that does not have easy access to utility lines.

Example: You are building a new home or remote cabin. The local utility will provide power, but at a cost of $20,000 for installation of power lines and poles. This cost could be avoided by installing a solar electric system and becoming your own utility. The utility costs may be amortized as part of the mortgage costs.

Before investing in a solar electric system, research potential obstacles. Some communities, for example, restrict the exterior appearance of homes in residentially zoned areas, although variances are often obtainable. Check the zoning restrictions by contacting the local building inspector, board of supervisors, or planning board. They can specify if a building permit is needed and provide a list of requirements. Condominium and townhouse developments may also restrict installations. An electrical permit is always required.

Most zoning and aesthetic concerns can be addressed by supplying objective data. For example, adding a solar electric system may defer the need for constructing additional power lines in the community. Many solar electric systems may be incorporated within a roof assembly or hidden by the roof or other sections of a building or plantings.

Determine solar resources

Does the sun shine often enough and long enough to make a small solar electric system economically worthwhile? The answer has more to do with the cost of the solar electric system than the amount of sun we receive. It is true that Arizona receives more sun than Minnesota (and that Minnesota receives more sunlight than New York), but the difference is small compared to the cost of the system—being in Arizona versus Minnesota may influence the decision but the costs will ultimately be the major factor. A discussion of solar resources is important, however.

Solar resource maps can be used to estimate the available solar resources. The Minnesota Department of Commerce has created a map by measuring solar insolation, which is the amount of radiation that penetrates the earth's atmosphere and actually reaches the ground.

Solar resource mapping shows that a solar electric system would work well just about anywhere in Minnesota —although some areas of the state have slightly stronger solar resources than other areas of the state, there wasn't a broad range in strength of solar insolation statewide. The values range from 140 watts per square meter in the northern regions of the state up to 165 watts in the southwestern region.

To put the state's solar power into perspective, Minneapolis and Jacksonville, Fla. are nearly equal in terms of estimated annual solar energy production. Minneapolis has a greater summer solar resource than Jacksonville due to longer days and clearer skies, but a much lower winter solar resource. Although Minnesota's solar energy is intermittent, it does have the strongest solar resources when it is needed most—in the summer months when electrical demands for air conditioning are highest.

Local terrain and weather patterns may cause the solar resource at a specific site to differ considerably from these estimates, such as the palisade along the Lake Superior shoreline.

Select the best site

Unobstructed access to the sun for the collector surface is an absolute must for any solar electric system. Obstacles such as trees, houses, utility poles, branches, chimneys, and sheds need to be considered, as well as planning ahead for future obstructions such as new buildings

For a residential grid-connected application, the balance of system parts may include a controller, storage batteries (if back-up power is desired), a power conditioning unit (inverter), and wiring. Some solar electric systems will include controllers, inverters or other electrical devices. It is critical that all components be approved by a recognized testing agency, like Underwriters Laboratories (UL), to assure the component meets safety standards.

Equipment for stand-alone systems

A stand-alone or off-grid system, which is not connected to the utility grid, uses batteries to store excess generated power. This system can also be used in hours of darkness, power outages or during high demand. A charge controller is needed to prevent the batteries from overcharging. Deep-cycle batteries, such as those used for golf carts, can discharge and recharge 80 percent of their capacity hundreds of times, which makes them a good option for remote renewable energy systems. Automotive and other shallow-cycle batteries should not be used in renewable energy systems.

Small solar electric systems generate direct current (DC) electricity. In very small systems, such as those serving cabins or remote homes, DC appliances operate directly off the batteries. In conventional housing, most people want to use standard appliances that use alternating current (AC) so an inverter must be installed to convert DC electricity from the batteries to AC. Although the inverter slightly reduces the overall efficiency of the system, it allows the home to be wired for AC, a definite plus with financial lenders and future homebuyers.

For safety, batteries should be isolated from living areas and electronics because they contain battery acids and generate small amounts of flammable gas that need to be vented to the outside to prevent build-up. Lead-acid batteries also require protection from temperature extremes to avoid significant power loss.

Equipment for grid-connected systems

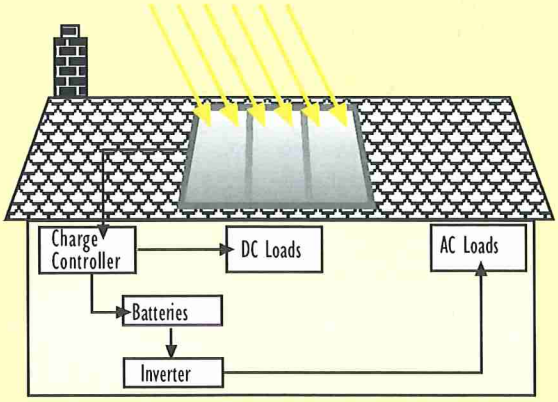
In grid-connected systems, the only additional equipment required is a power conditioning unit (inverter) and switching gear to disconnect the system from the grid in the event of a power outage. Batteries added to this configuration provide a power supply during power outage situations. Power conditioning equipment is needed to make solar electric system output electrically compatible with the utility grid.

Mounted and tracking solar electric panels

Stationary mounted panels can be adjustable, permitting the panels to face the sun as near to perpendicular as possible.

Solar electric panels may also be mounted on a tracking system, which will automatically adjust so that the PV panels face the sun throughout the day.

Basic Parts of a Small Solar Electric System



Installation and maintenance

Many manufacturers and dealers also offer installation and maintenance services. A list of installers may be available from the manufacturer, the local utility or the phone book. The Department of Commerce State Energy Office also maintains a list of dealers and installers, but does not endorse or recommend specific companies.

A credible installer will provide many services such as obtaining necessary permits. As a general rule the Department of Commerce State Energy Office recommends installation by a trained licensed electrical contractor or licensed electrical professional.

Choosing to self-install

Some people elect to install the systems themselves. When deciding to self-install, first consider the following questions:

- Can you install the panel mounting system on roof or yard?
- Do you know the difference between AC and DC wiring?
- Do you know enough about electricity to safely wire the system?
- Do you know how to safely handle and install batteries?

If the answer is no to any of the above questions, the system should probably be installed by a system integrator or installer, including a licensed electrician or licensed electrical contractor.

Although small solar energy systems are very simple devices, they do require some maintenance. If you do not have the expertise to maintain the system, an installer may provide a service and maintenance program.

Bolts and electrical connections should be checked and tightened if necessary. The mounting components should be checked for corrosion and for proper angle tension. With proper installation and maintenance, the system should last up to 30 years or longer.

Grid-connected systems

Small solar electric energy systems connected to the local utility's electricity distribution system and are called grid-connected systems. A grid-connected solar electric system can reduce consumption of utility-supplied electricity for lighting, appliances and other uses. If the solar electric system cannot deliver the full amount of energy needed, the utility makes up the difference. When the solar electric system produces more electricity than the household requires, the excess is sent or sold to the utility (see sidebar on Net Metering).

Grid-connected systems can be practical if the following conditions exist:

- Utility-supplied electricity is expensive (about 10 to 15 cents per kilowatt-hour) or the net cost of the system is reduced by a rebate.
- The cost and requirements for connecting the solar electric system to the grid are not prohibitively expensive.
- There are good incentives for the sale of excess electricity or for the purchase of solar-generated electricity. (Average retail rate of the utility combined with any other production incentive)

Federal regulations (specifically, the Public Utility Regulatory Policies Act of 1978, or PURPA) require utilities to connect with and purchase power from small solar electric energy systems. However, contact the utility before connecting to their distribution lines to address any power quality and safety concerns. The utility can provide a list of requirements for connecting a solar electric system to the grid. The American Solar Energy Association is another good source for information on utility interconnection requirements.

Net Metering

A net metering program allows the electric meters of customers with generating facilities to turn backwards—and send electricity back into the grid—when a customer's generator produces more energy than is used. Net metering allows customers to offset their electricity consumption over the entire billing period, not just instantaneously. This offset enables customers with generating facilities to receive retail prices for the excess electricity they generate.

Safety Requirements

Whether or not the solar electric system is connected to the utility grid, the installation and operation of the solar electric system is subject to the State Electrical Code.

The state's principal concern is with the safety of the system, so code requirements emphasize proper wiring and installation and the use of components that have been certified for fire and electrical safety by approved testing laboratories, such as Underwriters Laboratories (UL).

Electrical code requirements are based on the current National Electrical Code (NEC), which is published by the National Fire Protection Association. Solar electric energy installations are governed by the NEC.

If the solar electric system is connected to the local utility grid, then the utility also has legitimate concerns about safety and power quality that need to be

depending on terrain,
- there is a personal desire for energy independence from the utility,
- there is a personal desire to generate clean power; and/or
- a backup power supply is needed in the event of power outages.

Conclusion

Solar electricity for a home or business is one of several energy options in Minnesota. Energy can be generated to meet all or part of the demand, or become a net generator and potentially sell extra power to the local utility. Deciding whether a solar electric system is feasible depends on many factors; for best results, conduct careful research and make some economic decisions before proceeding with plans.

This off-grid home near Red Wing, Minn., combines wind and solar power. On the roof are five solar thermal collectors for space heating and domestic hot water needs, and two skylights provide day lighting and passive solar heat of the upstairs. A PV panel array will be installed on a pole-mounted tracker in summer, 2003. Annual production data for the home, completed in 2002, is not available yet. The home exceeds the energy code by 50 percent and incorporates energy-efficient and environmentally sustainable features. An ethanol-fueled generator provides back-up power to the home.

Glossary of Terms

Ampacity—The current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Ampere-hour—A unit for the quantity of electricity obtained by integrating current flow in amperes over the time in hours for its flow; used as a measure of battery capacity.

Converter—A device the converts direct current (DC) to alternating current (AC). Also called an inverter.

Grid—The utility distribution system that connects electricity generators to electricity users.

Inverter—A device the converts direct current (DC) to alternating current (AC). Also called a converter

W—watt, a measure of power for electrical current equal to 3.4 Btu's

kW—Kilowatt, a measure of power for electrical current (one thousand watts).

kWh—Kilowatt-hour, a measure of energy equal to the use of one kilowatt in one hour.

MW—Megawatt, a measure of power (one million watts).

O&M Costs—Operation and maintenance costs.

PUC—Public Utility Commission, a state agency which regulates utilities.

PURPA—Public Utility Regulatory Policies Act (1978), 16 U.S.C. § 2601.18 CFR § 292 that refers to small generator utility connection rules.

Rated output capacity—The maximum output power of a solar electric panel operating in sunlight of 1000 W/m2 .

Periodicals

Solar Today An award-winning bimonthly magazine that covers all solar technologies, from photovoltaics to climate-responsive buildings to wind power. Regular topics include building case studies, energy policy and community-scale projects. Published by the American Solar Energy Society. 2400 Central Ave., G-1, Boulder, CO 80301. Phone: 303-443-3130. Web site: http://www.ases.org.

Home Power Magazine The definitive magazine for the homemade power enthusiast, published bimonthly. PO Box 520, Ashland, OR 97520 Phone: (800) 707-6586. Web site: http://www.homepower.com.

Web Sites

Minnesota Department of Commerce, State Energy Office, Energy Information Center

A Minnesota clearinghouse for energy efficiency and renewable energy information and resources within Minnesota. E-mail: energy.info@state.mn.us. Web site: www.commerce.state.mn.us

The American Solar Energy Society (ASES) Provides answers to frequently asked questions and information on all aspects of solar energy. Web site: http://www.ases.org

Database of State Incentives for Renewable Energy A comprehensive source of information on state, local, utility and selected federal incentives that promote renewable energy. A project of the Interstate Renewable Energy Council (IREC) http://www.dsireusa.org/

Green Power Network Net Metering Web Site. Net metering programs are now available in 30 states. http://www.eren.doe.gov/greenpower/netmetering

Solar Energy for Homeowners Offers things to consider before investing in a small solar energy system and also basic information about the systems. http://www.eren.doe.gov

National Renewable Energy Laboratory The U.S. Department of Energy's premier laboratory for renewable energy research & development and a lead lab for energy efficiency research and design. http://www.nrel.gov

This solar-powered lighting system is owned and operated by the Minnesota Department of Natural Resources and provides lighting at a remote public access point.

This publication is adapted from "Small Wind Energy Systems" produced for the U.S. Department of Energy by the National Renewable Energy Laboratory, a DOE Laboratory. DOE/GO-102001-1293 ay 2001

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Incentives/Policies for Renewables & Efficiency

Solar-Electric (PV) Rebate Program

Last DSIRE Review: 04/27/2010

Program Overview:

State:	Minnesota
Incentive Type:	State Rebate Program
Eligible Renewable/Other Technologies:	Photovoltaics
Applicable Sectors:	Commercial, Residential, Multi-Family Residential, (Small Businesses Only for Commercial Sector)
Amount:	Base incentive: $1.50/W DC NABCEP certified installer: add $0.25/W DC Small businesses: add $0.25/W for applications submitted by April 30, 2010 if final rebate claims made by September 30, 2010.
Maximum Incentive:	Based on system size limitations and incentive calculation methods: Residential: $7,500 - $8,750 Small business: $15,000 - $20,000
Eligible System Size:	0.5 kW Minimum
Equipment Requirements:	Systems components must be new, UL-listed, in compliance with all applicable performance and safety standards; Inverters must carry a minimum 5-year warranty; PV panels must carry a 20-year warranty.
Installation Requirements:	Installation must comply with all federal, state and local codes; grid-connected or off-grid systems eligible; systems must be installed by a licensed, qualified professional; installations must comply with detailed siting criteria specified in program guidelines; performance should be at least 90% of ideally sited system
Ownership of Renewable Energy Credits:	Not specified
Expiration Date:	When funds are exhausted
Program Administrator:	Minnesota Department of Commerce
Funding Source:	American Recovery and Reinvestment Act (ARRA)
Program Budget:	$2.5 million (2010)
Start Date:	2002
Web Site:	http://www.state.mn.us/portal/mn/jsp/content....
Date Effective:	2002

Summary:

Note: Current funding for this program is now fully reserved; however, the Minnesota Office of

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Incentives/Policies for Renewables & Efficiency

Wind and Solar-Electric (PV) Systems Exemption

Last DSIRE Review: 07/02/2009

Program Overview:

State:	Minnesota
Incentive Type:	Property Tax Incentive
Eligible Renewable/Other Technologies:	Photovoltaics, Wind
Applicable Sectors:	Commercial, Residential
Maximum Incentive:	None
Start Date:	05/17/2009
Web Site:	http://www.state.mn.us/portal/mn/jsp/content....
Authority 1:	Minn. Stat. § 272.02
Date Effective:	01/01/1992
Authority 2:	Minn. Stat. § 272.028
Date Enacted:	06/30/2001
Date Effective:	07/01/2001
Authority 3:	Minn. Stat. § 272.029
Date Enacted:	05/18/2002 (subsequently amended)
Date Effective:	01/01/2003
Authority 4:	H.F. 1298, Article 2, Sec. 12
Date Enacted:	05/16/2009
Date Effective:	05/17/2009

Summary:
Minnesota excludes the value added by solar-electric (PV) systems from real property taxation, and all real and personal property of wind-energy systems is exempt from the state's property tax. However, the land on which a PV or wind system is located remains taxable.

In lieu of a property tax on large wind-energy systems, a production tax was implemented in 2002. Wind systems greater than 12 MW are taxed at a rate of 0.12 cents/kWh; systems between 2 MW and 12 MW are taxed at a rate of 0.036 cents/kWh; and systems between 250 kW and 2 MW are taxed at a rate of 0.012 cents/kWh. Wind systems less than 250 kW are exempt from the production tax, as are systems with a capacity of 2 MW or less that are owned by political subdivisions. Effective for 2006 - 2009 (Minn. Stat. § 272.029 Subd. 6), the revenue generated by the production tax is distributed to local taxing districts as follows: 80% to counties; 14% to cities and townships; and 6% to school districts. For 2010 and thereafter, the distribution of revenues will be 80% to counties and 20% to cities and townships (H.F. 1298 of 2009).

Notably, a provision in a separate statute (Minn. Stat. § 272.028) allows a mutually agreeable alternative to be negotiated between the local government authority and the wind facility owner for the purpose of

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Solar Energy Sales Tax Exemption

Last DSIRE Review: 07/02/2009

Program Overview:

State:	Minnesota
Incentive Type:	Sales Tax Incentive
Eligible Renewable/Other Technologies:	Solar Water Heat, Solar Space Heat, Photovoltaics
Applicable Sectors:	Commercial, Residential, General Public/Consumer
Amount:	100% exemption
Maximum Incentive:	None
Program Administrator:	Minnesota Department of Commerce
Start Date:	08/01/2005
Web Site:	http://www.state.mn.us/portal/mn/jsp/content....
Authority 1:	Minn. Stat. § 297A.67, Subd. 29
Date Enacted:	07/13/2005
Date Effective:	08/01/2005

Summary:
In Minnesota, solar-energy systems purchased on or after August 1, 2005, are exempt from the state's sales tax. This exemption applies to solar electric (PV) systems, solar water-heating systems and solar space-heating systems. All components of these systems are exempt, including panels, wiring, pipes, pumps and racks. Buyers must complete Minnesota Department of Revenue Form ST3 "Certificate of Exemption" in order to claim the exemption. Sellers are required to keep the form in their files for tax reference. This incentive has no expiration date.

Contact:

Energy Information Center
Minnesota Department of Commerce
Office of Energy Security
85 7th Place East, Suite 500
St. Paul, MN 55101-2198
Phone: (651) 296-5175
Phone 2: (800) 657-3710
Fax: (651) 297-7891
E-Mail: energy.info@state.mn.us
Web Site: http://www.energy.mn.gov/

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Xcel Energy - Solar*Rewards Program

Last DSIRE Review: 03/02/2010

Program Overview:

State:	Minnesota
Incentive Type:	Utility Rebate Program
Eligible Renewable/Other Technologies:	Photovoltaics
Applicable Sectors:	Commercial, Residential, Nonprofit, Local Government
Amount:	$2.25/W DC
Maximum Incentive:	$90,000 (as determined by the incentive level and maximum system size)
Eligible System Size:	Minimum of 0.5 kW, maximum of less than 40 kW DC
Equipment Requirements:	Equipment must be new and have a minimum five-year warranty; inverters must be UL-1741 certified.
Installation Requirements:	Systems must be grid-connected and oriented to be free of shade from the center point of the solar array through a horizontal angle plus or minus 60 degrees and through a vertical angle between 15 degrees and 90 degrees above the horizontal plane.
Ownership of Renewable Energy Credits:	Xcel Energy
Program Administrator:	Xcel Energy
Start Date:	03/01/2010
Web Site:	http://www.xcelenergy.com/Minnesota/Residential/RenewableEnergy/S...
Authority 1:	Solar*Rewards Customer Contract (Sheet 9-13 et seq.)
Date Effective:	03/01/2010

Summary:

Xcel Energy's Solar*Rewards Program provides an incentive for residential and commercial customers that install grid-connected photovoltaic (PV) systems of at least 0.5 kilowatts (kW) and less than 40 kW. Systems larger than 40 kW do not qualify for the program. The incentive takes the form of an up-front rebate of $2.25 per watt DC. In exchange for the up-front incentive, the customer is required to enter into a 20-year contract with Xcel Energy that transfers ownership of all renewable energy credits (RECs) produced by the system to the utility during the life of the contract.

In order to qualify for the program, the PV system must be installed on a property or a building located in Minnesota that is owned by the applicant and that receives electric service from Xcel Energy. New construction projects are eligible for incentives, but must have an Xcel Energy electric meter on-site and an electricity account set up with the utility. In addition, customers must have performed energy audit within the last three years that meets the standards of Xcel Energy's energy audit program and may be required to implement certain measures identified in the energy audit prior to participating in the Solar*Rewards program. In lieu of an energy audit, residential customers with homes that have been Energy Star certified through the utility's Energy Star project automatically qualify. Likewise, commercial customers that have participated in one of several commercial energy efficiency programs offered by the utility also automatically qualify.

To receive the incentive, participants must submit an application and receive approval from Xcel Energy prior to installing the system. The program has a $250 application fee. If, prior to the completion of an engineering review, the application is denied or the customer elects not participate in the program, the customer's application fee will be refunded. All PV systems must use new equipment, carry a five-year warranty, and meet several other equipment and installation requirements designed to assure the safe and effective operation of the system.

Net metering is available for Xcel Energy's customers, although customers may be eligible to enroll in one of several other customer-generation options if they wish instead of net metering. Under net metering net excess generation (NEG) at the end of a monthly billing period is generally credited to the next month's bill. If a customer's NEG balance exceeds $25.00 at the end of a billing period, the customer will be issued a check for the balance by the utility. Net metering takes place using a bi-directional meter for which the

customer pays a small monthly fee. The program also requires a generation meter installed at the utility's expense to measure energy (i.e., REC production) by the solar system. Applicants can view the Solar*Rewards Customer Contract at the link above.

Contact:

Program Information - Solar*Rewards Program
Xcel Energy
414 Nicollet Mall, 6th Floor
Minneapolis, MN 55401
Fax: (612) 318-4787
E-Mail: SolarProgramMN@xcelenergy.com
Web Site: http://www.xcelenergy.com

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Minnesota - Net Metering

Last DSIRE Review: 09/23/2009

Program Overview:

State:	Minnesota
Incentive Type:	Net Metering
Eligible Renewable/Other Technologies:	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Municipal Solid Waste, CHP/Cogeneration, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies
Applicable Sectors:	Commercial, Industrial, Residential
Applicable Utilities:	All utilities
System Capacity Limit:	Less than 40 kW
Aggregate Capacity Limit:	No limit specified
Net Excess Generation:	Reconciled monthly; customer may elect to take compensation as a payment or as a bill credit at the retail utility energy rate
REC Ownership:	Not addressed
Meter Aggregation:	Not addressed
Authority 1:	Minn. Stat. § 216B.164
Date Enacted:	1983
Date Effective:	1983
Authority 2:	Minn. R. 7835.3300
Date Effective:	2000
Authority 3:	Minn. R. 7835.9910
Date Effective:	2000

Summary:
Minnesota's net-metering law, enacted in 1983, applies to all investor-owned utilities, municipal utilities and electric cooperatives. All "qualifying facilities" less than 40 kilowatts (kW) in capacity are eligible.* There is no limit on statewide capacity.

Each utility must compensate customers for customer net excess generation (NEG) at the "average retail utility energy rate," defined as "the total annual class revenue from sales of electricity minus the annual revenue resulting from fixed charges, divided by the annual class kilowatt-hour sales." This rate is basically the same as a utility's retail rate. Compensation may take the form of an actual payment (i.e., check for purchase) for NEG or as a credit on the customer's bill. The option to have NEG purchased by the utility at the retail rate distinguishes Minnesota's net-metering law from net-metering laws and programs in most other states, where monthly reconciliation is generally limited to a bill credit.

Wisconsin is the only other state that provides for the actual purchase -- in the form of a check payable to the customer -- of NEG at the utility's retail rate for electricity generated by a renewable-energy system. However, in Wisconsin a check will only be issued to the customer if NEG exceeds $25. Compensation takes place under the state's Uniform Statewide Contract (Minn. R. 7835.9910).

** The term "qualifying facility" is defined in the federal Public Utility Regulatory Policy Act of 1978 (PURPA). It generally includes most renewable-energy systems and combined-heat-and-power (CHP) systems.*

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Incentives/Policies for Renewables & Efficiency

Renewable Development Fund (RDF)

Last DSIRE Review: 03/17/2010

Program Overview:

State:	Minnesota
Incentive Type:	Public Benefits Fund
Eligible Renewable/Other Technologies:	Photovoltaics, Wind, Biomass, Hydroelectric, CHP/Cogeneration, Anaerobic Digestion, Renewable Fuels, Fuel Cells using Renewable Fuels
Applicable Sectors:	Commercial, Industrial, Residential, General Public/Consumer, Nonprofit, Schools, Local Government, Utility, State Government, Tribal Government, Fed. Government, Agricultural, Institutional
Types:	Renewables
Total Fund:	$19.5 million annually (beginning in 2008)
Web Site:	http://www.xcelenergy.com/Minnesota/Company/E...
Authority 1:	Minn. Stat. § 116C.779
Date Enacted:	1994 (subsequently amended)
Date Effective:	1999
Expiration Date	None

Summary:
Xcel Energy's Renewable Development Fund (RDF) was created in 1999 pursuant to the 1994 Radioactive Waste Management Facility Authorization Law (Minn. Stat. § 116C.779). Originally, Xcel Energy was required to donate to the fund $500,000 annually for each dry cask containing spent nuclear fuel being stored at the Prairie Island nuclear power plant, amounting to about $9 million annually. Subsequent legislation, enacted in May 2003, extended nuclear-waste storage at Xcel Energy's Prairie Island plant and increased the amount Xcel must pay toward the development of renewable-energy resources to $16 million annually for as long as the utility's Prairie Island nuclear plant is in operation and $7.5 million for each year the plant is not in operation.

In May 2007, S.F. 2096 amended Minn. Stat. § 116C.779 yet again after Xcel petitioned the Minnesota Public Utilities Commission (PUC) to begin dry cask storage at Monticello, a second nuclear power plant. Under this legislation Xcel is required to contribute $350,000 towards the fund for each dry cask storage device containing spent fuel at the Monticello plant for as long as the plant remains in operation and $5.25 million annually for each year the plant is not in operation. Xcel's petition for dry cask storage at Monticello (which continues to operate) has been approved according to the following schedule:

- 2008: 10 casks (+ $3.5 million)
- 2012: 10 casks (+ $3.5 million)
- 2016: 10 casks (+ $3.5 million)

Thus, Xcel's annual contribution to the RDF was increased from $16 million to $19.5 million during 2008 and is scheduled to increase again in 2012 and 2016.

Through January 1, 2021, up to $10.9 million annually must be allocated from available funds in the account to support renewable-energy production incentives. Of this amount, $9.4 million supports production incentives for electricity generated by wind-energy systems. The balance of the $10.9 million sum -- up to $1.5 million annually -- may be used for production incentives for on-farm biogas recovery facilities, hydroelectric facilities, or for production incentives for other renewables. Unspent portions of this allocation from any calendar year may be used for other purposes. Separately, as a result of 2009 legislation a total of $20 million ($5 million annually from July 1, 2009 through July 1, 2012) must be must be allocated to fund a grant for the University of Minnesota's Initiative for Renewable Energy and the Environment (IREE). The IREE in turn is required to use this money for a variety of activities, including environmentally sound renewable energy production and hydrogen production; the development of energy conservation, efficient energy utilization, and energy storage technologies; and analysis of policy options for facilitating the

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Interconnection Standards

Incentive Type: Interconnection

Eligible Renewable/Other Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, CHP/Cogeneration, Microturbines, Other Distributed Generation Technologies

Applicable Sectors: Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government

Special Rules for Net-Metered Systems? Yes

Limit on System Size/Overall Enrollment: 10 MW (40 kW for net-metered systems)

Standard Interconnection Agreement? Yes

Additional Insurance Requirements? $300,000 for systems under 40 kW

External Disconnect Required? Yes

Rules for Non-Net-Metered DG? Yes

Authority 1: Minn. Stat. § 216B.1611

Date Enacted: 2001

Authority 2: Minnesota PUC Order, Docket No. E-999/CI-01-1023

Date Enacted: 9/28/04

Effective Date: 9/28/04

Website: http://www.puc.state.mn.us/docs/orders/04-0131.pdf

Summary:

Minnesota's net-metering law, enacted in 1983, applies to all investor-owned utilities, municipal utilities and rural electric cooperatives. Qualifying facilities up to 40 kilowatts (kW) are eligible for net metering; there is no statewide capacity limit for net metering. However, uniform interconnection regulations were not implemented when net metering was established.

In September 2004, the Minnesota Public Utilities Commission (PUC) adopted an order establishing generic standards for utility tariffs for interconnection and the operation of distributed-generation facilities up to 10 megawatts (MW) in capacity. All Minnesota utilities have filed compliance tariffs that have been approved by the PUC.

All Minnesota utilities must report annually on the number of interconnected systems. The PUC has developed streamlined uniform interconnection applications and a process that addresses safety, economics and reliability issues.

Contact:

Stuart Mitchell
Minnesota Public Utilities Commission
121 E. 7th Place, 3rd Floor
St. Paul, MN 55101-2147
Phone: (651) 201-2242
Fax: (651) 297-7073
E-Mail: stuart.mitchell@state.mn.us

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Incentives/Policies for Renewables & Efficiency

NEC Minnesota Energy Loan Program

Last DSIRE Review: 04/07/2010

Program Overview:

State:	Minnesota
Incentive Type:	State Loan Program
Eligible Efficiency Technologies:	Ceiling Fan, Water Heaters, Lighting, Furnaces , Central Air conditioners, Caulking/Weather-stripping, Duct/Air sealing, Building Insulation, Windows, Custom/Others pending approval
Eligible Renewable/Other Technologies:	Solar Water Heat, Photovoltaics, Geothermal Heat Pumps
Applicable Sectors:	Residential
Amount:	Varies by project
Maximum Incentive:	$35,000 ($2,000 minimum)
Terms:	Loan terms from 1 - 20 years at a fixed rate of 5.75%; Maximum household income of $96,500
Program Administrator:	Neighborhood Energy Connection
Funding Source:	Minnesota Housing and Finance Agency (MHFA)
Web Site:	http://www.thenec.org/energy_financing/index....

Summary:
The Neighborhood Energy Connection (NEC) offers secured, low-interest loans for qualified energy efficiency and renewable energy improvements to Minnesota residences. Loans are available for single family homes, duplexes, and quads with household incomes of $96,500 or less, in amounts ranging from $2,000 - $35,000. Loan repayment terms vary from 1 to 20 years according the amount of the loan at a fixed interest rate of 5.75%. Most costs of this financing offer, including a 1% origination fee, credit report fee, and document preparation fee can be rolled into the loan.

In order to be eligible for a loan, qualified homeowners must generally contact the NEC to schedule an energy audit. Customers of Xcel Energy may be eligible for a reduced rate on an energy audit and should contact Xcel Energy (1-800-895-4999) directly to request an audit. The actual improvements undertaken are up to the homeowner, but financed projects must include at least one of the recommendations made by the auditor. The NEC may also provide assistance in selecting a contractor and will perform follow-up inspections at the request of the homeowner. All loans are secured by a mortgage on the property.

The Minnesota Energy Loan is funded by Minnesota Housing and Finance Agency and processed and underwritten by the NEC.

Contact:

LeAnne Karras
Neighborhood Energy Connection
624 Selby Avenue
Saint Paul , MN 55104
Phone: (651) 221-4462 Ext.132
E-Mail: leannek@thenec.org
Web Site: http://www.thenec.org/

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Incentives/Policies for Renewables & Efficiency

Modified Accelerated Cost-Recovery System (MACRS) + Bonus Depreciation (2008-2009)

Last DSIRE Review: 01/20/2010

Program Overview:

State:	Federal
Incentive Type:	Corporate Depreciation
Eligible Renewable/Other Technologies:	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Anaerobic Digestion, Microturbines, Geothermal Direct-Use
Applicable Sectors:	Commercial, Industrial
Program Administrator:	U.S. Internal Revenue Service
Start Date:	1986
Authority 1:	26 USC § 168
Date Effective:	1986
Authority 2:	26 USC § 48

Summary:

Note: While the general Modified Accelerated Cost Recovery System (MACRS) remains in effect, the provision authorizing additional first-year bonus depreciation of 50% of eligible costs expired December 31, 2009. Although it is possible that bonus depreciation could be renewed for projects placed in service in 2010, as of this writing no such renewal had been enacted.

Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation deductions. The MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. A number of renewable energy technologies are classified as five-year property (26 USC § 168(e)(3)(B)(vi)) under the MACRS, which refers to 26 USC § 48(a)(3)(A), often known as the energy investment tax credit or ITC to define eligible property. Such property currently includes:

- a variety of solar electric and solar thermal technologies
- fuel cells and microturbines
- geothermal electric
- direct-use geothermal and geothermal heat pumps
- small wind (100 kW or less)
- combined heat and power (CHP).
- The provision which defines ITC technologies as eligible also adds the general term "wind" as an eligible technology, extending the five-year schedule to large wind facilities as well.

In addition, for certain other biomass property, the MACRS property class life is seven years. Eligible biomass property generally includes assets used in the conversion of biomass to heat or to a solid, liquid or gaseous fuel, and to equipment and structures used to receive, handle, collect and process biomass in a waterwall, combustion system, or refuse-derived fuel system to create hot water, gas, steam and electricity.

The 5-year schedule for most types of solar, geothermal, and wind property has been in place since 1986. The federal *Energy Policy Act of 2005* (EPAct 2005) classified fuel cells, microturbines and solar hybrid lighting technologies as five-year property as well by adding them to § 48(a)(3)(A). This section was further expanded in October 2008 by the addition of geothermal heat pumps, combined heat and power, and small

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Residential Energy Conservation Subsidy Exclusion (Personal)

Incentive Type: Personal Exemption

Eligible Efficiency Technologies:

Eligible Renewable/Other Technologies: Solar Water Heat, Solar Space Heat, Photovoltaics

Applicable Sectors: Residential, Multi-Family Residential

Amount: 100% of subsidy

Authority 1: 26 USC § 136 (2005)

Website: http://www.irs.gov/publications/p525/index.html

Summary:

According to Section 136 of the IRS Code, energy conservation subsidies provided by public utilities, either directly or indirectly, are nontaxable: "Gross income shall not include the value of any subsidy provided (directly or indirectly) by a public utility to a customer for the purchase or installation of any energy conservation measure."

Energy conservation measure includes installations or modifications that are primarily designed to reduce consumption of electricity or natural gas, or improve the management of energy demand.

Dwelling unit includes a house, apartment, condominium, mobile home, boat, or similar property. If a building or structure contains both dwelling and other units, any subsidy must be properly allocated.

Given the definition of "energy conservation measure" there is strong evidence that utility rebates for residential solar thermal and solar electric projects may be nontaxable. However, the IRS has not ruled definitively on this issue. For taxpayers considering using this provision for renewable energy systems, consultation with a tax attorney is advised.

Other types of utility subsidies that may come in the form of credits or reduced rates may also be nontaxable:

"**Utility rebates.** If you are a customer of an electric utility company and you participate in the utility's energy conservation program, you may receive on your monthly electric bill either: a reduction in the purchase price of electricity furnished to you (rate reduction), or a nonrefundable credit against the purchase price of the electricity. The amount of the rate reduction or nonrefundable credit is not included in your income." (IRS Publication 525)

Contact:

Information Specialist - IRS
Internal Revenue Service
1111 Constitution Avenue, N.W.
Washington, DC 20224
Phone: (800) 829-1040
Web site: http://www.irs.gov

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Federal
Incentives/Policies for Renewable Energy

USDA - Rural Energy for America Program (REAP) Loan Guarantees

Last DSIRE Review: 05/27/2009

Incentive Type: Federal Loan Program
State: Federal
Eligible Efficiency Technologies: Yes; specific technologies not identified
Eligible Renewable/Other Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Direct-Use Geothermal, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines
Applicable Sectors: Commercial, Agricultural
Amount: Varies
Max. Limit: $25 million per loan guarantee
Web Site: http://www.rurdev.usda.gov/rbs/busp/bprogs.htm
Authority 1: 7 USC § 8106
Date Enacted: 5/13/2002
Date Effective: FY 2003

Summary:
NOTE: The U.S. Department of Agriculture's Rural Development has issued a Notice of Solicitation of Applications for the Rural Energy for America Program (REAP). The deadline to apply for grants and loan guarantees under this solicitation is July 31, 2009. Grants and loan guarantees will be awarded for investments in renewable energy systems, energy efficiency improvements and renewable energy feasibility studies.

The Food, Conservation, and Energy Act of 2008 (H.R. 2419), enacted by Congress in May 2008, converted the federal Renewable Energy Systems and Energy Efficiency Improvements Program,* into the Rural Energy for America Program (REAP). Similar to its predecessor, the REAP promotes energy efficiency and renewable energy for agricultural producers and rural small businesses through the use of (1) grants and loan guarantees for energy efficiency improvements and renewable energy systems, and (2) grants for energy audits and renewable energy development assistance. Congress has allocated funding for the new program in the following amounts: $55 million for FY 2009, $60 million for FY 2010, $70 million for FY 2011, and $70 million for FY 2012. REAP is administered by the U.S. Department of Agriculture (USDA).

Of the total REAP funding available, 96% is dedicated to grants and loan guarantees for energy efficiency improvements and renewable energy systems. These incentives are available to agricultural producers and rural small businesses to purchase renewable energy systems (including systems that may be used to produce and sell electricity), to make energy efficiency improvements, and to conduct relevant feasibility studies. Eligible renewable energy projects include wind, solar, biomass and geothermal; and hydrogen derived from biomass or water using wind, solar or geothermal energy sources. These grants are limited to 25% of a proposed project's cost, and a loan guarantee may not exceed $25 million. The combined amount of a grant and loan guarantee may not exceed 75% of the project's cost. In general, a minimum of 20% of the funds available for these incentives will be dedicated to grants of $20,000 or less. The USDA likely will announce the availability of funding for this component of REAP through a Notice of Funds Availability (NOFA).

The USDA will also make competitive grants to eligible entities to provide assistance to agricultural producers and rural small businesses "to become more energy efficient" and "to use renewable energy technologies and resources." These grants are generally available to state government entities, local governments, tribal governments, land-grant

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Federal
Incentives/Policies for Renewable Energy

Residential Renewable Energy Tax Credit

Last DSIRE Review: 02/19/2009

Incentive Type: Personal Tax Credit

State: Federal

Eligible Renewable/Other Technologies: Solar Water Heat, Photovoltaics, Wind, Fuel Cells, Geothermal Heat Pumps, Other Solar Electric Technologies

Applicable Sectors: Residential

Amount: 30%

Maximum Incentive: Solar-electric systems placed in service before 1/1/2009: $2,000
Solar-electric systems placed in service after 12/31/2008: no maximum
Solar water heaters placed in service before 1/1/2009: $2,000
Solar water heaters placed in service after 12/31/2008: no maximum
Wind turbines placed in service in 2008: $4,000
Wind turbines placed in service after 12/31/2008: no maximum
Geothermal heat pumps placed in service in 2008: $2,000
Geothermal heat pumps placed in service after 12/31/2008: no maximum
Fuel cells: $500 per 0.5 kW

Carryover Provisions: Excess credit may be carried forward to succeeding tax year

Eligible System Size: Fuel cells: 0.5 kW minimum

Equipment/Installation Requirements: Solar water heating property must be certified by SRCC or by comparable entity endorsed by the state in which the system is installed. At least half the energy used to heat the dwelling's water must be from solar. Geothermal heat pumps must meet federal Energy Star requirements. Fuel cells must have electricity-only generation efficiency greater than 30%.

Authority 1: 26 USC § 25D

Date Enacted: 8/8/2005 (subsequently amended)

Date Effective: 1/1/2006

Expiration Date: 12/31/2016

Authority 2: IRS Form 5695 & Instructions: Residential Energy Credits

Summary:
Note: The American Recovery and Reinvestment Act of 2009 does not allow taxpayers eligible for the residential renewable energy tax credit to receive a U.S. Treasury Department grant instead of taking this credit.

Established by the federal *Energy Policy Act of 2005*, the federal tax credit for residential energy property initially applied to solar-electric systems, solar water heating systems and fuel cells. *The Energy Improvement and Extension Act of 2008* (H.R. 1424) extended the tax credit to small wind-energy systems and geothermal heat pumps, effective January 1, 2008. Other key revisions included an eight-year extension of the credit to December 31, 2016, the ability to take the credit against the alternative minimum tax, and the removal of the $2,000 credit limit for solar-electric systems beginning in 2009. The credit was further enhanced in February 2009 by *The American Recovery and Reinvestment Act of 2009* (H.R. 1: Div. B, Sec. 1122, p. 46), which removed the maximum credit amount for all eligible technologies (except fuel cells) placed in service after 2008.

A taxpayer may claim a credit of 30% of qualified expenditures for a system that serves a dwelling unit located in the United States and used as a residence by the taxpayer. Expenditures with respect to the equipment are treated as made when the installation is completed. If the installation is on a new home, the "placed in service" date is the date of

residential solar electric and solar water heating property and a 30% tax credit (up to $500 per 0.5 kilowatt) for fuel cells. Initially scheduled to expire at the end of 2007, the tax credits were extended through December 31, 2008, by the *Tax Relief and Health Care Act of 2006*.

In October 2008, the *Energy Improvement and Extension Act of 2008* extended the tax credits once again (until December 31, 2016), and a new tax credit for small wind-energy systems and geothermal heat pump systems was created. In February 2009, *The American Recovery and Reinvestment Act of 2009* removed the maximum credit amount for all eligible technologies (except fuel cells) placed in service after 2008.

Contact:

Public Information - IRS
U.S. Internal Revenue Service
1111 Constitution Avenue, N.W.
Washington, DC 20224
Phone: (800) 829-1040
Web Site: http://www.irs.gov

DSIRE
Database of State Incentives for Renewables & Efficiency

Energy Efficiency and Renewable Energy
North Carolina Solar Center
IREC

10/9/09

Federal
Incentives/Policies for Renewable Energy

Renewable Energy Production Incentive (REPI)

Last DSIRE Review: 03/18/2009

Incentive Type: Production Incentive
State: Federal
Eligible Renewable/Other Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal
Applicable Sectors: Local Government, State Government, Tribal Government, Municipal Utility, Rural Electric Cooperative, Native Corporations
Amount: 2.1¢/kWh (subject to availability of annual appropriations in each federal fiscal year of operation)
Terms: 10 years
Web Site: http://apps1.eere.energy.gov/repi
Authority 1: 42 USC § 13317
Date Enacted: 10/24/1992 (subsequently amended)
Authority 2: 10 CFR 451

Summary:
Note: Contact the program administrator to find out the current funding status of this program.

Established by the federal *Energy Policy Act of 1992*, the federal Renewable Energy Production Incentive (REPI) provides incentive payments for electricity generated and sold by new qualifying renewable energy facilities. Qualifying systems are eligible for annual incentive payments of 1.5¢ per kilowatt-hour in 1993 dollars (indexed for inflation) for the first 10-year period of their operation, *subject to the availability of annual appropriations in each federal fiscal year of operation.* REPI was designed to complement the federal renewable energy production tax credit (PTC), which is available only to businesses that pay federal corporate taxes.

Qualifying systems must generate electricity using solar, wind, geothermal (with certain restrictions), biomass (excluding municipal solid waste), landfill gas, livestock methane, or ocean resources (including tidal, wave, current and thermal). The production payment applies only to the electricity sold to another entity. Eligible electric production facilities include not-for-profit electrical cooperatives, public utilities, state governments and political subdivisions thereof, commonwealths, territories and possessions of the United States, the District of Columbia, Indian tribal governments or political subdivisions thereof, and Native Corporations.

Payments may be made only for electricity generated from an eligible facility first used before October 1, 2016. Appropriations have been *authorized* for fiscal years 2006 through fiscal year 2026. If there are insufficient appropriations to make full payments for electricity production from all qualified systems for a federal fiscal year, 60% of the appropriated funds for the fiscal year will be assigned to facilities that use solar, wind, ocean, geothermal or closed-loop biomass technologies; and 40% of the appropriated funds for the fiscal year will be assigned to other eligible projects. Funds will be awarded on a pro rata basis, if necessary.

Contact:
Christine Carter
U.S. Department of Energy
1617 Cole Blvd.
Golden, CO 80401-3393

Q&A Technical Questions & Answers

Accounting for PV System Rebates

Until recently, I assumed that federal tax credits for PV systems were based on the net cost of the system after subtracting any utility rebates. But a newsletter I received indicates that the 30% investment tax credit is based on the total PV system cost, before subtracting the state incentive. Is this accurate?

This depends on whether your customer is a homeowner or a business. The distinction hinges on the terms *personal tax credit* and *investment tax credit.* The Database of State Incentives for Renewable Energy (DSIRE) makes this distinction, for example. On the DSIRE Web site (dsireusa.org), the "Residential Renewable Energy Tax Credit" is described as a personal tax credit, whereas the "Business Energy Investment Tax Credit" is identified as a corporate tax credit. Personal and corporate tax codes are quite different, specifically with regards to the way one accounts for utility rebates.

Homeowners. For most homeowners who purchase a grid-tied PV system, there are two principal financial incentives: a rebate and the federal tax credit. The rebate is usually available from the utility to which the system is connected. The federal tax credit takes the form of a personal tax credit (PTC) that is available to the homeowner.

When a rebate is available from the utility company, the rebate is treated as a purchase price reduction. This means that the value of the rebate is subtracted from the total purchase price, resulting in a net adjusted cost for the purposes of determining the value of the federal tax credit. So, for homeowners the value of the PTC is calculated as follows, where P is the purchase price and R is the rebate amount:

$$PTC = (P - R) \times 30\%$$

Prior to January 1, 2009, the federal tax credit for homeowners was capped at $2,000. This made for pretty simple math, since this cap was reached on all but the smallest PV systems. For example, assuming a rebate of $3.50 per watt, a purchase price of $12,750 ($8.50/watt) and a 2008 placed-in-service date, the $2,000 cap for the Residential Renewable Energy Tax Credit is exceeded even on a 1.5 kW grid-direct PV system:

$$PTC = (\$12{,}750 - \$5{,}250) \times 30\%$$
$$PTC = \$7{,}500 \times 0.30$$
$$PTC = \$2{,}250 \geq \$2{,}000 \text{ cap}$$

With the passage of the Emergency Economic Stabilization Act of 2008, the $2,000 cap on the PTC for PV systems was lifted, and tax credits for solar were extended for 8 years. Residential grid-tied PV systems installed between January 1, 2009 and December 31, 2016 qualify for a full 30% tax credit. For a 5.6 kW PV system with a purchase price of $46,200 ($8.25/watt) and a 2009 placed-in-service date, an additional $5,980 PTC ($7,980 - $2,000) results compared to a 2008 placed-in-service date, under the same $3.50 per watt rebate:

$$PTC = (\$46{,}200 - \$19{,}600) \times 30\%$$
$$PTC = \$26{,}600 \times 0.30$$
$$PTC = \$7{,}980$$

Two items are worth noting before we look at how the federal tax credit is calculated for businesses. First, according to version 2.0 of the Solar Energy Industries Association (SEIA) *Guide to Federal Tax Incentives for Solar Energy,* "Most rebates from state governments or non-profit organizations do not reduce the basis for the federal credit." So make sure you know where your rebate comes from and its tax classification. Second, dwelling units with a home office serve a dual residential and commercial purpose. So while depreciation in general is unavailable to homeowners, those with an in-home business may be able to depreciate the portion of the PV system that qualifies according to the IRS as commercial property, usually on the basis of a square foot determination.

Businesses. In addition to rebates and federal tax credits, commercial customers who purchase grid-tied PV systems are also entitled to a third major financial incentive: depreciation. Depreciation is a mechanism for spreading out the cost of acquiring large capital items over time. Solar projects, even though they have a 25-year service life, qualify for 5-year accelerated depreciation. Furthermore, systems placed in service in 2008 and 2009 also qualify for bonus depreciation. These PV systems are still depreciated over 5 years, but they can take 50% the first year and 12.5% in each of the succeeding 4 years. Originally, the bonus depreciation of 50% in year one was available only for systems placed in service in 2008, and it expired on January 1, 2009. But the American Recovery and Reinvestment Act, signed into law by President Obama on February 17, 2009, reinstates bonus depreciation for PV projects completed in 2009.

Unlike the PTC, the commercial tax credit—usually referred to as the investment tax credit (ITC)—can be calculated in two different ways. The first process is the rebate-first method, which is the same as for homeowners. In this case, the business subtracts the rebate amount from the purchase price of the PV system and uses the net difference

Solar-Electric Systems SIMPLIFIED

Scott Russell

Perhaps what the home-scale renewable energy (RE) world needs most are ways to introduce people to RE technologies and the gizmos that make it possible. After all, even the best ideas aren't embraced until they are explained in simple terms.

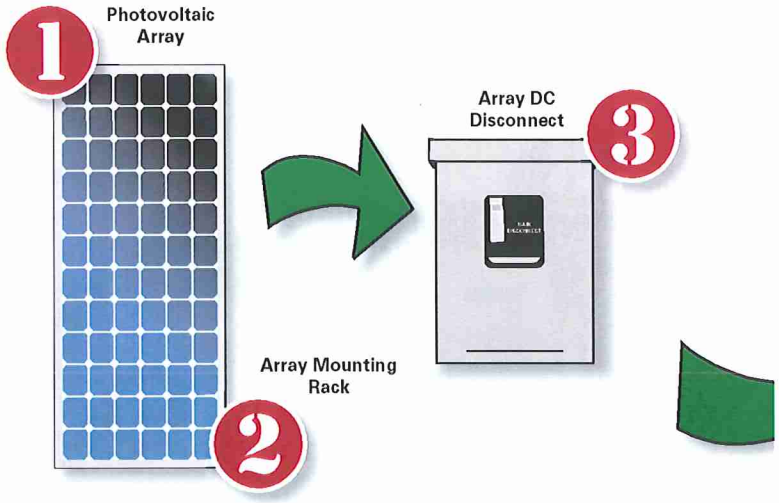
So whether *you* are the rookie who wants to understand how solar-electric systems work, or that better describes your spouse, friend, or prospective customer, this article explains the guts and bolts of the three most common options in solar-electric systems: grid-intertied, grid-intertied with battery backup, and off-grid (stand-alone).

Understanding the basic components of an RE system and how they function is not an overwhelming task. Here are some brief descriptions of the common equipment used in grid-intertied and off-grid solar-electric systems. Systems vary—not all equipment is necessary for every system type. In the diagrams, the numbers in red correspond to the components needed.

GRID-INTERTIED SOLAR-ELECTRIC SYSTEM

Also known as on-grid, grid-tied, or utility-interactive (UI), grid-intertied solar-electric systems generate solar electricity and route it to the electric utility grid, offsetting a home's or business's electrical consumption and, in some instances, even turning the electric meter backwards. Living with a grid-connected solar-electric system is no different than living with grid power, except that some or all of the electricity you use comes from the sun.

In many states, the utility credits a homeowner's account for excess solar electricity produced. This amount can then be applied to other months when the system produces less or in months when electrical consumption is greater. This arrangement is called net metering or net billing. The specific terms of net metering laws and regulations vary from state to state and utility to utility. Consult your local electricity provider or state regulatory agency for their guidelines.



3 Array DC Disconnect

AKA: PV disconnect

The DC disconnect is used to safely interrupt the flow of electricity from the PV array. It's an essential component when system maintenance or troubleshooting is required. The disconnect enclosure houses an electrical switch rated for use in DC circuits. It also may integrate either circuit breakers or fuses, if needed.

4 Charge Controller

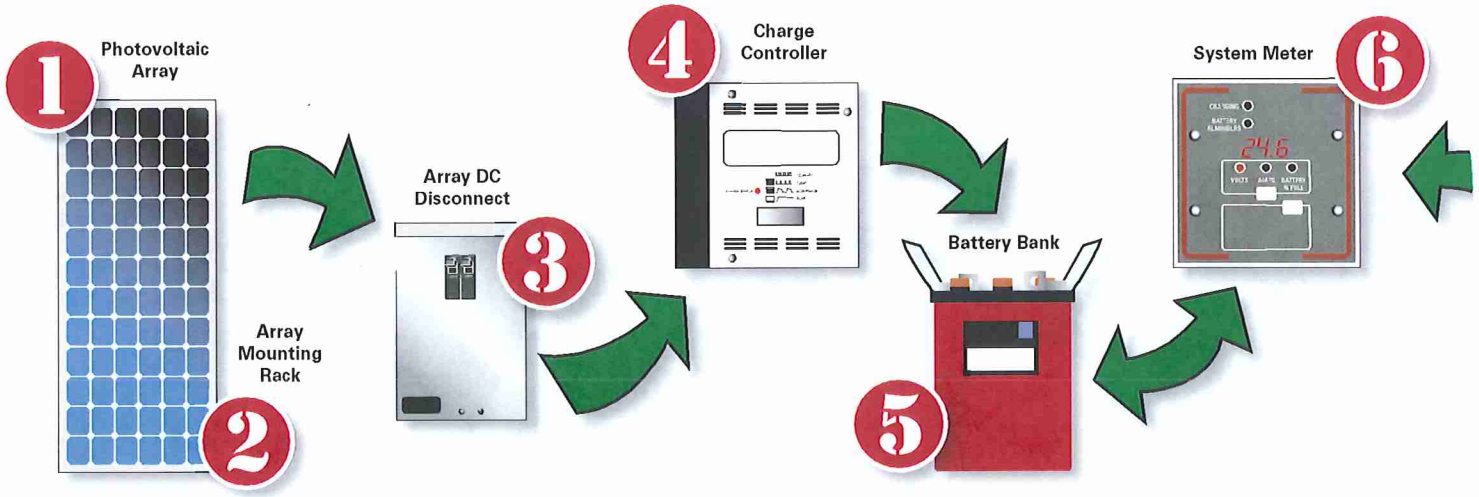
AKA: controller, regulator

A charge controller's primary function is to protect your battery bank from overcharging. It does this by monitoring the battery bank—when the bank is fully charged, the controller interrupts the flow of electricity from the PV panels. Batteries are expensive and pretty particular about how they like to be treated. To maximize their life span, you'll definitely want to avoid overcharging or undercharging them.

Most modern charge controllers incorporate maximum power point tracking (MPPT), which optimizes the PV array's output, increasing the energy it produces. Some battery-based charge controllers also include a low-voltage disconnect that prevents overdischarging, which can permanently damage the battery bank.

GRID-INTERTIED SOLAR-ELECTRIC SYSTEM WITH BATTERY BACKUP

Without a battery bank or generator backup for your grid-intertied system, when a blackout occurs, your household will be in the dark, too. To keep some or all of your electric needs (or "loads") like lights, a refrigerator, a well pump, or computer running even when utility power outages occur, many homeowners choose to install a grid-intertied system with battery backup. Incorporating batteries into the system requires more components, is more expensive, and lowers the system's overall efficiency. But for many homeowners who regularly experience utility outages or have critical electrical loads, having a backup energy source is priceless.



8 Inverter

Inverters transform the DC electricity produced by your PV modules into the alternating current (AC) electricity commonly used in most homes for powering lights, appliances, and other gadgets. Grid-tied inverters synchronize the electricity they produce with the grid's "utility-grade" AC electricity, allowing the system to feed solar-made electricity to the utility grid.

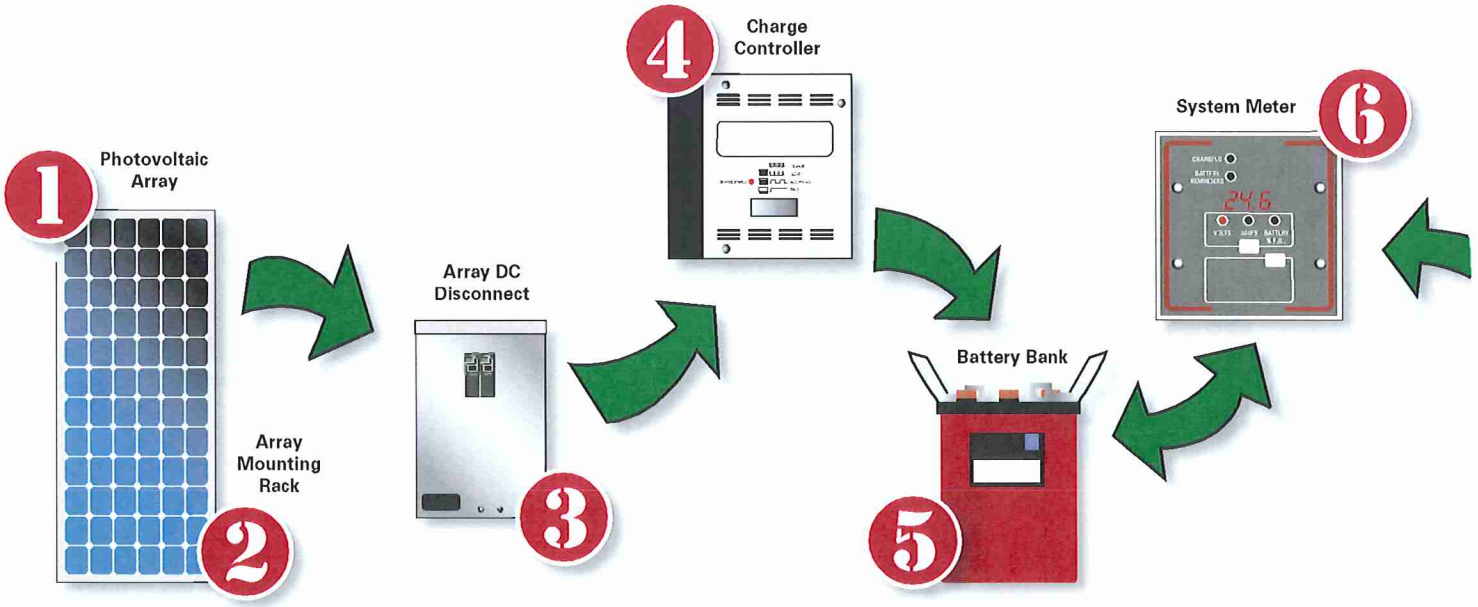
Most grid-tie inverters are designed to operate without batteries, but battery-based models also are available. Battery-based inverters for off-grid or grid-tie use often include a battery charger, which is capable of charging a battery bank from either the grid or a backup generator during cloudy weather.

Most grid-intertie inverters can be installed outdoors (ideally, in the shade). Most off-grid inverters are not weatherproof and should be mounted indoors, close to the battery bank.

OFF-GRID SOLAR-ELECTRIC SYSTEMS

Although they are most common in remote locations without utility grid service, off-grid solar-electric systems can work anywhere. These systems operate independently from the grid to provide all of a household's electricity. That means no electric bills and no blackouts—at least none caused by grid failures.

People choose to live off-grid for a variety of reasons, including the prohibitive cost of bringing utility lines to remote homesites, the appeal of an independent lifestyle, or the general reliability a solar-electric system provides. Those who choose to live off-grid often need to make adjustments to when and how they use electricity, so they can live within the limitations of the system's design. This doesn't necessarily imply doing without, but rather is a shift to a more conscientious use of electricity.



11 Backup Generator

AKA: gas guzzler

Off-grid solar-electric systems can be sized to provide electricity during cloudy periods when the sun doesn't shine. But sizing a system to cover a worst-case scenario, like several cloudy weeks during the winter, can result in a very large, expensive system that will rarely get used to its capacity. To spare your pocketbook, size the system moderately, but include a backup generator to get through those occasional sunless stretches.

Engine generators can be fueled with biodiesel, petroleum diesel, gasoline, or propane, depending on the design. These generators produce AC electricity that a battery charger (either stand-alone or incorporated into an inverter) converts to DC energy, which is stored in batteries. Like most internal combustion engines, generators tend to be loud and stinky, but a well-designed solar-electric system will require running them only 50 to 200 hours a year.

Solar-Electric Systems Demystified

As you can see, the anatomy of a photovoltaic system isn't that complicated. All of the parts have a purpose, and once you understand the individual tasks that each part performs, the whole thing makes a bit more sense. Now you're ready to look at the system articles and schematics in *Home Power* without your eyes glazing over, and you'll have a clearer understanding of what is going on in the articles.

To solidify your understanding, your next task should be to examine a solar-electric system in person. The National Tour of Solar Homes each fall is one way to see a variety of systems. Also, many renewable energy fairs and workshops feature tours of solar homes. Check the listings for your area in the *Happenings* calendar in each *Home Power* issue to find out where you can learn more about RE systems and meet the people who are using renewable energy in your area.

Access

Scott Russell • c/o *Home Power* magazine, PO Box 520, Ashland, OR 97520 • scott.russell@homepower.com

Creating A *Brighter* Future

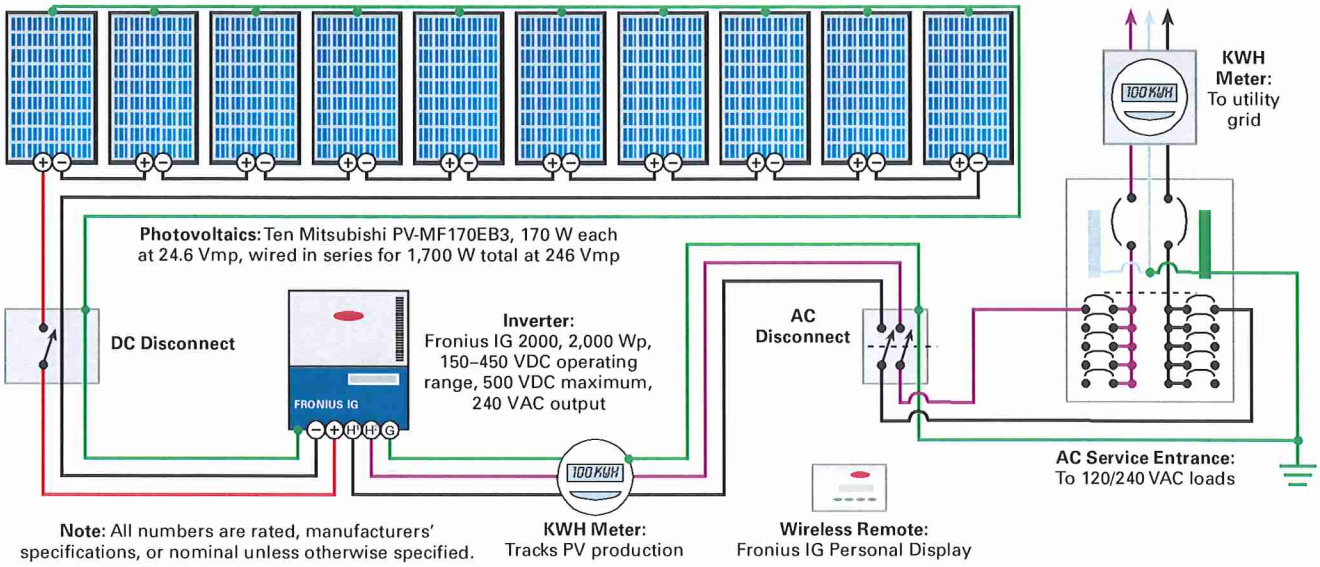
by Justine Sanchez

Courtesy Khanti Munro

Justine Sanchez, shown with daughter Ruby and husband Mike, invested in home energy efficiency upgrades and a solar-electric system for a cleaner energy present—and future.

For the past eight years, I have been teaching solar electricity workshops for Solar Energy International (SEI). It's always been important to me to practice what I teach, so I can help students from firsthand experience. The funny thing is that my life keeps changing, and every time it does, I am again faced with a new home upgrade to meet my sustainability goals.

Sanchez On-Grid PV System

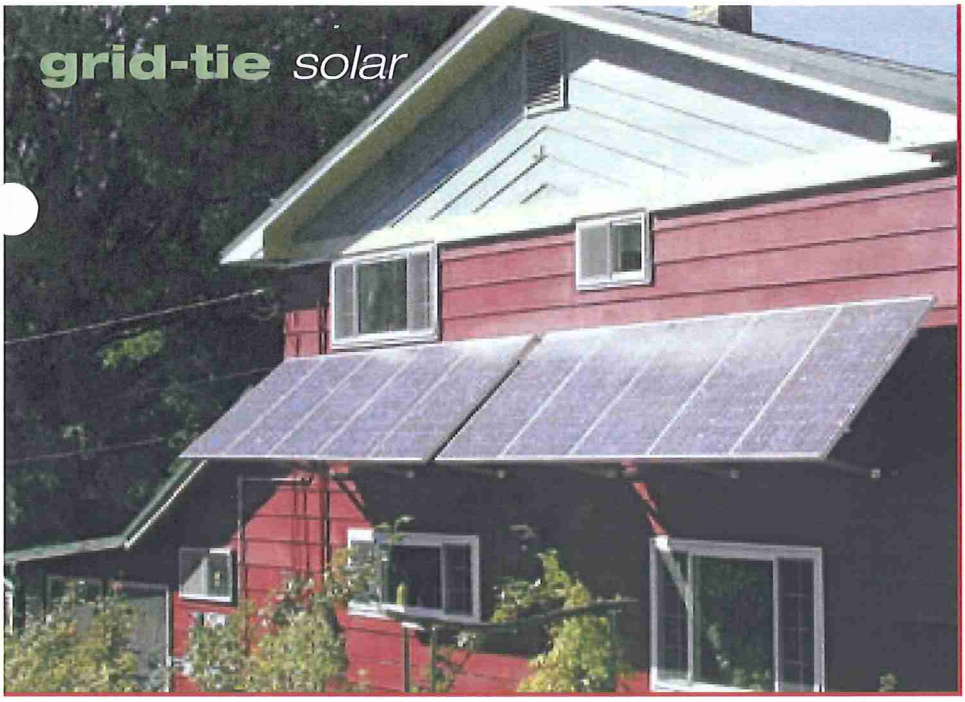


clean, renewable energy. Last year, Colorado voters passed Amendment 37, which requires investor-owned utilities (IOUs) servicing Colorado to obtain 3 percent of their electricity from renewable energy resources by 2007 and 10 percent by 2015. As a result of this legislation, Xcel Energy is offering a solar-electric rebate program to customers in their territory.

Though we are not serviced by Xcel Energy, for a limited time, they also offered to buy renewable energy credits (RECs) from PV systems in Colorado that are outside of their service territory and purchase the RECs with a one-time payment of $2.50 per DC watt of installed PV. The Xcel Energy REC purchase offer, combined with the $2,000 federal tax credit now available for solar-electric and solar hot water systems, gave us the financial incentives we needed to design, purchase, and install our PV system immediately (see PV System Costs table).

Our local utility, Delta Montrose Electric Association (DMEA), offers net metering for systems up to 25 KW. Ironically, while DMEA is one of the progressive utility cooperatives in Colorado, their $20 monthly minimum utility bill policy can undermine the financial benefits of residential-scale grid-tied PV systems. The result is that even if you offset *all* of your electricity consumption with a solar-electric system, you will still be charged $240 each year for electricity! While this policy significantly reduces (or may even negate) the financial payback of a grid-tied PV system in their service territory, and is in direct conflict with energy efficiency and green power strategies otherwise promoted by DMEA, we refused to be deterred from accomplishing our green power goals.

Running the DC wiring from the array to the disconnect.



Courtesy Mike Pendy

The dual-purpose solar-electric awning generates year-round electricity and, in the summertime, shades the first-floor windows.

An Eye on Electricity

Although electricity is an indispensable part of our everyday lives, most people know very little about how much electricity they use, where it comes from, or what the environmental consequences are. Part of the problem is that electricity is invisible—it just does its job in the background. But some grid-tie inverter manufacturers now offer convenient, wireless system performance displays that allow system owners to "see" the results of their investment in solar energy.

Once our system was installed, we were excited to try out the new wireless display available for Fronius inverters, especially since it was a piece of PV gear that I had not installed before. The Fronius IG Personal Display shows instantaneous data such as power, voltage, and current, and daily and cumulative energy (KWH) production values. You can also view CO_2 offset and the amount of money your PV system is saving.

The wireless display works great anywhere in our house or out in the yard (the manual says the range is 150 feet indoors or up to 450 feet outdoors). We tend to leave it on our kitchen counter so we can check our system's performance over a cup of coffee in the morning or before we sit down for dinner.

*Fronius Wireless Display Values**

Max. Watts Today: 1,461 W

KWH Today: 8 KWH

KWH Total: 642 KWH

CO_2 Offset: 1,251 lbs

$ Saved: $89

*Reading from 12/23/2006; system installation completed 8/31/2006

Have Modules, Add Sunshine

We decided to use Mitsubishi modules (sourced from Bob-O Schultze of Electron Connection) and a Fronius inverter. We also ordered a prefabricated Direct Power and Water (DP&W) mount that we could simply attach to the house. Jeff Randall from DP&W helped us adapt their standard mounting structure for our particular situation. The roof–ground mount is normally installed so that the adjustable legs sit underneath the top of the array. For wall-mounting, we flipped the mount so that the legs would be adjustable from the bottom of the array.

Our PV project coincided with one of SEI's PV Design and Installation workshops, and we were fortunate to have several of the students volunteer to help with the installation. Their skills and attention to detail were top notch. We spent two and a half days mounting and wiring all the system components—PV array, AC and DC disconnects, inverter, and an AC PV system production meter (required by our local utility)—along with mounting the junction box and wiring gutter, running and securing the conduit, pulling the wire, and, finally, completing all wiring connections.

On the last day of the installation, after double-checking our wiring and connections, it was finally time to bring the system online. Once the inverter was energized and producing electricity, we all rushed over to see the electrical meter merrily spinning in reverse! And as all of us were cheering, I was reminded that this was the first grid-tied PV installation these students had been involved with, and what a thrill it is to see solar energy hit the grid for the first time.

Another Day in the Sun

The system has worked flawlessly since its installation. When the sun is shining, the PV array produces more electricity than we typically use around the house. In this case, our electrical meter spins backwards and the utility gives us a "credit" for the surplus kilowatt-hours generated. When the PV array produces less electricity than we consume, we simply pull whatever amount of additional electricity is needed from the grid, dipping into our surplus credits.

The Fronius inverter and its wireless display have proven to be very user-friendly, and overall system production has been impressive. On bright, sunny days during the fall, our 1,700-watt array produced about 10 AC KWH each day. Around the winter solstice, the system produced about 8 AC KWH on sunny days. This past year we experienced an unusually cloudy late fall and early winter, so our total KWH production has been lower than expected. But considering that our PV modules will generate electricity for 30 years or more, there's a lot of sunshine—and solar electricity—coming our way!

(continued on page 32)

A Cleaner Future

It has been a fun and exciting project to blend our growing family needs with our "green power" goals. If your primary goal is environmental, it's best to pursue energy efficiency strategies first. Once a home's energy efficiency has been addressed, installing a PV system to meet the remaining electrical demand makes good sense, both financially and environmentally.

By investing in a PV system when we did, we were able to take advantage of solar incentive programs that reduced the up-front cost, while hedging ourselves against future electricity rate increases. But the primary factor that motivated us to invest in energy efficiency and PV technology wasn't money or cutting-edge PV gear; we did it to create a cleaner environment for our daughter Ruby and the generations that follow.

Access

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Electron Connection • 530-475-3401 • www.electronconnection.com • Equipment supplier

System Components:

Direct Power and Water Corp. • 800-260-3792 • www.directpower.com • PV rack

Fronius USA LLC • 805-683-2200 • www.fronius-usa.com • Inverter & display

Mitsubishi Electric Corp. • 714-229-3814 • www.mitsubishielectric.com/products/solar.html • PVs

Grid-Tie Solar Electric Systems

A New Path to Financial Security

SunWize

Reliable People ::: Reliable Products ::: Reliable Power!

Go Solar Today and Save Tomorrow!

With a SunWize® Grid-Tie System you'll reduce or eliminate your electricity bill, protect against future rate increases, and receive free electricity after your system pays for itself.

A SunWize Grid-Tie System is a wise, recession-proof investment. You'll earn a rate of return better and safer than many investments while helping the local economy. Now is the time to take advantage of the new 30% Federal tax credit as well as applicable state and local incentives to dramatically discount the cost of your system. A solar electric system also increases the value of your home, should you ever want to borrow against or sell it.

Going solar also has positive environmental and societal impacts in addition to its significant financial benefits. SunWize Grid-Tie Systems generate clean energy, reducing air pollution and the CO2 emissions that contribute to global climate change. They also lessen our dependence on fossil fuels and foreign oil while generating electricity from an abundant, renewable source: the sun. Going solar is just the right thing to do, on many levels.

The Tried-and-True Advantages of SunWize Grid-Tie Systems

SunWize Grid-Tie Systems are highly engineered, standard designs, continually improved over the years, while the typical solar electric system is pieced together from available components. Grid-Tie Systems utilize the highest grade components and are packaged under strict quality controlled procedures in our facility in the United States. Systems are designed for a lifetime of 40+ years and solar modules typically come with a 25-year manufacturer's warranty.

- *Clean, renewable energy from the sun*
- *Reliable, automatic operation*
- *Long life with virtually no maintenance*
- *Proven performance*

SunWize Grid-Tie Systems have a long track record of reliable, proven performance in the field. The same system that goes on your roof has been successfully installed and operating on hundreds of homes across America. There are over 300 system configurations available. They come in different sizes and with different components, depending on your requirements, and can be adapted for all roof types. Rest assured there's one that's just right for you.

Here's what some of our satisfied customers from around the country have to say about SunWize Dealers and the installation of their SunWize Grid-Tie System:

2.4 kW Grid-Tie System installed by Sun Lion Energy Systems on the Brackbill residence, New Holland, PA

"We wanted to create the ultimate retirement home that was easy to maintain and inexpensive to live in. Our SunWize dealer, Sun Lion Energy Systems, expertly installed our Grid-Tie System in just one day in an aesthetically pleasing manner. We saved 80% on our first electricity bill and get great satisfaction from watching our meter spin backwards. Moreover, solar fits nicely with our upbringing and values of self-reliance and practicality." – Don and Rolinda Brackbill

otography by Bruce B. Gage

2.4 kW Grid-Tie System installed by Eco Depot on the Portch residence, Spokane County, WA

"We were concerned about rising costs and were looking for a way to fix our expenses, particularly with retirement looming. With Washington State's tax and energy incentives, we not only cut our electricity costs every month, but our utility pays us for all the power we generate at roughly three times what we buy it for. At this rate, our system will pay for itself in about 11 ½ years. EcoDepot, our SunWize dealer, was very knowledgeable and did everything they said they would. It's been a great investment and experience in every way." – Rod and Debra Portch

5.0 kW Grid-Tie System installed by Solar-Fit on the Harper home in New Smyrna Beach, FL

"Our goal was to reduce our utility bills to set the stage for retirement. Our annual electricity bill was reduced by 65% and, with the state rebate and federal tax credit, the system paid for itself in three years. The system looks beautiful on our roof. Our SunWize dealer, Solar-Fit, was outstanding in every way and we're contemplating adding another 2.0 kW so the utility can send us a check each month, instead of the other way around." – Joe and Edda Harper

3.0 kW Grid-Tie System installed by Bombard Electric on the Holt home in Henderson, NV

"The main reason we went solar was to help the environment. The second was the significant rebate offered by Nevada Power, making the system affordable and, combined with all-day blazing sun, maximizes our production. The third was a hedge against future increases in energy costs. Bombard Electric, our SunWize dealer, is one of the most experienced installers in the Las Vegas area and did a great job on our clay tile roof. It worked out so well, that we're planning to expand the system." – Dave and Linda Holt

The SunWize Difference

Reliable People!

SunWize is widely recognized as the premier integrator and distributor of solar electric solutions for homeowners. We supply a nationwide network of experienced SunWize Dealers, who provide the sales and installation of Grid-Tie Systems. Twenty regional SunWize offices and a dedicated engineering staff, provide the pre and post-sales support that has long been the benchmark for the industry. We've been in the solar business since 1992, you can count on us.

Reliable Products!

We integrate only well proven, high quality components and technologies. SunWize Grid-Tie Systems are backed by our Dealer's installation warranty and manufacturer warranties. Our two distribution centers, one on each coast, provide same day shipping of Grid-Tie Systems to Dealers all across the country.

Reliable Power!

A SunWize Grid-Tie System operates quietly and seamlessly in the background of your home's electrical system. Day in and day out, it will steadfastly produce power while you go about your life. Think of it as a durable, dependable appliance that will tirelessly serve you for decades.

SunWize Technologies, Inc.
1155 Flatbush Road, Kingston, NY 12401
Tel: 800.817.6527 • Email: gts@sunwize.com • www.sunwize.com

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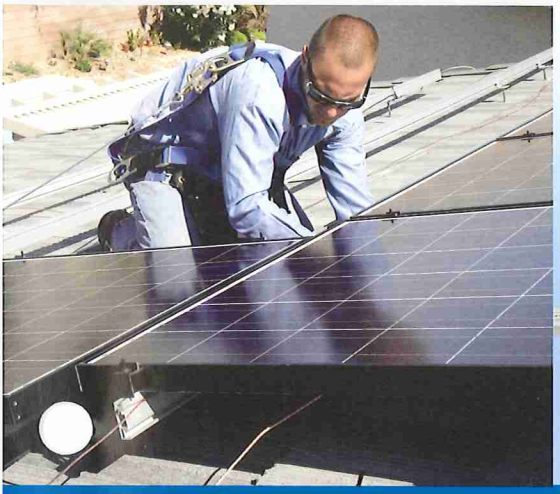
SunWize® Grid-Tie System Packages



Saving Solar Installers Time and Money

- Field-proven system reliability
- Single part number ordering
- Permit-ready documentation
- Next day shipment from stock
- Free delivery to your shop or job site
- Increased installation efficiency

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SunWize® Grid-Tie Systems

Complete, Engineered, Packaged Photovoltaic Systems

Finding ways to reduce cost and streamline operations is imperative in today's increasingly competitive world of residential solar installation. Traditionally, residential solar electric systems involve design, documentation, sourcing of individual components, off-site receiving and staging, and one-of-a-kind on site installation. This method is complex, prone to error, and time consuming. SunWize Grid-Tie System packages are a superior approach, saving photovoltaic (PV) installers substantial time and money. Here's how:

Complete, Packaged Kits: Delivered to your shop or the job site using a single part number

Everything needed is included. Time and effort is saved by not having to generate a bill of materials and order multiple items. A single part number gets the whole system shipped right to your shop or the customer's driveway with no staging or double handling. Moreover, it eliminates the possibility of errors in ordering or in loading the truck. The job never comes to a halt because something is missing.

Engineered Systems: Proven reliability and permit-ready

SunWize Grid-Tie Systems are fully engineered and documented systems. They are proven, standard systems that free installers from having to design and engineer a system, and generate drawings. Installers have everything they need to obtain a permit and facilitate an inspection. The resources usually expended in design, engineering and documentation can go right to the bottom line or be redirected to revenue generating activities.

Standard Systems: Increased installation efficiency

Grid-Tie Systems stay the same. Crews that continually work with Grid-Tie Systems quickly move through the learning curve and become very skilled, reducing installation time.

No Hidden Costs: Free delivery and no surcharges

Delivery is included and there are no handling or other charges.

Module and Balance of System Availability: No waiting

Many manufacturers are back-ordered and cannot ship until months after ARO (after receipt of order). SunWize Grid-Tie Systems are in-stock and ship 1-2 days ARO. Having modules and balance of system components immediately available improves cash flow and increases customer satisfaction. The revenue from booked business is realized quicker. More importantly, the customer does not have to wait to start receiving the benefit of their PV system.

Broad Range of Systems: Choose from Over 300 configurations

Dealers can select a given system size using a wide variety of module and inverter options. There is a configuration for virtually every residential customer situation.

SunWize Grid-Tie System Packages

SunWize Grid-Tie Systems contain high quality, UL listed components. Every component needed for a successful installation is included in the package. In addition to modules and inverters, each package includes UniRac® SolarMount® flush PV racks, and necessary hardware and electrical components. The installer supplies the wiring from the solar array to the main panel and roofing anchors. Packages also include complete documentation, an installation guide and operation/owner's manual.

Multiple systems can be installed for higher power output and systems may also be expanded in the future as budget or electrical requirements grow. Grid-Tie System packages can be installed on any type of composition or tile roof. The array is securely attached to the roof of the building with the mounts in compliance with US building codes.

Some SunWize Grid-Tie Systems are certified by the Florida Solar Energy Center (FSEC) for high quality, reliable and safe operation compliant to the NEC. The FSEC certificate is useful for permitting and the field inspections of installed systems.

SunWize Grid-Tie System packages allow you to choose from a multiple selection of solar modules matched with a variety of grid-tie inverters. Your pre-engineered SunWize Grid-Tie System will include:

1. Solar Modules - choose one of the following:
• Sanyo190W or 200W • Sharp 176W, 198W or 224W • Kaneka 60W. Solar modules are supplied equipped with "MC" type interconnects.

2. UniRac® SolarMount® code-compliant, flush PV mounting structure of clear anodized aluminum including rail set with L–feet and attachments for tile roofs, top-clamps and splice kits. Adjustable tilt leg sets for mounting to horizontal surfaces are sold separately. Systems using the Sharp 176W and 198W modules are installed with the Sharp OnEnergy mounting system.

3. Outdoor-rated Grid-Tie Inverter with LCD digital output display- choose one of the following:
• Xantrex GT series with integrated AC/DC disconnect switch • SMA-Sunny Boy series with integrated AC/DC disconnect switch and 4 PV string fused combiner • Fronius IG series with a pre-wired SunWize Power Center consisting of an aluminum back panel, NEMA 3R, AC and DC disconnect switches. The Power Center is designed to facilitate easy on-site installation of the inverter. Also available is an optional digital kWh meter with socket box (Part # 400010). Inverters come with standard 10-year warranties. Fronius offers the option to extend the warranty to 15-years.

For three-phase installations, SMA inverters are field configurable for AC output voltage, (see selection table). More Grid-Tie Systems for 208Vac versions are available with Fronius IG or Xantrex GT inverters. See SunWize web site for details.

4. Wiring – Includes #10 AWG MC interconnect extension sub-array cords, wire management system with cable ties and wire clips, PV copper grounding lug system, PV fused combiner (if needed) and array wiring pull boxes. The home-run wiring from the solar array to the main panel is supplied by the installer.

6. Documentation – Includes electrical drawings, data sheets, warranties, installation instructions and owner's manual.

The following selection guide is a partial listing of Grid-Tie System packages. It contains the highest power module of different manufacturers used in a variety of configurations in combination with a variety of inverters. Please refer to the current SunWize dealer price list for a complete listing of all available SunWize Grid-Tie Systems.

Sample of SunWize Grid-Tie System Configurations

GTS Model Part #	PV Module Model	PV # Series x Parallel	Array Power (STC Watts)	Array Power (CEC Watts)	Inverter Model	Inverter Power (kW)	Output Vac
999GTS501	Sanyo HIP-190BA3	7 x 3	3990	3752.7	SMA SB4000US	4.0	240/208
999GTS503	Sanyo HIP-190BA3	7 x 3	3990	3752.7	Xantrex GT4.0	4.0	240
999GTS504	Sanyo HIP-190BA3	6 x 4	4650	4288.8	Xantrex GT5.0	5.0	240
999GTS505	Sanyo HIP-190BA3	7 x 4	5320	5003.6	Xantrex GT5.0	5.0	240
999GTS517	Sanyo HIP-190BA3	5 x 3	2850	2680.5	SMA SB3000US	3.0	240/208
999GTS522	Sanyo HIP-190BA3	5 x 2	1900	1787.0	Fronius IG2000	2.0	240
999GTS542	Sanyo HIP-190BA3	4 x 4	3040	2859.2	Fronius IG3000	2.7	240
999GTS545	Sanyo HIP-190BA3	6 x 4	4560	4288.8	Fronius IG4000	4.0	240
999GTS584	Sanyo HIP-190BA3	5 x 3	2850	2680.5	Xantrex GT2.8	2.8	240
999GTS591	Sanyo HIP-190BA3	6 x 2	2280	2144.4	Xantrex GT2.8	2.8	240
999GTS592	Sanyo HIP-190BA3	5 x 2	1900	1787.0	Xantrex GT2.8	2.8	240
999GTS596	Sanyo HIP-190BA3	6 X 3	3420	3216.6	Xantrex GT3.3	3.3	240
999GTS602	Sanyo HIP-190BA3	6 x 6	6840	6433.2	SMA SB7000US	7.0	240/208/277
999GTS603	Sanyo HIP-190BA3	7 x 4	5320	5003.6	SMA SB5000US	5.0	240/208/277
999GTS604	Sanyo HIP-190BA3	7 x 5	6650	6254.5	SMA SB6000US	6.0	240/208/277

Add Z – for packages without mounting structure. Contact SunWize sales rep for roof mounting accessories.
NOTE: GTS packages are designed for best operation in regions with average ambient temperatures from 5°F to 104°F. SunWize Grid-Tie Systems systems must be installed by a qualified electrical or solar contractor.

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Sample of SunWize® Grid-Tie System Configurations

GTS Model Part #	PV Module Model	PV # Series x Parallel	Array Power (STC Watts)	Array Power (CEC Watts)	Inverter Model	Inverter Power (kW)	Output Vac
999GTS623	Sanyo HIP-190BA3	6 x 5	5700	5361.0	Fronius IG5100	5.0	240
999GTS637	Sanyo HIP-200BA3	5 x 2	2000	1887.0	Fronius IG2000	2.0	240
999GTS642	Sanyo HIP-200BA3	5 x 3	3000	2830.5	Fronius IG3000	2.7	240
999GTS645	Sanyo HIP-200BA3	5 x 4	4000	3774.0	Fronius IG4000	4.0	240
999GTS651	Sanyo HIP-200BA3	4 x 7	5600	5283.6	Fronius IG5100	5.0	240
999GTS652	Sanyo HIP-200BA3	7 x 1	1400	1320.9	Xantrex GT2.8	2.8	240
999GTS654	Sanyo HIP-200BA3	6 x 2	2400	2264.4	Xantrex GT2.8	2.8	240
999GTS656	Sanyo HIP-200BA3	5 x 3	3000	2830.5	Xantrex GT2.8	2.8	240
999GTS657	Sanyo HIP-200BA3	6 x 3	3600	3396.6	Xantrex GT3.3	3.3	240
999GTS659	Sanyo HIP-200BA3	7 x 3	4200	3962.7	Xantrex GT4.0	4.0	240
999GTS664	Sanyo HIP-200BA3	5 x 3	3000	2830.5	SMA SB3000US	3.0	240/208
999GTS667	Sanyo HIP-200BA3	7 x 3	4200	3962.7	SMA SB4000US	4.0	240/208
999GTS668	Sanyo HIP-200BA3	6 x 4	4800	4528.8	SMA SB5000US	5.0	240/208/277
999GTS670	Sanyo HIP-200BA3	6 x 5	6000	5661.0	SMA SB6000US	6.0	240/208/277
999GTS672	Sanyo HIP-200BA3	6 x 6	7200	6793.2	SMA SB7000US	7.0	240/208/277
999GTS673	Sanyo HIP-200BA3	7 x 4	5600	5283.6	Xantrex GT5.0	5.0	240
999GTS674	Sanyo HIP-200BA3	6 x 4	4800	4528.8	Xantrex GT5.0	5.0	240
999GTS205	Kaneka G-SA060	10 x 3	1800	1680.0	Fronius IG2000	2.0	240
999GTS206	Kaneka G-SA060	12 x 4	2880	2688.0	Fronius IG3000	2.7	240
999GTS312	Sharp NT-175U1	9 x 2	3150	2779.2	SMA SB3000US	3.0	240/208
999GTS314	Sharp NT-175U1	11 x 2	3850	3396.8	SMA SB4000US	4.0	240/208
999GTS317	Sharp NT-175U1	11 x 3	5775	5095.2	SMA SB5000US	5.0	240/208/277
999GTS319	Sharp NT-175U1	10 x 4	7000	6176.0	SMA SB6000US	6.0	240/208/277
999GTS323	Sharp NT-175U1	6 x 2	2100	1852.8	Fronius IG2000	2.0	240
999GTS325	Sharp NT-175U1	9 x 5	7875	6948.0	SMA SB7000US	7.0	240/208/277
999GTS326	Sharp NT-175U1	9 x 3	4725	4168.8	Xantrex GT4.0	4.0	240
999GTS327	Sharp NT-175U1	10 x 3	5220	4632.0	Xantrex GT5.0	5.0	240
999GTS332	Sharp NT-175U1	11 x 3	5775	5095.2	Xantrex GT5.0	5.0	240
999GTS342	Sharp NT-175U1	9 x 2	3150	2779.2	Fronius IG3000	2.7	240
999GTS366	Sharp NT-175U1	9 x 3	4725	4168.8	Fronius IG4000	4.0	240
999GTS380	Sharp NT-175U1	7 x 2	2450	2161.6	Xantrex GT2.8	2.8	240
999GTS382	Sharp NT-175U1	9 x 2	3150	2779.2	Xantrex GT2.8	2.8	240
999GTS384	Sharp NT-175U1	7 x 3	3675	3242.4	Xantrex GT3.3	3.3	240
999GTS387	Sharp NT-175U1	9 x 1	1575	1389.6	Xantrex GT2.8	2.8	240
999GTS389	Sharp NT-175U1	11 x 1	1925	1698.4	Xantrex GT2.8	2.8	240
999GTS391	Sharp NT-175U1	11 x 2	3850	3396.8	Xantrex GT4.0	4.0	240
999GTS392	Sharp NT-175U1	8 x 3	4200	3705.6	Xantrex GT4.0	4.0	240
999GTS397	Sharp NT-175U1	8 x 4	5600	4940.8	Fronius IG5100	5.0	240

Add Z – for packages without mounting structure. Contact SunWize sales rep for roof mounting accessories.
NOTE: GTS packages are designed for best operation in regions with average ambient temperatures from 5°F to 104°F. SunWize Grid-Tie Systems systems must be installed by a qualified electrical or solar contractor.

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Solar Basics

PV power generation systems are made up of interconnected components, each with a specific function. One of the major strengths of PV systems is modularity. As your needs grow, individual components can be replaced or added to provide increased capacity. Following is a brief overview of a typical PV system.

Solar Array – The solar array consists of one or more PV modules which convert sunlight into electric energy. The modules are connected in series and/or parallel to provide the voltage and current levels to meet your needs. The array is usually mounted on a metal structure and tilted to face the sun.

Charge Controller – Although charge controllers can be purchased with many optional features, their main function is to maintain the batteries at the proper charge level, and to protect them from overcharging.

Battery Bank – The battery bank contains one or more deep-cycle batteries, connected in series and/or parallel depending on the voltage and current capacity needed. The batteries store the power produced by the solar array and discharge it when required.

Inverter – An inverter is required when you want to power AC devices. The inverter converts the DC power from the solar array/batteries into AC power.

AC and DC Loads – These are the appliances (such as lights or radios), and the components (such as water pumps and microwave repeaters), which consume the power generated by your PV array.

Balance of System – These components provide the interconnections and standard safety features required for any electrical power system. These include: array combiner box, properly sized cabling, fuses, switches, circuit breakers and meters.

Five Steps to Sizing a PV System

We have provided you with an easy-to-follow, step-by-step guide for sizing your photovoltaic (PV) system. Follow these five steps to determine your requirements and specify the components you will need.

1. Determine Your Power Consumption Demands

Make a list of the appliances and/or loads you are going to run from your PV system. Find out how much power each item consumes while operating. Most appliances have a label on the back which lists the wattage. Specification sheets, local appliance dealers, and the product manufacturers are other sources of information. We have provided a chart that lists typical power consumption demands of common devices which you can use as a guide. Once you have the wattage ratings, fill out the load sizing worksheet.

Load-Sizing Worksheet

List all of the electrical appliances to be powered by your PV system. Separate AC and DC devices and enter them in the appropriate table. Record the operating wattage of each item. Most appliances have a label on the back that lists the wattage. Local appliance dealers and the product manufacturers are other sources of this information. Specify the number of hours per day each item will be used. Multiply the first three columns to determine the watt-hour usage per day. Enter the number of days per week you will be using each item to determine the total watt-hours per week each appliance will require.

	DC Appliance	Watts	X	Qty	X	Hrs/Day	=	Wh/Day	X	Days/Wk	=	Wh/Wk
A.												
B.												
C.												
D.												
E.												

Total the numbers in the last column. This is your DC power requirement. Total _____

Multiply the total by 1.2 to compensate for system losses during battery charge/discharge cycle. DC WH/WK _____

... Power Consumption *continued*

Load Sizing Worksheet

	AC Appliance	Watts	X	Qty	X	Hrs/Day	=	Wh/Day	X	Days/Wk	=	Wh/Wk
A.												
B.												
C.												
D.												
E.												

Total the numbers in the last column. This is your AC power requirement. Total _____

Multiply the total by 1.2 to compensate for system losses during battery charge/discharge cycle. AC WH/WK _____

1. Add AC WH/WK and DC WH/WK together. This is your total power requirement per week. Total _____

2. Enter the voltage of your battery bank (usually 12 or 24 volts) VOLTS _____

3. Divide line 1 by line 2. This is your amp-hour requirement per week. AH/WK _____

4. Divide line 3 by 7 days. This is your average amp-hour requirement per day that will be used to size your battery bank and your PV module array. AH/DAY _____

2. Optimize Your Power System Demands

At this point, it is important to examine your power consumption and reduce your power needs as much as possible. (This is true for any system, but it is especially important for home and cabin systems, because the cost savings can be substantial.) First identify large and/or variable loads (such as water pumps, outdoor lights, electric ranges, AC refrigerators, clothes washers, etc.) and try to eliminate them or examine alternatives such as propane or DC models. The initial cost of DC appliances tends to be higher than AC, but you avoid losing energy in the DC to AC conversion process, and typically DC appliances are more efficient and last longer. Replace incandescent fixtures with fluorescent lights wherever possible. Fluorescent lamps provide the same level of illumination at lower wattage levels. If there is a large load that you cannot eliminate, consider using it only during peak sun hours or only during the summer. (In other words, be creative!) Revise your Load Sizing Worksheet now with your optimized results.

3. Size Your Battery Bank

Read "Characteristics of Batteries" and then choose the appropriate battery for your needs.
Fill out the Battery Sizing Worksheet.

Characteristics of Batteries

Sizing Your Battery Bank

The first decision you need to make is how much storage you would like your battery bank to provide. Often this is expressed as "days of autonomy," because it is based on the number of days you expect your system to provide power without receiving an input charge from the solar array. In addition to the days of autonomy, you should also consider your usage pattern and the criticality of your application. If you are installing a system for a weekend home, you might want to consider a larger battery bank, because your system will have all week to charge and store energy. Alternatively, if you are adding a PV array as a supplement to a generator-based system, your battery bank can be slightly undersized since the generator can be operated if needed for recharging.

Temperature Effects

Batteries are sensitive to temperature extremes, and you cannot take as much energy out of a cold battery as a warm one. Use the chart on the Battery-Sizing Worksheet to correct for temperature effects. Although you can get more than rated capacity from a hot battery, operation at hot temperatures will shorten battery life.

Battery Bank *continued*

Temperature Effects *continued*
Try to keep your batteries near room temperature. Charge controllers can be purchased with a temperature compensation option to optimize the charging cycle at various temperatures and lengthen your battery life.

Depth of Discharge
Depth of Discharge is the percentage of the rated battery capacity that is withdrawn from the battery. The capability of a battery to withstand discharge depends on its construction. Two terms, shallow-cycle and deep-cycle, are commonly used to describe batteries. Shallow-cycle batteries are lighter, less expensive and have a short lifetime. For this reason, we do not sell shallow-cycle batteries. Deep-cycle batteries should always be used for stand-alone PV systems. These units have thicker plates and most will withstand daily discharges up to 80% of their rated capacity. Most deep-cycle batteries are flooded electrolyte which means the plates are covered with the electrolyte and the level of fluid must be monitored and distilled water added periodically to keep the plates fully covered. We also offer sealed, lead-acid batteries that do not require liquid refills. There are other types of deep-cycle batteries such as nickel cadmium used in special applications. The maximum depth of discharge value used for sizing should be the worst case discharge that the battery will experience. The system control should be set to prevent discharge below this level.

Rated Battery Capacity
The ampere-hour capacity of a battery is usually specified together with some standard hour reference such as ten or twenty hours. For example, suppose the battery is rated at 100 ampere-hours and a 20-hour reference is specified. This means the battery is fully charged and will deliver a current of 5 amperes for 20 hours. If the discharge current is lower, for example 4.5 amperes, then the capacity will go to 110 ampere-hours. The relationship between the capacity of a battery and the load current can be found in the manufacturer's literature.

Battery Life
The lifetime of any battery is difficult to predict, because it is dependent on a number of factors such as charge and discharge rate, depth of discharge, number of cycles and operating temperature extremes. It would be unusual for a lead-acid battery to last longer than fifteen years in a PV system but many last for five to eight years.

Maintenance
Batteries require periodic maintenance. Even the sealed battery should be checked to make sure connections are tight and there is no indication of overcharging. For flooded batteries, the electrolyte level should be maintained well above the plates and the voltage and specific gravity of the cells should be checked for consistent values. Wide variations between readings may indicate cell problems. The specific gravity of the cells should be checked with a hydrometer particularly before the onset of winter. In cold environments, the electrolyte in lead-acid batteries may freeze. The freezing temperature is a function of a battery state of charge. When a battery is completely discharged, the electrolyte becomes water and the battery may freeze.

Battery Sizing Worksheet

1. Enter your daily amp-hour requirement. (From the Load Sizing Worksheet, line 4) AH/Day _____

2. Enter the maximum number of consecutive cloudy weather days expected in your area, or the number of days of autonomy you would like your system to support. _____

3. Multiply the amp-hour requirement by the number of days. This is the amount of amp-hours your system will need to store. AH _____

4. Enter the depth of discharge for the battery you have chosen. This provides a safety factor so that you can avoid over-draining your battery bank.
(Example: If the discharge limit is 20%, use 0.2.) This number should not exceed 0.8. _____

5. Divide line 3 by line 4. AH _____

▪▪▪ Battery Bank *continued*

Battery-Sizing Worksheet

6. Select the multiplier below that corresponds to the average wintertime ambient temperature your battery bank will experience. _____

Ambient Temperature		Multiplier
80°F	26.7°C	1.00
70°F	21.2°C	1.04
60°F	15.6°C	1.11
50°F	10.0°C	1.19
40°F	4.4°C	1.30
30°F	-1.1°C	1.40
20°F	-6.7°C	1.59

7. Multiply line 5 by line 6. This calculation ensures that your battery bank will have enough capacity to overcome cold weather effects. This number represents the total battery capacity you will need. AH _____

8. Enter the amp-hour rating for the battery you have chosen. _____

9. Divide the total battery capacity by the battery amp-hour rating and round off to the next highest number. This is the number of batteries wired in parallel required. _____

10. Divide the nominal system voltage (12V, 24V or 48V) by the battery voltage and round off to the next highest number. This is the number of batteries wired in series. _____

11. Multiply line 9 by line 10. This is the total number of batteries required. _____

4. Determine The Sun Hours Available Per Day

Several factors influence how much sun power your modules will be exposed to:

- When you will be using your system – summer, winter, or year-round.
- Typical local weather conditions.
- Fixed mountings vs. trackers.
- Location and angle of PV array.

We have provided the following charts which show ratings that reflect the number of hours of full sunlight available to generate electricity. Your solar array's power generation capacity is dependent on the angle of the rays as they hit the modules. Peak power occurs when the rays are at right angles or perpendicular to the modules. As the rays deviate from perpendicular, more and more of the energy is reflected rather than absorbed by the modules. Depending on your application, sun tracking mounts can be used to enhance your power output by automatically positioning your array.

The charts reflect the difference in sunlight during spring, summer, autumn and winter. It is more difficult to produce energy during the winter because of shorter days, increased cloudiness and the sun's lower position in the sky. The charts list the sun hour ratings for several cities in North America for summer, winter and year round average. If you use your system primarily in the summer, use the summer value; if you are using your system year-round, especially for a critical application, use the winter value. If you are using the system most of the year (spring, summer and fall) or the application is not critical, use the average value. With the chart and the map, you should be able to determine a reasonable estimate of the sun's availability in your area.

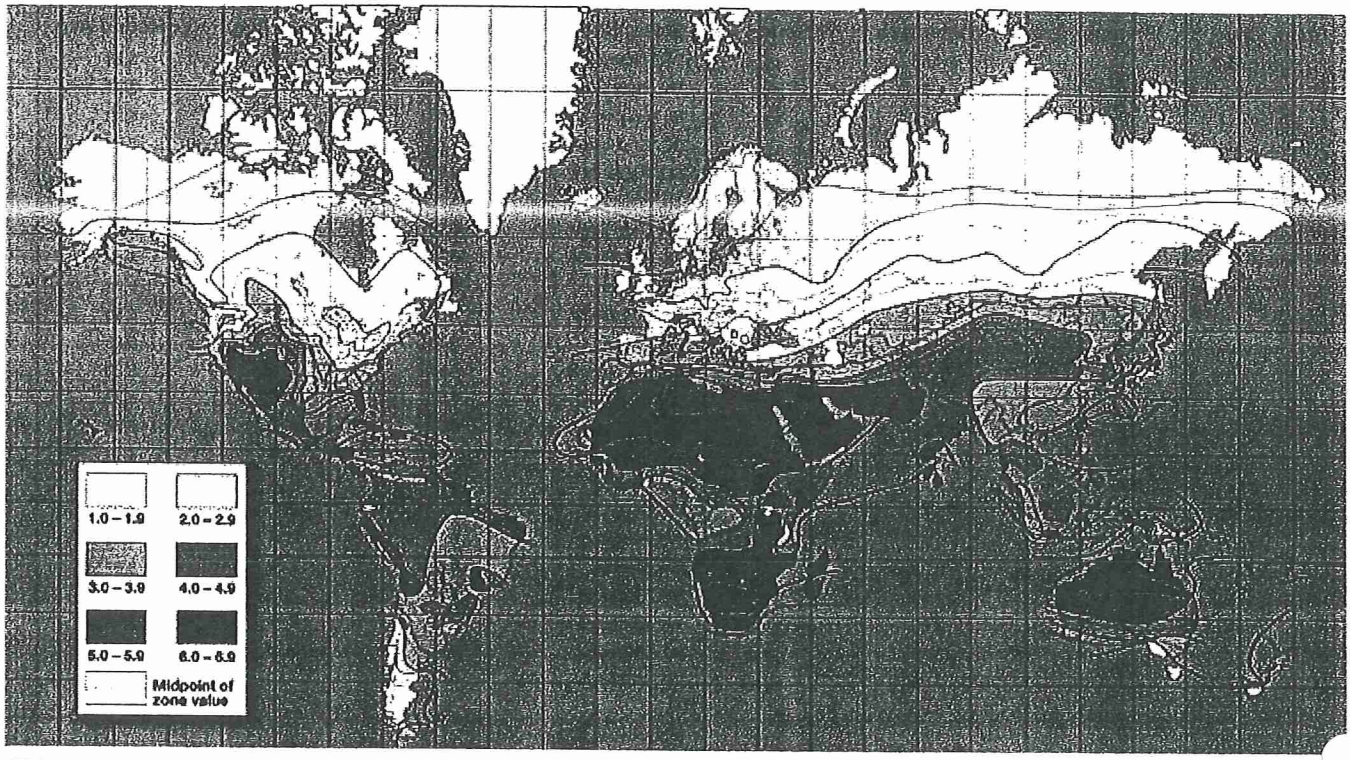
SUN HOURS PER DAY - NATIONAL

State, City	Summer Avg.	Winter Avg.	Yr. Round Avg	State, City	Summer Avg.	Winter Avg.	Yr. Round Avg
AL, Montgomery	4.69	3.37	4.23	CA, La Jolla	5.24	4.29	4.77
AK, Bethel	6.29	2.37	3.81	CA, Los Angeles	6.14	5.03	5.62
AK, Fairbanks	5.87	2.12	3.99	CA, Riverside	6.35	5.35	5.87
AK, Mantanuska	5.24	1.74	3.55	CA, Santa maria	6.52	5.42	5.94
AZ, Page	7.30	5.65	6.36	CA, Soda Springs	6.47	4.40	5.60
AZ, Phoenix	7.13	5.78	6.58	CO, Boulder	5.72	4.44	4.87
AZ, Tucson	7.42	6.01	6.57	CO, Granby	7.47	5.15	5.69
AR, Little Rock	5.29	3.88	4.69	CO, Grand Junction	6.34	5.23	5.86
CA, Davis	6.09	3.31	5.10	CO, Grand Lake	5.86	3.56	5.08
CA, Fresno	6.19	3.42	5.38	D.C. Washington	4.69	3.37	4.23
CA, Inyokern	8.70	6.97	7.66	FL, Apalachicola	5.98	4.92	5.49

Sun Hours Per Day - National *continued*

State, City	Summer Avg.	Winter Avg.	Yr Round Avg.
FL, Belle Island	5.31	4.58	4.99
FL, Gainsville	5.81	4.71	5.27
FL, Miami	6.26	5.05	5.62
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, Twin Falls	5.42	3.41	4.70
ID, Boise	5.83	3.33	4.92
IL, Chicago	4.08	1.47	3.14
IN, Indianapolis	5.02	2.55	4.21
KS, Dodge City	4.14	5.28	5.79
KS, Manhattan	5.08	3.62	4.57
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, Blue Hill	4.38	3.33	4.05
MA, Boston	4.27	2.99	3.84
MA, E. Wareham	4.48	3.06	3.99
MA, Lynn	4.60	2.33	3.79
MA, Natick	4.62	3.09	4.10
MD, Silver Hill	4.71	3.84	4.47
ME, Caribou	5.62	2.57	4.19
ME, Portland	5.2	3.56	4.51
MI, E. Lansing	4.71	2.70	4.00
MI, Sault Ste. Marie	4.83	2.33	4.20
MN, St. Cloud	5.43	3.53	4.53
MO, Columbia	5.5	3.97	4.73
MO, St. Louis	4.87	3.24	3.78
MS, Meridian	4.86	3.64	4.44
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
NC, Cape Hatteras	5.81	4.69	5.31
NC, Greensboro	5.05	4.00	4.71
ND, Bismark	5.48	3.97	5.01
NE, Lincoln	5.40	4.38	4.79
NE, North Omaha	5.28	4.26	4.90
NJ, Sea Brook	4.76	3.20	4.21
NM, Albuquerque	7.16	6.21	6.77
NV, Ely	6.48	5.49	5.98
NV, Las Vegas.	7.13	5.83	6.41
NY, Bridgehampton	3.93	1.62	3.16
NY, Ithaca	4.57	2.29	3.79
NY, New York	4.97	3.03	4.08
NY, Rochester	4.22	1.58	3.31
NY, Schenectady	3.92	2.53	3.55
OH, Cleveland	4.79	2.69	3.94
OH, Columbus	5.26	2.66	4.15
OK, Oklahoma City	6.26	4.98	5.59
OK, Stillwater	5.52	4.22	4.99
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	2.78	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, Brownsville	5.49	4.42	4.92
TX, El Paso	7.42	5.87	6.72
TX, Port Worth	6.00	4.80	5.83
TX, Midland	6.33	5.23	5.83
TX, San Antonio	5.88	4.65	5.30
UT, Flaming Gorge	6.63	5.48	5.83
UT, Salt Lake City	6.09	3.78	5.26
VA, Richmond	4.50	3.37	4.13
WA, Prosser	6.21	3.06	5.03
WA, Pullman	6.07	2.90	4.73
WA, Richland	6.13	2.01	4.43
WA, Seattle	4.83	1.60	3.57
WA, Spokane	5.53	1.16	4.48
WV, Charleston	4.12	2.47	3.65
WI, Madison	4.85	3.28	4.29
WY, lander	6.81	5.50	6.06
Province, City			
Alberta, Edmonton	4.95	2.13	3.75
Alberta, Suffield	5.19	2.75	4.10
British Columbia, Kamloops	4.48	1.46	3.29
British Columbia, Prince George	4.13	1.33	3.14
British Columbia, Vancouver	4.23	1.33	3.14
Manitoba, The Pas	5.02	2.02	3.56
Manitoba, Winnipeg	5.23	2.77	4.02
New Brunswick, Fredericton	4.23	2.54	3.56
Newfoundland, Goose Bay	4.65	2.02	3.33
Newfoundland, St. Johns	3.89	1.83	3.15
Northwest Territory, Fort Smith	5.16	0.88	3.29
Northwest Territory, Norman Wells	5.04	0.06	2.89
Nova Scotia, Halifax	4.02	2.16	3.38
Ontario, Ottawa	4.63	2.35	3.70
Ontario, Toronto	3.98	2.13	3.44
Prince Edward Isl., Charlottetown	4.31	2.29	3.56
Quebec, Montreal	4.21	2.29	3.50
Quebec, Sept-Isles	4.29	2.33	3.50
Saskatchewan, Swift Current	5.25	2.77	4.23
Yukon, Whitehorse	4.81	0.69	3.10

World Insolation Map



This map divides the world into six solar performance regions based on winter peak sun hours in the worst case month. A larger map in full color is located on the back cover of this catalog.

5. Size Your Array

1. Enter your daily amp-hour requirement (from your Load Sizing Worksheet, line 4) AH/Day _____
2. Enter the sun-hours per day for your area. Refer to chart. H/Day _____
3. Divide line 1 by line 2. This is the total amperage required from your solar array. _____
4. Enter the peak amperage of the solar module you have selected Peak A _____
5. Divide line 3 by line 4. This is the number of solar modules needed in parallel. _____
6. Select the required modules in series from the following chart. _____

Battery Bank Voltage	No. of Modules in Series
12V	1
24V	2
48V	4

7. Multiply line 5 by line 6 to find the total number of modules needed in your array. Total _____
8. Enter the nominal power rating (in watts) of the module you have chosen. W _____
9. Multiply line 7 by line 8. This is the nominal power output of your system. W _____

HIT Solar Module Limited Warranty

Models: All HIP-xxxBA3 Models
(xxx = the model's output, such as "200" watts)

Scope of Warranty Coverage: This warranty applies to HIT solar cell module model number(s) listed above (hereinafter, "Product(s)") and sold by SANYO Energy (USA) Corporation (hereinafter, "SANYO") and is extended to the original end-user purchaser (hereinafter, "Customer")

1. Limited Product Warranty – Two-Year Repair or Replacement. SANYO warrants the Product(s) to be free from defects in materials and workmanship under normal application, installation, use, and service conditions. If the Product(s) fails to conform to this warranty, SANYO will, at its sole option, either repair or replace the Product(s). This warranty shall extend for a period ending twenty-four (24) months from date of purchase by the Customer. This repair or replacement remedy shall be the sole and exclusive remedy provided under this warranty and the original product warranty period remains in effect and will not be extended, nor will a new warranty period begin, upon repair or replacement of defective Product(s).

The following conditions apply to this Limited Product Warranty:

a) The warranty remedy will extend only to claims received before the end of the warranty period.
b) SANYO reserves the right to repair or replace the original Product(s) with new or refurbished Product(s). Only one option will be implemented at SANYO's sole discretion.
c) Product(s) removal, transportation, reinstallation, and related fees are excluded from this Limited Product Warranty.
d) This warranty is applicable to the Product(s) only and does not apply to any other system components or parts.

2. Limited Power Output Warranty – Limited Remedy. SANYO warrants the power output degradation will not fall under 80% of the designated Minimum Power (Pmin) output shown below on Table 1 from date of Product(s) purchase by the Customer. Upon receipt of a warranty claim, SANYO or its designated representative shall conduct measurements to determine the actual power output of the Product(s). SANYO's measurement shall be the sole determination for purposes of warranty settlement. If SANYO measures power loss under the warranted level and such power loss is the result of a product defect, as determined by SANYO in its sole and absolute discretion, SANYO will supplement the output deficiency using one of the following remedies:

a) SANYO may provide additional new or refurbished Product(s) to restore the deficient output; or
b) SANYO may repair or replace the Product(s) with new or refurbished Product(s); or
c) SANYO may refund the Customer the original Product(s) purchase price less depreciation. The refund will be pro-rated by the number of years and/or months from the date of purchase by the Customer.

When one of the power output supplemental remedies is employed, the following conditions will apply:

a) The warranty remedy will extend only to claims received before the end of the warranty period.
b) The purchase date of original Product(s) shall determine the start of the warranty period in the event SANYO repairs, replaces, or adds more Product(s).
c) Supplemental remedies may not be combined. One remedy option (additional Product(s), repair/replacement of Product(s), or prorated refund) will be employed, at SANYO's sole option.
d) Product(s) removal, transportation, reinstallation, and related fees are excluded from this Limited Power Output Warranty.

Table 1. Limited Power Output Warranty

Period	Remarks	Example
At the Time of Purchase	The Maximum Power (Pmax) stated in "Specification of Photovoltaic Module"	200 Watts
0-10 years	90% of the Minimum Power (Pmin)	171 Watts
10-20 years	80% of the Minimum Power (Pmin)	152 Watts

Note: Maximum Power (Pmax) and Minimum Power (Pmin) are measured under Standard Test Conditions (STC) 1000W/m^2, Cell Temperature 25°C, Air Mass 1.5.
Note: Minimum Power (Pmin) = 95% of Maximum Power at the time of purchase.

3. Limited Warranty Exclusions. The Limited Warranties described above in sections 1 and 2 exclude all of the following conditions:

a) Improper usage, installation, wiring, handling, removal, or maintenance and abuse, neglect, vandalism or accident.
b) Product(s) sold and/or installed outside the geographic territory of North America, defined as the United States, Canada, and Mexico.
c) Lack of compliance with National Electric Code, or SANYO installation instructions, or use and maintenance instructions.
d) Marine, recreation vehicle and/or mobile installations of any kind.
e) Alteration or improper application, such as, but not limited to, use with mirrors, under concentrated sunlight, and direct contact with solar thermal systems.
f) Damage from abuse, alteration, installation or improper repair by anyone other than SANYO-authorized and trained technicians.
g) Improper storage, packaging or transportation.
h) Damage from external stress, such as falling rocks or other debris.
i) Damage from environmental pollution such as soot, salt damage, or acid rain.
j) Damage from defects in system-related parts and components, or non-compatibility of Product(s) with system and related components.
k) Damage from extreme natural conditions (earthquakes, typhoons, tornados, volcanic activity, flooding, tsunami, lightning, heavy snow, etc.) and fire, power surges, power failures or other unforeseen circumstances that are beyond SANYO's control.
l) Damage from terrorist acts, riots, war or other man-made disasters.
m) External stains or scratches that do not affect output.
n) Damage due to sound, vibration, rust, scratching, or discoloration that are the result of normal wear and tear, aging or continuous use.
o) Expiration of warranty, no evidence of purchase or no proof of delivery, and no installation by a SANYO-authorized representative or licensed electrical contractor.
p) Altered, removed, or illegible Product(s) serial number(s).
q) Product(s) installed in a location that exceeds Operating Conditions.

4. Limitation of Warranty. THE EXPRESS WARRANTIES SET FORTH HEREIN SHALL CONSTITUTE THE ONLY WARRANTIES APPLICABLE TO THE PRODUCT(S). SANYO HEREBY EXPRESSLY DISCLAIMS ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION, AND ALL OTHER OBLIGATIONS OR LIABILITIES ON SANYO'S PART, UNLESS SUCH OTHER WARRANTIES, OBLIGATIONS OR LIABILITIES ARE EXPRESSLY AGREED TO IN WRITING BY SANYO.

SANYO SHALL NOT BE RESPONSIBLE OR LIABLE IN ANY WAY FOR DAMAGE OR INJURY TO PERSONS OR PROPERTY, OR FOR OTHER LOSS OR INJURY RESULTING FROM ANY CAUSE WHATSOVER ARISING OUT OF OR RELATED TO THE PRODUCT(S), INCLUDING, WITHOUT LIMITATION, ANY DEFECTS IN THE PRODUCT(S), OR FROM USE OR INSTALLATION. IN NO EVENT SHALL SANYO BE LIABLE FOR INCIDENTAL, CONSQUENTIAL OR SPECIAL DAMAGES, LOSS OF USE, LOSS OF PROFITS, LOSS OF PRODUCTION, OR LOSS OF REVENUES FOR ANY REASON WHATSOEVER. SANYO'S TOTAL LIABILITY, IF ANY, IN DAMAGES OR OTHERWISE, SHALL NOT EXCEED THE INVOICE VALUE PAID BY THE CUSTOMER FOR THE PRODUCT(S) OR SERVICE(S) FURNISHED, WHICH IS THE SUBJECT OF CLAIM OR DISPUTE. THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY IN SOME STATES THAT DO NOT ALLOW LIMITATIONS ON IMPLIED WARRANTIES OR THE EXCLUSION OF DAMAGES.

5. Obtaining Warranty Performance. Customers who believe they have a justified claim covered by this Limited Warranty must immediately notify an authorized SANYO representative or contact SANYO directly by writing to:

SANYO Energy (USA) Corporation
Attn: Solar Products Warranty Claim
2600 Network Blvd., Suite 600
Frisco, TX 75034

Customers may also contact SANYO via its website under Industrial, Solar products at www.sanyo.com. Claims must accompany evidence of the product purchase date by the Customer. Note that the return of any Product(s) will not be accepted by SANYO unless accompanied by a valid return material authorization and prior written authorization issued by SANYO.

6. Severability. If a part, provision or clause of this Limited Warranty, or its application to any person or circumstance is held invalid, void or unenforceable, such holding shall not affect this Limited Warranty and all other parts, provisions, clauses or applications shall remain, and, to this end, such other parts, provisions, clauses or applications of this Limited Warranty shall be treated as severable.

7. Disputes. The Customer may bring no action, regardless of form, arising out of or in any way connected with this Limited Warranty, more than one (1) year after the cause of action has occurred. THIS LIMITED WARRANTY GIVES THE CUSTOMER SPECIFIC LEGAL RIGHTS; CUSTOMERS MAY ALSO HAVE OTHER RIGHTS THAT VARY FROM STATE TO STATE.

8. **Replacements.** Product(s) that is replaced by SANYO shall become the property of SANYO. SANYO reserves the right, at its sole option, to deliver another type of new or refurbished Product(s) that may differ in size, color, shape, model number, and/or power level.

9. **Force Majeure.** SANYO shall not be held responsible or liable to the Customer or any third-party arising out of any non-performance or delay in performance of any terms and conditions of sale, including this Limited Warranty, due to acts of God, war, riots, strikes, unavailability of suitable and sufficient labor, material, die, or capacity or technical or yield failures and any unforeseen event beyond its control, including, without limitations, any technological or physical event or conditions which is not reasonably known or understood at the time of the sale of the Product(s) or the claim.

Effective 1 April 2007

www.ecowerc.com
WERC
Winkelman's Environmentally Responsible Construction
9121 County Road 23, Brainerd, MN 56401-Phone: 218-764-2321

WERC Services

OUR MISSION is to design and build long-lasting, efficient buildings and energy generation systems that conserve natural resources and reduce pollution. As a result, we create good returns on investments that build a more environmentally sustainable economy.

Project Pre-plan Consulting

Design phase consulting, includes site planning, feasibility research, cost-payback projections of green technologies, sustainable building products, energy systems and resources for installers/builders. Ranges: $1000 to $4000 for an average home, $2000 to $10,000 for a small commercial project. This WERC is done partially with spreadsheets and design software, such as:

- Energy 10
- RET Screen
- Geothermal Loop Design
- Auto CAD
- Chief Architect

Design and Blueprint Services

This WERC includes the above services, plus architectural renderings, schematic drawings, building specifications, shop drawings, blueprint services, photo-realistic designs, 3-D walk-throughs, with detailed estimates of costs, benefits and paybacks.

Construction Project Management Services

Complete project management and renewable energy systems installation services, priced per project.

David Winkelman, WERC Founder, RE Designer, Project Manager, Speaker

LuAnn Nelson, Certified Energy Engineer, LEED AP, Designer, Consultant

Rick Lewandowski, Solar Engineer, Founder: SunWize & Prism Solar, Speaker

Angela Demonte, Green Building Design, Product Sourcing, Consultant

Howard McElroy, Designer, Consultant, Engineer

Peter Skadberg, Engineer, Consultant, Designer

Doug Wogstad, Engineer, Designer, Consultant, Project Manager, Speaker

Mario Monesterio, RE Designer, Energy 10 Teacher, Solar Installer, Consultant

Also:

- Paul Hunt, Inventer, Bio-Chemist, Physicist.
- Brian Sakry, Mechanical, Controls Engineer
- Jason Edens, RE Designer, Installer
- Allen Cibuzar, Bio-Chemist, Water Research
- Jim Chamberlain, Forester, Water, Soils
- Darryl Thayer: RE Designer, NABCEP Installer,

WERC Team: Over 100 years of combined experience as engineers, designers and installers.

The WERC Team Conducts

Installation and Planning for:

• Wind Turbines • Solar Electric/Heat • Sustainable Buildings • Geothermal • Hydronics

Simple or In-Depth Energy Audits of Existing Buildings.

• Lighting • Building Materials • Ventilation • Insulation • Thermal Imaging
• Blower Doors • Controls • Appliances • EnergyScaping™ • HVAC

Comprehensive Water Planning

• Storm Water • Grey Water • Process Water • Water Plans • Water Gardens • Waterless Toilets

Other Conservation Services for Construction

Community-Based, Commercial and Residential: Project Lifecycle Costs Analysis, Speakers on Renewable Energy, Green Buildings, Workshops for Solar, Wind, Biofuels, Energy Efficiency, Preferred Contractor Referrals, Resources for Renewable EnergyTechnologies, Projects, Internet Locator Services, Project Management, Computer Assisted Design Services, Site Planning tools and services.

Building Projects

- **Kennedy Community School, St. Joseph, MN**
- **Apple Valley School of Environmental Studies**
- **Bay Pointe on Pelican Lake**
- **Dodge Nature Center**
- **Eco-Domes™ Conservation Campus**
- **Hunt Utility Group - Wind Turbine**
- **Prairie Woods Environmental Learning Center**
- **Winkelman Building Corporation Solar Roof**
- **White Bear Lake Racquet & Swim Club**

If you'd like to visit one of our Commercial, Public, Community or Residential Development Projects, please call 218-764-2321 for location.

Awards

- **National Home Center Institute** (for Energy Education)
- **Minnesota Waste Wize** (Pollution Prevention Award)
- **MN Governors Award for Green Building of the Year**
- **National Retail Hardware Association -** (Award for Environmental Excellence and an Award for Outstanding Achievement)

Professional Associations

- American Solar Energy Society
- American Wind Energy Association
- US EPA Energy Star
- Home Center Institute
- International Ground Source Heat Pump Assoc.
- Minnesota Waste Wize
- Minnesota Office of Environmental Assistance
- Minnesota Pollution Control Agency
- National Renewable Energy Lab (NREL)
- National Retail Hardware Assoc.(NRHA)
- Green Architect Association (SBIC)

Conservation Technology Affiliations

- US Green Building Council-LEED
- Int'l Ground Source Heat Pump Assn.-IGSPHA
- N. Amer. Board of Cert. Energy Practitioners-NABCEP
- Sustainable Buildings Industry Council-SBIC
- Energy Star Builder and Energy Star Products
- Energy 10 (Building Life-Cycle Energy Analysis)
- Photo-Voltaic Installer Certification (Uni-Solar)
- Wind Turbine Industries Corporation (Jacobs)
- National Home Builders Association

WERC *A Service of The Eco-Domes LLC* 9121 County Road 23, Brainerd, MN 56401
Phone: 218-764-2321 • Fax: 218-764-3582 • E-Mail: info@ecowerc.com • Website: www.ecowerc.com

I want my own solar system!

solar thermal

What is solar thermal energy?

Solar thermal technologies use sunlight to provide heat for domestic hot water, space heating, and heating swimming pools. These systems are generally divided into passive designs, which allow heat from the sun to be absorbed and stored by building components (like concrete or stone surfaces) and active systems, which use collector panels and mechanical components to provide thermal energy to a building. Solar thermal systems are meant to supplement a building's primary hot water and space heating systems; usually they are not intended to replace them.

Is solar thermal energy effective in Minnesota?

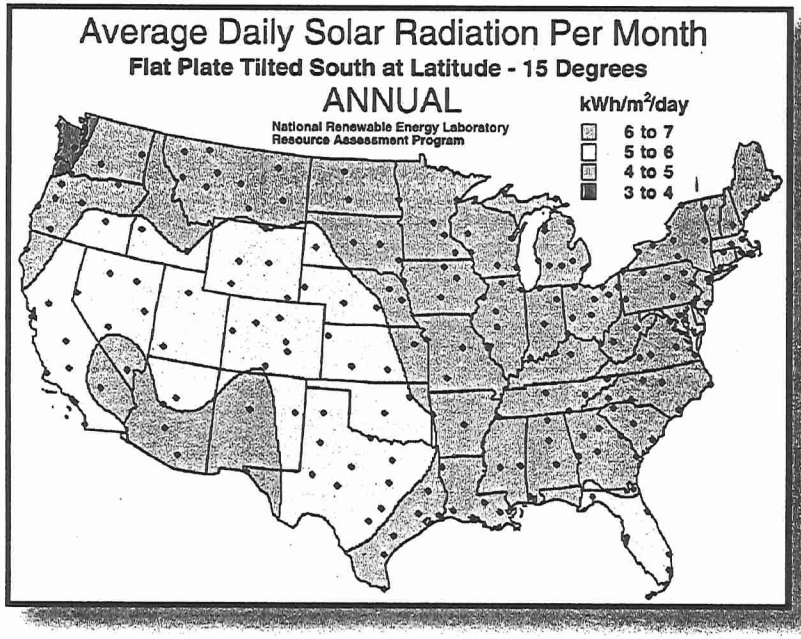
Solar energy is plentiful in Minnesota, having as much solar energy annually as most of the U.S. For example, a typical solar water heating system in Minnesota can provide 50 to 75% of total energy required for hot water. Space heating requires a larger system, but is effective in significantly reducing a building's need for other energy resources like natural gas, fuel oil, or propane.

What are the benefits of solar thermal energy?

Solar thermal energy is a renewable or sustainable energy source, and can be a cost effective and reliable way to provide heat for buildings. Adding passive solar into building design and remodeling will make your building more sustainable. In addition, solar thermal is a strategy for addressing climate change, diversifying our energy supply, increasing Minnesota's energy independence, and boosting the state's economy.

Where should solar thermal systems be located?

Not every site is well suited for solar thermal applications. The site should have good solar access to the south with minimal shading from trees, buildings, or other obstructions. Still, solar thermal siting requirements are much more forgiving than those of solar electricity. Therefore, solar thermal is more versatile and appropriate for a greater number of locations. If you have a south facing roof or yard area with good southern exposure, free of trees, buildings and other obstructions, you should consider having a more formal site assessment done by a solar contractor. See the Minnesota Renewable Energy Society's website at www.mn-renewables.org and click on *Explore Renewables* to access a list of contractors.



How much do solar thermal systems cost?

Solar hot water is the most cost effective solar technology available. Since sunlight is free, once the equipment is purchased, there is only maintenance, which is minimal.

The installed cost of a solar hot water system is approximately $6,000–10,000 for a typical residential installation (before incentives). For a residential system that employs both water and space heating, the range is $18,000 - $25,000.

Energy efficient mortgage financing is one way to make a solar thermal system cost effective. Rolling the cost of the system into a mortgage alleviates the need for a large upfront expense and distributes the cost of the system over a number of years. The FHA 203(k) program enables a home buyer or investor to obtain a single loan to finance both property purchase and complete major improvements (like a solar thermal system) after the time of loan closing.

What incentives exist for solar thermal technologies?

There is a personal federal tax credit of 30% of the cost of a solar thermal system (up to $2,000) for residential systems and a business tax credit of 30% of the cost of a solar thermal system for commercial systems installed between January 1, 2006 and December 31, 2008. In addition, the state of Minnesota exempts solar equipment from sales tax. Many homes with solar thermal systems will also qualify for Energy Efficient Mortgages through the FHA. For a current list of government and utility incentives for solar thermal and other renewable energy technologies, visit the Database of State Incentives for Renewable Energy at **www.dsireusa.org**.

(over)

I want my own solar system!

solar electric

What is solar electricity?

Solar electricity is the process of using sunlight to generate electric current, which can then be used to provide power to a building. The process, although somewhat complicated, is familiar to most of us in the form of solar powered calculators.

Does solar electricity make sense in Minnesota?

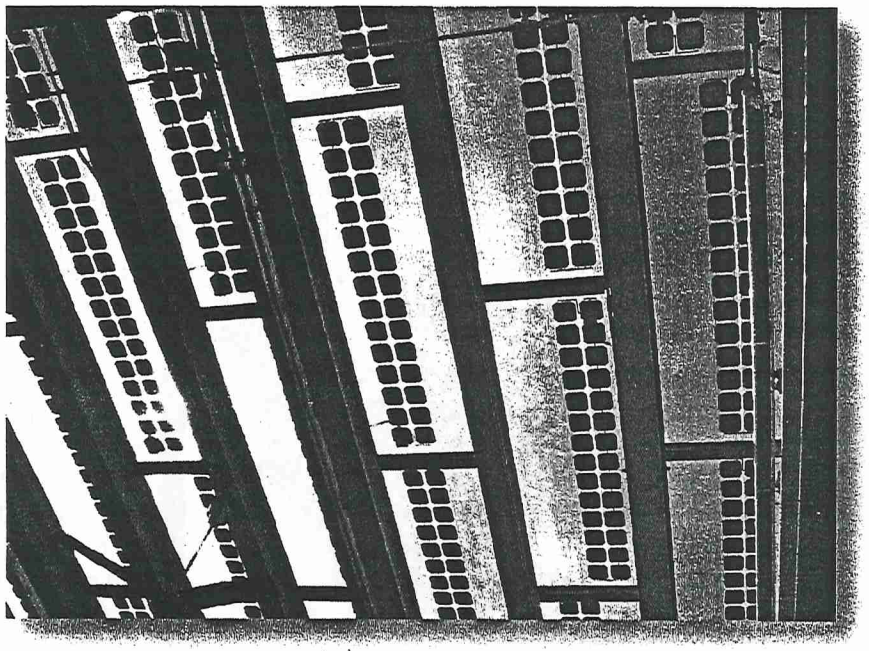
Virtually every region in the United States has plenty of solar energy to produce electricity from the sun, and Minnesota is no exception. Currently, there are approximately 500 kW of installed solar electric capacity in Minnesota.

What are the benefits of solar electricity?

Solar electric systems have low maintenance and operating costs and can produce electricity for 30-50 years, well past their payback period. Solar electric is a source of non-polluting power and helps mitigate climate change by reducing fossil fuel consumption. It also helps to diversify the energy supply and increases Minnesota's energy independence. Solar electric is creating local jobs and stimulating the local economy, as well.

What are the challenges of solar electricity?

The single biggest barrier to solar electricity is initial investment. However, the costs of solar electric panels are expected to decline, perhaps by up to 50% by 2010. Siting a solar electric system can be a challenge since any shading from obstructions significantly reduces the system's performance. State law allows local zoning boards to create solar access easements to protect a property owner's solar investment from shading.



An integrated solar PV system installed in the skylights at the Marjorie McNeely Conservatory at Como Park in St. Paul

What does a solar electric system cost?

The cost of a solar electric system varies with the size and type of system and available incentives. A typical 2-3 kW residential system costs approximately $20,000-30,000 installed, before incentives.

What is the Minnesota Solar Rebate Program?

The Solar Rebate Program was established in July 2002 to provide rebates for up to 500 kW of grid-connected photovoltaic (solar electric) systems in Minnesota. The program offsets the cost of installing new solar electric systems by $2 per watt, up to 10 kilowatts. This in effect reduces the cost of a system by about 20% for consumers. The availability of funding for the rebates is determined by legislative allocations.

What other incentives exist for solar electricity?

There is a personal federal tax credit of 30% of the cost of a solar electric system (up to $2,000) for residential systems and a business tax credit of 30% of the cost of a solar electric system for commercial systems installed between January 1, 2006 and December 31, 2008. In addition, the state of Minnesota exempts solar equipment from sales tax. Many solar electric systems will also qualify for Energy Efficient Mortgages through the FHA. For a current list of government and utility incentives for solar thermal and other renewable energy technologies, visit the Database of State Incentives for Renewable Energy at **www.dsireusa.org**.

For more information...

To learn more about solar energy options, check out:
National Renewable Energy Laboratory **www.nrel.gov**
Department of Energy **www.eere.doe.gov**
Minnesota Department of Commerce
www.commerce.state.mn.us

STATE ENERGY INFORMATION OFFICE
MINNESOTA DEPARTMENT OF COMMERCE

85 7th Place East, Suite 500, St. Paul, MN 55101-2198
651-296-5175 800-657-3710 www.commerce.state.mn.us

SUV vs. PV

Jeremy Smithson

IS SOLAR ENERGY TOO EXPENSIVE?...YOU DO THE MATH!

JEEP GRAND CHEROKEE LAREDO

5 KILOWATT GRID-TIED PV SYSTEM

Age	Value[1]	Emissions[2]	Cost[3]	Age	Value[4]	Emissions[5]	Cost[6]
New	$29,499	0.5 tons	$29,499	New	$29,499	0.5 tons	$29,499
1 year	$21,710	12.5 tons	$33,099	1 year	$29,351	-2.7 tons	$28,959
5 years	$10,445	62.5 tons	$51,099	5 years	$28,759	-13.5 tons	$26,571
10 years	$4,075	125.0 tons	$65,500	10 years	$28,019	-27.0 tons	$23,009
20 years	$550	250.0 tons	$101,500	20 years	$26,539	-54.0 tons	$13,401
	[1] Bluebook	[2] 10 K Miles per year	[3] Operating cost		[4] -5% per year	[5] vs. Gas turbine	[6] -Avoided cost

When I put this sign together for my booth in a local fair, it was an attempt to rebut the time-worn argument that we've all heard—solar-electricity is too expensive.

As a newbie solar contractor, I was appalled at the negative attitude of my more experienced peers regarding cost. As an experienced remodeling contractor, I knew that cost was not necessarily a factor. For example, my clients would spend US$1,500 on a bathroom faucet, or US$20 per square foot on tile.

The products of the auto industry are *never* subjected to the kind of scrutiny regarding cost effectiveness to the purchaser that renewable energy products must endure constantly. Let's get over it! PV gives a return on investment (ROI) of 4 percent over the life of the system (50 years) in Seattle, Washington, right now. Compare that to a passbook savings account that presently yields around 1 percent.

If you don't remember anything else about my sign, remember that *if you can afford a car, you can afford a solar-electric system.* Perhaps PV module manufacturers could take a hint from the auto industry and offer zero percent financing.

What if we selected our mode of transportation the way we are told that we must select our source of electricity? Those of us who live in cities would all be using public transportation or bicycles, unless we were hauling loads. (How often do you see an SUV on the road with only one or two occupants?)

In the comparison chart, the Jeep values are Blue Book prices, Jeep emissions were based on 10,000 miles per year, and Jeep cost is incremented by the cost per mile allowed by the IRS. The PV is devalued 0.5 percent per year, RETScreen (from Natural Resources Canada) was used to compute ROI and emissions saved compared to a modern gas turbine generator, and to decrement the PV cost based on a current utility rate of 8.7 cents per KWH. The installed cost of the PV system is US$6 per watt. We do 'em for as low as US$5.75, give the purchaser a 50 year product, and still make money, all without rebates.

So where is *your* money going—down the road or back in your pocket?

Access

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Fax: 206-297-1814 • jeremy@pugetsoundsolar.com
www.pugetsoundsolar.com

Global Warming and Climate Change in Minnesota

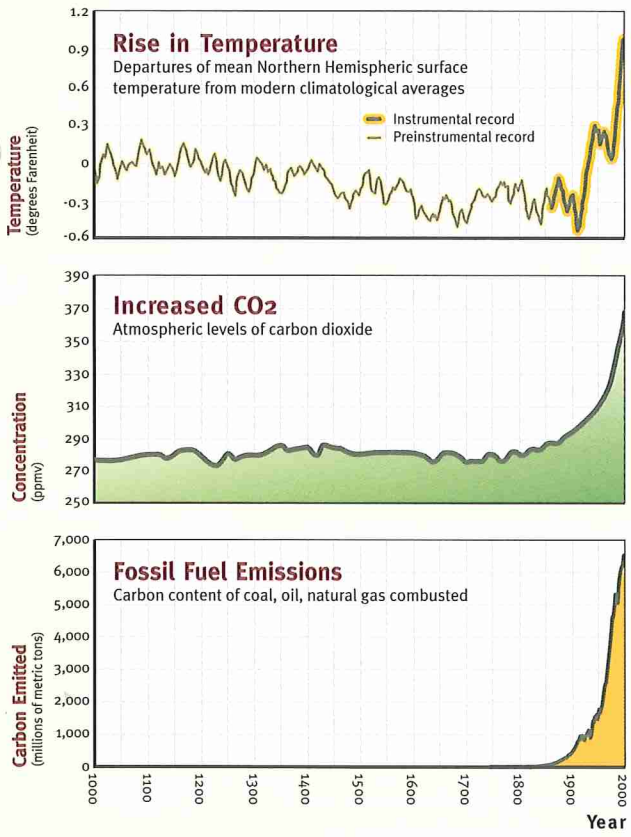
A Big Experiment

On a global basis, we know that in recent years the surface of the earth is warming.

Nine of the ten warmest years in the instrumental record (1861-present) have occurred since 1990. 1998 was the warmest year on record and 2002 was the second warmest. Most scientists agree that the earth's surface temperature warmed more during the last century than any other century during the last thousand years [World Meteorological Organization, 2002].

IT'S REAL AND IT'S NOW!

There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.



Information graphics by Matt Kania/ Map Hero

Recent warming appears to be linked to the burning of oil, coal and gas for energy in vehicles, businesses and homes and increased atmospheric levels of carbon dioxide.

BUT DON'T TAKE OUR WORD FOR IT:

"Climate change stands out from other environmental issues because of its potentially serious consequences and its direct relationship to our industry."

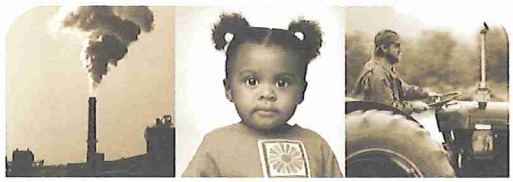
William Ford Jr., Chairman, Ford Motor Company

"There is general agreement that the observed warming is real and has been particularly strong within the past 20 years."

U.S. Climate Action Report 2002, U.S. EPA, Bush Administration

"Ducks Unlimited believes that the prospects of climate change are serious, and we are taking steps to keep informed and do prudent planning for conservation."

Wetlands in a Warmer World, Ducks Unlimited



Impacts of Global Warming

Global warming is changing our climate and is impacting our natural systems. While it is impossible to say that any one event is due to global warming, the following evidence is consistent with what would be expected in a warming climate.

▸ Sea level has risen worldwide approximately 15-20 cm (6-8 inches) in the last century.

▸ A general increase in heavy rainfall events contributes to increased flooding and erosion.

▸ Coral reefs are dying from the warming of tropical seas. Some experts predict many will be gone by 2020.

▸ Annual lake and river ice cover declined by about two weeks in the Northern Hemisphere during the past century.

▸ 50 million acres of Alaskan forest are under attack by spruce budworms that thrive in warmer weather.

▸ In Glacier National Park, the number of glaciers has fallen from 150 to 50 since 1850.

Source: Evidence and impact estimates based on data from the Intergovernmental Panel on Climate Change (IPCC).

April 2006

Has Minnesota's climate changed over the past 100 years?

- The average temperature in Minnesota has risen almost one degree Fahrenheit over the past century.
- Since 1900, precipitation has increased by about 20 percent in parts of Minnesota, especially southern Minnesota.

If temperature readings and precipitation continue to increase within the next century, Minnesota might soon feel and look more like Missouri.

What can we expect?

The following impacts may already be underway or could be expected from a changing climate.

- Shifts in location of Minnesota forests and grasslands, changing the types of plants and animals that live in the state.
- Loss of species unable to adapt quickly to new climates.

- Damage may increase from floods and violent storms.
- Some pests, diseases and exotic species may be able to extend their range into Minnesota.

- More poor air quality (smoggy) days in the summer.
- Reduced water quality — increased algal blooms and less oxygen in warmer waters.

- Less habitat for trout, whitefish, and other coldwater species.
- Shorter season of snow and ice cover, less winter recreational opportunities.

As a result of concerns about global climate change, we're committed to a four-fold plan of action"... including "reducing greenhouse-gas emissions and increasing energy efficiency."
Chevron Texaco Statement on the Environment

WHAT CAN YOU DO TO HELP?

Dealing with the impacts of global warming will require the involvement of everyone: governments, businesses and individuals.

Steps to reduce carbon dioxide emissions will reduce the main greenhouse gas contributing to climate change. In addition, our actions can also save money and protect our air, water and soil.

Six things you can do:

1 Purchase green power

- Minnesota law requires the state's electric utilities to offer customers voluntary options to purchase power generated from renewable sources that emit far fewer greenhouse gases. Contact your electrical provider for details.

2 Reduce your energy use for transportation

- Buy a fuel efficient or alternative fuel vehicle.
- Drive less – bus, bike, walk or carpool.
- If you do drive, don't idle your vehicle.

3 Reduce energy use at home

- Turn your thermostat down in the winter, set your air conditioner higher in the summer.
- Buy energy-efficient bulbs and appliances, look for the ENERGY STAR label.
- Get a home energy audit.

Energy
Money Isn't All You're Saving

4 Plant trees

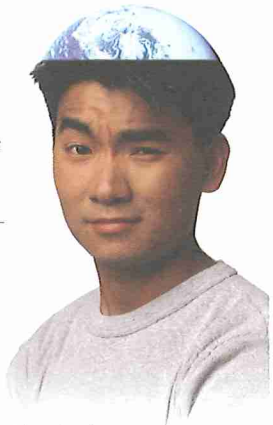
- Trees capture and hold carbon dioxide, a major greenhouse gas, and provide shade, which can reduce the need for air conditioning.

5 Reduce, reuse, recycle

- Waste reduction and recycling saves energy and resources.

6 Educate others

- Share the facts on global warming and encourage all to do their part.



More information on climate change:

- www.pca.state.mn.us/hot/globalwarming.html

More information on things you can do:

- www.reduce.org
- www.commerce.state.mn.us
- Minnesota Pollution Control Agency's Education Clearinghouse: 651-215-0232 or 800-877-6300

Minnesota Pollution Control Agency

Minnesota Department of Commerce

Minnesota Department of Natural Resources

The World's Single Most Powerful Photovoltaic Module

Utilized in a wide range of applications, the ASE-300-DGF/50 is an industrial-grade solar power module built to the highest standards. Extremely powerful and reliable, the module delivers maximum performance in large systems that require higher voltages, including the most challenging conditions of military, utility and commercial installations. For superior performance, quality and peace of mind, the ASE-300-DGF/50 is renowned as the first choice among those who recognize that not all solar modules are created equal.

Faster Installation

- Large surface area requires fewer interconnects and structural members
- Multi-Contact Plug-n-Play connectors mean source-circuit wiring takes just minutes
- Unique mounting systems available for commercial roofs eliminate need for traditional mounting rails, heavy ballast, and roof penetrations

More Reliability

- Bypass diode protection for every 18 solar cells in series, thus minimizing power loss, and mitigating overheating/safety problems
- Advanced encapsulation system ensures steady long-term module performance by eliminating degradation associated with traditional EVA-encapsulated modules
- Moisture impermeable glass on *both* sides of the module protects against tears, perforations, fire, electrical conductivity, delamination and moisture
- Patented no-lead, high-reliability soldering system guarantees long life and ensures against environmental harm should the module break or be discarded

Higher Quality

- Each of the module's 216 individual semi-crystalline silicon cells is inspected and power matched to ensure consistent performance between modules
- Every module is tested utilizing a calibrated solar simulator to ensure that the electrical ratings are within the specified tolerance for power, voltage, and current
- Module-to-module wiring loss is factored into the module's labeled electrical ratings by testing through the module's cable/connector assemblies
- ± 4% tolerance means better current matching, lower mismatch losses

Independently Certified

- The ASE-300-DGF/50 is independently certified to meet IEEE 1262, IEC 61215, and UL 1703 Standards
- It is also the *only* standard module in the industry to receive a UL (Underwriters Laboratories) Class A fire rating

ASE-300-DGF/50 diode housing with bypass diodes, UV resistant cables with MC®-connectors.

Full square semi-crystalline EFG cells ensure maximum energy yield.

Designation:
DG = Double Glass
F = Frame
/50 = Nominal Voltage at STC

SCHOTT solar

Current/voltage characteristics with dependence on irradiance and module-temperature.

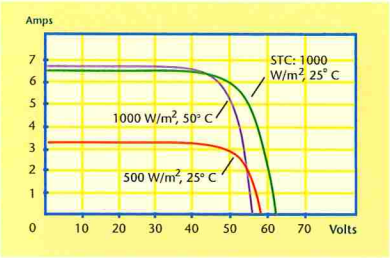
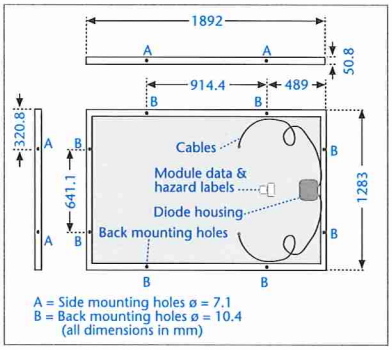


Chart applies to ASE 300 W module only.



Electrical data

The electrical data applies to standard test conditions (STC):
Irradiance at the module level of 1,000 W/m² with spectrum AM 1.5 and a cell temperature of 25° C.

Power (max.)	P_p (watts)	280 W	290 W	300 W	310 W	320 W
Voltage at maximum-power point	V_p (volts)	49.6 V	50.1 V	50.6 V	51.1 V	51.6 V
Current at maximum-power point	I_p (amps)	5.7 A	5.8 A	5.9 A	6.1 A	6.2 A
Open-circuit voltage	V_{oc} (volts)	61.9 V	62.5 V	63.2 V	63.8 V	64.4 V
Short-circuit current	I_{sc} (amps)	6.2 A	6.4 A	6.5 A	6.7 A	6.8 A

The rated power may only vary by ± 4% and all other electrical parameters by ±10%.
NOCT-value (800 W/m², 20° C, 1m/sec.) = 45° C.

Dimensions and weights

Length mm (in)	1,892.3 (74.5")
Width mm (in)	1,282.7 (50.5")
Weight kg (lbs)	46.6 ± 2 kg (107 ± 5lbs)
Area	2.43 sq meters (26.13 ft sq)

Characteristic data

Solar cells per module	216
Type of solar cell	Semi-crystalline solar cells (EFG process), 10x10 cm²
Connections	10 AWG single conductor, stranded copper with Multi-Contact connector. Junction box comes with 10 built-in bypass diodes.

Cell temperature coefficients

Power	T_K (P_p)	- 0.47 % / °C
Open-circuit voltage	T_K (V_{oc})	- 0.38 % / °C
Short-circuit current	T_K (I_{sc})	+ 0.10 % / °C

Limits

Maximum system voltage	600 VDC U.S.
Operating module temperature	-40 to +90° C
UL certified design load	50 PSF
Equivalent wind resistance	Wind speed of 192 km/h (120 mph)

The right is reserved to make technical modifications. For detailed product drawings and specifications please contact SCHOTT Solar or an authorized reseller.

Certifications and Warranty

The ASE-300-DGF/50 has been independently certified to IEC 61215, IEEE 1262, and UL 1703 (Class A Fire rating). The ASE-300-DGF/50 comes with a 20 year power warranty (see terms and conditions for details).

SCHOTT Solar, Inc.

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2260 Lava Ridge Court, Suite 102
Roseville, CA 95661
Toll free: 888-457-6527
Fax: 916-784-9781

SCHOTT solar

PD-00-009 C

UNI-SOLAR®

Solar Shingles
SHR-17

Sell Sheet

- **Power Rating 17W**
- **Lightweight & Flexible**
- **No Support Structures Needed**
- **Virtually Unbreakable (No Glass)**
- **Shadow & High Heat Tolerant**
- **Delivers Up To 20% More Real Energy**

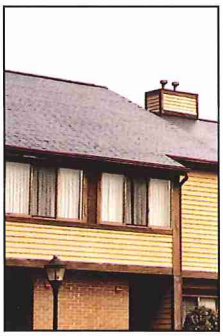
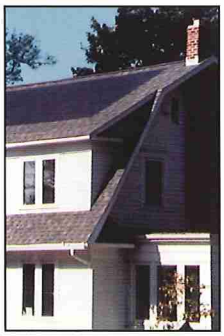


Photo Courtesy of Oakland University



UNI-SOLAR® shingles are unique and have

been honored with the prestigious Popular Science Grand Award, "Best of What's New (Environmental Technology)," and Discover Magazine's "Technological Innovation Award" for best innovation (Environment). The PV shingle permits the roof of commercial buildings or residential homes to evolve from mere protection from the weather to a source of electrical power. The flexible, thin film solar cell shingle blends into a roofing pattern or traditional asphalt shingles.

Applications

- Residential Grid Connected Systems
- Commercial Grid Connected Systems
- Schools & Institutions
- Apartment Complexes
- Condominiums
- Renovation Or New Construction

Why Do *UNI-SOLAR* Products Outperform Others?

All solar panels are rated in terms of peak power output (watts). Outdoors, under normally higher operating temperatures, solar panel performance changes, depending on temperature, solar spectrum (light color) and related effects. *UNI-SOLAR* products are less affected by temperature than monocrystalline or polycrystalline solar technology products. The result is up to 20% more delivered energy.**

** Source Solfest, "Module Shoot Out"

MORE kW HRS

LIGHTWEIGHT

NO-GLASS

DURABLE

HIGH TEMP PERFORMANCE

UNI-SOLAR

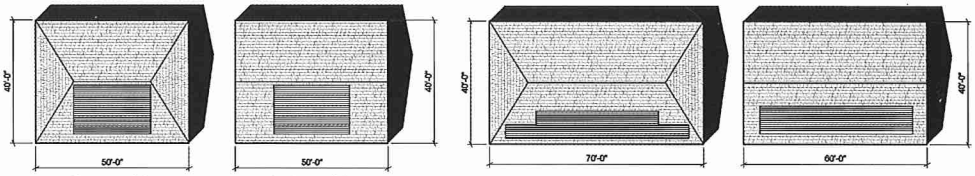
Solar Shingles SHR-17

UNI-SOLAR

Specifications

Model	SHR-17
Rated Power (Watts)	17
Max Power Point VMPP (V)	9
Max Power Point IMPP (A)	1.9
Open-Circuit Voltage (Volts)	13
Short-Circuit Current (Amps)	2.4
Shingle Length (in./mm)	86.4 in./2195 mm
Shingle Width (in./mm)	12 in. (5 in. exposed area)/305 mm
Shingle Thickness (in./mm)	0.1 in./4 mm
Weight (lb./kg)	4.8 lb./2.2 kg
Customer-Supplied Substrate	Wood Deck and Fire retardant underlayment
Minimum Slope	3:12 (15˚)
Maximum Slope	21:12 (60˚)
Warranty on Power Output	20 Year

During the first 8-10 weeks of operation, electrical output exceeds specific ratings. Power output may be higher by 15%, operating voltage may be higher by 11% and operating current may be higher by 4%. Electrical specifications (±10%) are based on measurements performed at standard test conditions of 1000 W/m² irradiance, Air Mass 1.5, and Cell Temperature of 25°C after long-term stabilization. Actual performance may vary up to 10% from rated power due to low temperature operation, spectral and other related effects. Maximum system open-circuit voltage not to exceed 600 VDC. Specifications subject to change without notice.



Quality Assurance, Proven Reliability

UNI-SOLAR shingles comply with the following qualification tests:

- UL Listed Up To 600 VDC as A Prepared Roofing Cover (UL)
- Capable Of Withstanding 80 mph Wind Speeds
- Meets IEC 61646 Requirements
- Thermal Cycling
- Humidity-Freeze Test
- Damp Heat Test
- UV-Test
- Wet Insulation Test
- Mechanical Load Test
- Hail Impact Test
- Robustness of Terminations Test

Product Description

Each SHR (solar home roofing) shingle utilizes the proprietary Triple Junction solar cells manufactured by *UNI-SOLAR.* These cells are made in a roll-to-roll deposition process on a continuous roll of stainless steel. The result is a unique, flexible, lightweight solar cell. The *UNI-SOLAR* PV Shingles are encapsulated in UV stabilized polymers making them exceptionally durable. Bypass diodes are connected across each cell, allowing the modules to produce power even when partially shaded.

The Solar Shingle will replace the conventional shingle. The shingles are UL Listed both as an electricity generator and as a prepared roofing cover. Each shingle has a pair of wires coming off the back of the shingle that will be fed through the roof deck for wiring inside the attic. The solar shingle wires can be "shorted" during installation. The wires from adjacent shingles are connected together using moisture resistant butt splices. The shingles are mounted over 30 lb. felt or a fire resistant underlayment (e.g. Elk® Versa Shield.)

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Fax: 248.364.0510
Email: info@uni-solar.com
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Toll Free: 800.397.2083
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Fax: +49.241.9631138
Email: europeinfo@uni-solar.com

Your *UNI-SOLAR* Distributor:

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9121 CR 23, Brainerd, MN 56401
218-764-2321
www.bogfrog.com/ctc.htm

UNI-SOLAR® ovonics@work
#D09-01

SHARP

MULTI-PURPOSE MODULE

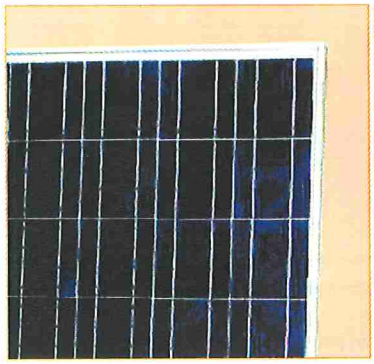
ND-208U1F

208 WATT

NEXT GENERATION. BREAKTHROUGH PERFORMANCE.

POLY-CRYSTALLINE SILICON PHOTOVOLTAIC MODULE WITH 208W MAXIMUM POWER

This poly-crystalline 208 watt module features 12.8% module efficiency for an outstanding balance of size and weight to power and performance. Using breakthrough technology perfected by Sharp's 45 years of research and development, these modules incorporate an advanced surface texturing process to increase light absorption and improve efficiency. Common applications include commercial and residential grid-tied roof systems as well as ground-mounted arrays. Designed to withstand rigorous operating conditions, Sharp's ND-208U1F modules offer high power output per square foot of solar array.



Solder-coated grid results in high fill factor performance under low light conditions.

Sharp multi-purpose modules offer outstanding performance for a variety of applications.

FEATURES

- High-power module (208W) using 156mm square poly-crystalline silicon solar cells with 12.8% module conversion efficiency
- Sharp's advanced surface texturing process increases light absorption and efficiency while providing a more subdued, "natural" look
- Bypass diodes minimize the power drop caused by shade
- Water white tempered glass, EVA resin, and a weatherproof film, plus aluminum frame for extended outdoor use
- UL Listings: UL1703, cUL
- Sharp modules are manufactured in ISO 9001 certified facilities
- 25-year limited warranty on power output (see dealer for details)

ND-208U1F

MULTI-PURPOSE MODULE

208 WATT

ELECTRICAL CHARACTERISTICS

Cell	Poly-crystalline silicon
No. of Cells and Connections	60 in series
Open Circuit Voltage (Voc)*	36.3V
Maximum Power Voltage (Vpm)*	28.71V
Short Circuit Current (Isc)	7.99A
Maximum Power Current (Ipm)	7.25A
Rated Power (Pmax)*	208W (+10% / -5%)
Module Efficiency Maximum Power (η_m)	12.8%
Maximum System Voltage	600VDC
Series Fuse Rating	15A
Type of Output Terminal	Lead Wire with MC Connector

* (STC) Standard Test Conditions: 25°C, 1 kW/m², AM 1.5

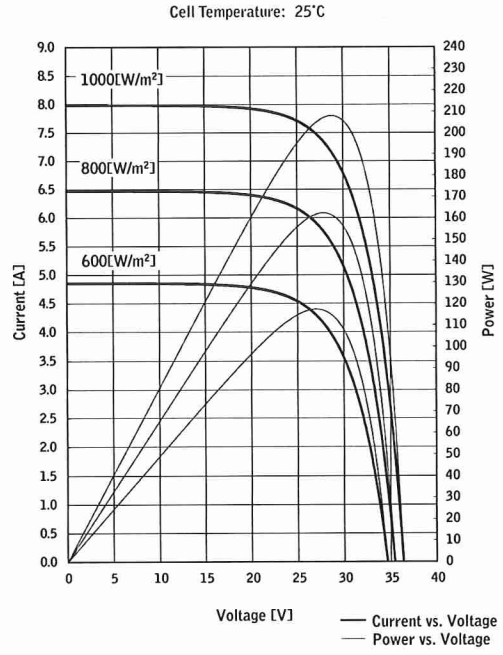
MECHANICAL CHARACTERISTICS

Dimensions A x B x C (below)	64.6" x 39.1" x 1.8" / 1640mm x 994m x 46mm
Weight	46.3lbs / 21kg
Size of Carton	68.3" x 43.2" x 4.5" / 1735mm x 1097mm x 114mm
Carton Quantity	2 pcs per carton
Pallet Quantity	28 pcs per pallet
Loading Capacity (48 ft container)	448 pcs (16 pallets)
Loading Capacity (53 ft container)	476 pcs (17 pallets)

ABSOLUTE MAXIMUM RATINGS

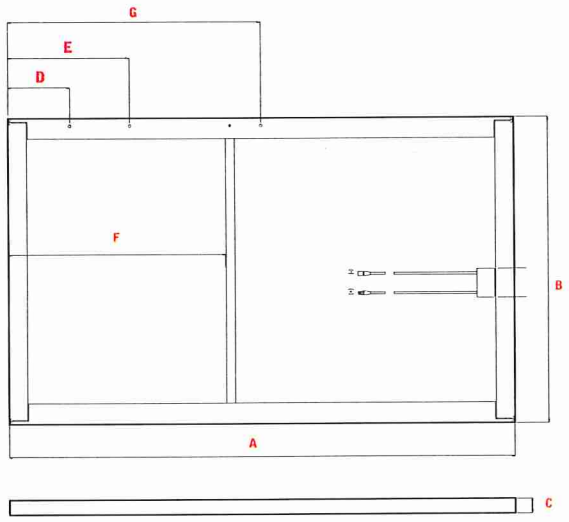
Operating Temperature (min to max, °F/°C)	-40 to +194°F / -40 to +90°C
Storage Temperature (min to max, °F/°C)	-40 to +194°F / -40 to +90°C

IV CURVES



Current, Power vs. Voltage Characteristics

DIMENSIONS



A	B	C	D
64.6"/1640m	39.1"/994mm	1.8"/46mm	7.87"/200mm

E	F	G
15.55"/395mm	27.8"/705mm	32.3"/820mm

Design and specifications are subject to change without notice.

06F0216

SHARP

SHARP ELECTRONICS CORPORATION • 5901 Bolsa Avenue, Huntington Beach, CA 92647
Tel: 1-800-SOLAR-06 • E-mail: sharpsolar@sharpusa.com • www.sharpusa.com/solar

Cover photo: Solar installation by Pacific Power Management, Auburn CA SESG-208-906 Printed in the USA