Electric (PV)
Site Assessment Report

Prepared for UWGB
Based on a site assessment November 2011

Material in this report does not imply a recommendation or endorsement of any product or service by the Focus on Energy Program or this site assessor. The Focus on Energy Program, or any subcontractor of Focus on Energy, is not responsible for inaccurate or incomplete data in this report.

focus on energy
The power is within you.

Introduction:

Site Assessor contact information:
Kenneth N. Statz
3821 10th Street S.
Wisconsin Rapids, WI
statz.industries@gmail.com
(715) 459-5309

Client Information

University of Wisconsin - Green Bay, 2420 Nicolet Drive, Green Bay, WI
(920) 465-2000
uwgb@uwgb.edu

UWGB
Jeff Cook, Paul Pinkston
Rick Warpinski, Director - University Union & Shorewood Golf Course
University of Wisconsin-Green Bay
2420 Nicolet Drive, Green Bay, WI 54311-7001
p: 920.465.2090 | c: 920.366.5936 | f: 920.465.2020
e: warpinsr@uwgb.edu | web: www.uwgb.edu/union web: www.uwgb.edu/shorewood

WPS
Jay Dressen, UWGB WPS Campus Sustainability Committee Member

Carla K. Martin
Renewable Energy Intern| Renewables| Wisconsin Public Service
P.O. Box 19001, 700 North Adams St.
Green Bay, WI 54307-9001
920-433-1379
920-412-1078 *cell*
888/333-8302 *toll free*
CKMartin@wisconsinpublicservice.com
www.wisconsinpublicservice.com

What is the client's motivation or interests in renewable energy?

- Clean energy/environmental concerns
- Reducing energy bills
- Energy independence
- Wants to do Their part
- Has money and student organizations have wanted to do something for a while.
- Sustainability Fund
    a. $18,200 in Segregated Fee allocations
    b. "Green" Projects, as outlined in by-laws
- Env. Affairs and SGA goals
    a. Spend Sustainability Fund wisely
    b. Highly visible Project
    c. Promote Community/student involvement
    d. Get some name recognition for SGA

What type of PV system is the client interested in?

- Direct Grid-tie without battery

Overview and goals:

- Env. Affairs and SGA goals
    a. Spend Sustainability Fund wisely
    b. Highly visible Project
    c. Promote Community/student involvement
    d. Get some name recognition for SGA

Electrical Service and Load History:

UWGB used 20,035,193 kWh-2010

Average daily consumption based upon year 2010: 54891 kilowatt hours (kWh) a day.

The campus has about 2000 occupants, 5000 students, and supports a community of 250,000.

Major loads and Efficiency Recommendations

Lighting, Computers, and Forced ventilation systems are the Major Loads. Future upgrades to LED lighting and a HVAC site assessment is recommended. Every dollar spent in energy efficiency can save $3 to $5 on the system.

Efficiency:

While the intent may be to reduce energy consumption and the resulting fossil fuel footprint through the use of renewable energy, energy efficiency is often the 'low hanging fruit' and should be considered prior to, or in conjunction with, the installation of a solar electric system. Again, it is often said that for every dollar invested in energy efficiency, three to five dollars may be saved on a solar system designed to power those loads.

By plugging the meter into a power outlet and plugging a appliance into the meter, power consumption can be determined and compared to modern day Energy Star models. A list of energy efficient appliances is available at www.aceee.org/consumerguide/. It should be noted that here in the Midwest,

as well as other cooler climates, power consumption of appliances like refrigerators and freezers may actually be lower than the rating this organization gives them.
Moving air feels cooler and more comfortable, and use of a fan or fans may allow air conditioning to be turned back a bit while maintaining the same comfort level. Water and humidity problems in the basement may be reduced by improving landscaping to ensure water is diverted away from the building, and the dehumidifier's power consumption could also be evaluated with the aforementioned power meter, as it is a likely candidate for replacement with a more efficient Energy Star unit.

Solar Electric (Photovoltaic or PV) Overview:
Most solar electric systems installed today are direct "grid-tied" systems with no battery backup. Essentially the utility's power grid acts as the storage (in place of batteries) for any excess power produced by the solar system. This not only eliminates the cost of the batteries, it also eliminates the required monthly maintenance and periodic replacement expenses while being more efficient in storing energy. This has been a big step forward in generating interest among the general public in installing solar PV systems. By Federal mandate, most utilities must credit the system owner for the excess electricity that their PV system generates. In many States including Wisconsin, all investor-owned and municipal utilities are required to 'net meter', meaning they credit the homeowner at the retail rate for excess energy produced by solar electric systems up to 20kW in system size.
A PV system is a collection of photovoltaic panels connected together to create an array of the desired size (wattage). For example an array may be composed of ten, 200 watt panels forming a 2,000 watt (2 kW) system. The framed PV modules sit side-by-side on a rack and the wires from the individual modules are connected together and then run to a "combiner box" which combines the outputs from the individual strings of modules into one larger output, which is then run to the balance of system components typically located within the home. The PV array produces DC power which, in a normal grid-tied application, is converted into AC power by an **inverter** and then connected to your load center (breaker box) to power the loads in the home. If more power is being produced than consumed the excess power flows out onto the power grid through the meter, and the utility credits the homeowner's account in a relationship called net metering.

Determining system size:

System size is determined by the customer. Determining factors are cost, available space, and yearly energy used.

Cost

See "The System Cost Analysis" for more details.

Each system has many variables that determine the cost. Wire run, trench length if needed, complexity of the system, size of the system, and mounting type all determine cost

Available Space

There may be limited space on the best location to put the BOS (Balance of System).

Yearly Energy Used

Some people would like have their electrical load match their system production. A simple calculation can estimate the size solar system needed to supply 100% of your power. Example, if a home uses 20kWh a day and there is 4.4 sun-hours and the system is .78 efficient , you can (20kWh / 4.4sun hours / .78 = 5.83kW). A 5.8.3kW system will be needed to supply 100% of their electrical needs.
See "Estimating System Production" for more information.

Mounting overview:

A PV array is very sensitive to shading, much more so for instance than a solar hot water collector, and when shading exists at ground level, the roof may be the best location for the array.
Some of the benefits of a roof-mounted array are:

- Utilizes an out of the way space
- Is generally considered to be less costly to install than a ground-mounted array
- Lowered concern about vandalism for some locations

Some of the benefits of a ground-mount array are:

- Avoids re-roofing issues inherent in most roof mounts
- Allows for proper array orientation
- Offers seasonal adjustability for better year-round solar gain
- Operates cooler, thereby increasing power output slightly
- Less snow shading than roof mounts
- Easy access
- Allows for the option of a 'tracker'

Example. On the left, a 1.9 kW roof mounted array on a standing metal seam roof. On the right, a 2.94 kW system on a corrugated metal roof

Example of a 3.2 kW pole mounted, fixed array that is seasonally adjustable.

Seasonally adjustable single axis pole mounts allows for the home owner or installer to manually adjust the angle of the array to be 90 degrees to the sun angle. This will result in a gain of about 5% and offer less snow shading as well (typically 1 - 2% less snow shading).

Back and front side of a single axis tracker, which follows the sun's apparent movement east to west daily.

Pole mounts can also be fitted with a tracker, a rack that moves to follow the sun's position in the sky. Single axis trackers follow this movement east to west, and dual axis trackers also follow the seasonal elevation movements up and down. Trackers can increase the output of the array by 20 – 30%, but to do so they need a wide open 'solar window', with little or no shading to the east and west. Tracking arrays cost more to install and also add mechanical complexity to the system design, which can translate into increased maintenance costs as well as the possibility of repair expenses.

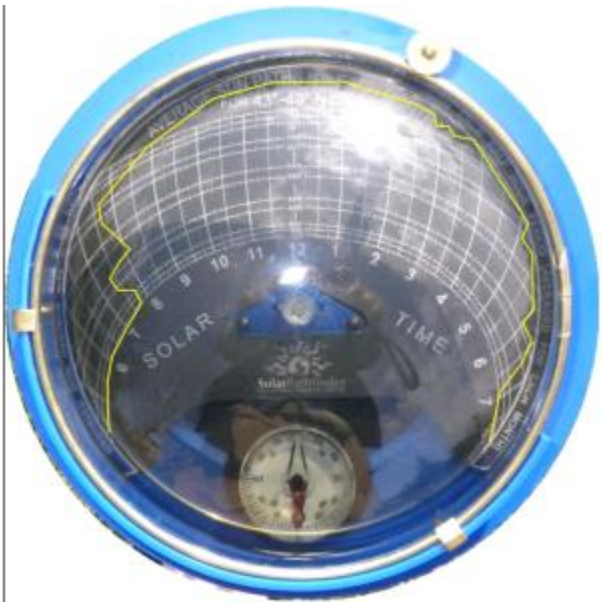
Site selection:

The original plan was to put the system in near the Union. SGA fees can could cover a grid intertied system on to this building. While looking at future expansion for the building, complexity and length of wire run, along with the lower electric rate of this building, we realized that housing may be a better option.

Small hall has a perfect non-shaded location that is highly visible to students and away from future expansions and areas where students may play a game of soccer. This site has a short and simple wire run for more efficiency and lower up front cost. No other dorms or campus housing had a spot close in comparison to this.

Shade Analysis:

A shade analysis tool called a Solar Pathfinder was used to determine the amount of shade existing at the site. The pathfinder dome is specially designed so items in the sun's path (mostly trees and buildings) are reflected on a clear dome. Underneath the dome is a plot that shows the sun's path for each month and all of the hours in the day. With this tool, the percent shading, the time of the day and time of the year of the shading can all be calculated.



This site has only 3.6% loss of sun hours from shading. The left side represents morning sun. You can see from the yellow line and reflections that there is minor shading between 5:00 am and 8:00 am. The upper part of the pathfinder represents winter months while the lower part represent summer months. You can see that from the yellow line and reflections that there is minor shading in the winter months when the sun is low in the sky. Between 10:00 and 12:00 is when solar intensity is the strongest. This is a very good solar window for that time and it is all year. This is a very good spot.

Estimated System Production:

Sun Hours

The average yearly sun anywhere on earth is 12 hours a day; However the average intensity is different in every location due to many variables. PV modules are rated at 1,000 watts per square where the voltage, amperage and wattage of the module for that amount of solar intensity. The solar intensity is rarely at 1,000 w/sm and nowhere on earth has the equivalent yearly average of 12 sun hours a day at 1000 w/sm. http://www.doe.gov/maps/solar-energy-potential. Green Bay has 4.2 sun hours and this number goes into the yearly calculation. A dual axis tracker can bring this equivalent up to 5.28.

Voltage and power losses associated with wiring and transformers, inverters and other components, as well as module 'mismatch', dust and grime, reduce system efficiency. We typically consider a direct grid-tie solar electric system to be 80% efficient, and that the system will lose perhaps an additional 1 to 3% due to 'snow shading' (the period of time the system isn't producing due to snow accumulation on the array). http://mapserve3.nrel.gov/PVWatts_Viewer/index.html

- **For a Dual Axis Tracker with 15 Solar World 245 Monos (3675) watts**
- **3675*97% unshaded=3567.75 DC rating**

Station Identification	
City:	Green Bay
State:	Wisconsin
Latitude:	44.48° N
Longitude:	88.13° W
Elevation:	214 m
PV System Specifications	
DC Rating:	3.6 kW
DC to AC Derate Factor:	0.800
AC Rating:	2.9 kW
Array Type:	2-Axis Tracking
Array Tilt:	N/A
Array Azimuth:	N/A
Energy Specifications	
Cost of Electricity:	12.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.99	384	46.08
2	5.13	446	53.52
3	6.06	556	66.72
4	6.95	590	70.80
5	7.96	678	81.36
6	8.27	661	79.32
7	8.60	692	83.04
8	6.79	559	67.08
9	5.86	473	56.76
10	4.91	424	50.88
11	3.02	259	31.08
12	3.10	289	34.68
Year	5.89	6011	721.32

- **For a Dual Axis Tracker with 15 Solar World 245 Monos (3675) watts**
- **3675*97% unshaded=3567.75 DC rating**

Station Identification	
City:	Green Bay
State:	Wisconsin
Latitude:	44.48° N
Longitude:	88.13° W
Elevation:	214 m
PV System Specifications	
DC Rating:	3.6 kW
DC to AC Derate Factor:	0.800
AC Rating:	2.9 kW
Array Type:	Fixed Tilt
Array Tilt:	44.5°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	12.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.31	316	37.92
2	4.17	360	43.20
3	4.94	450	54.00
4	5.21	434	52.08
5	5.53	459	55.08
6	5.52	429	51.48
7	5.83	456	54.72
8	5.05	404	48.48
9	4.53	359	43.08
10	4.08	349	41.88
11	2.59	221	26.52
12	2.59	240	28.80
Year	4.45	4477	537.24

System Incentives:

Focus on Energy:
For additional details about these programs go to the Focus on Energy web site www.focusonenergy.com and follow the links for renewable energy incentives.

Federal Incentives
Solar Investment Tax Credit: There is a Federal tax credit in effect through the year 2016 for 30% of the installed cost of the solar property. A tax credit is a reduction in taxes owed, not a deduction on income earned. The installed cost is considered to be the cost of the system after other installation incentives. For more information on this incentive go to http://www.dsireusa.org and follow the link for Federal incentives. You should consult a qualified tax adviser to determine your eligibility and incentive level.

State Incentives
Net Metering: Wisconsin is a net metering State, meaning all investor-owned and municipal utilities are mandated to credit you at the retail rate – the same rate they charge you – for any excess power generated by a PV system that is up to 20kW in size. Net metering may include time of use rates as well standard rates.

Property Tax Exemption: In Wisconsin, solar electric systems are exempt from property taxes, making renewable energy an investment you can make on your property without increasing your tax liability.

System Cost Analysis:

Each system has many variables that determine the cost. Wire run, trench length if needed, complexity of the system, size of the system, and mounting type all determine cost. These are very ball park estimates and before incentives if applicable. There may be a short live period in January to receive funding for non-residential. The dorms may count as residential and if they are privately operated there is a small chance to get a tax rebate.

3675W Dual Axis Tracker

DH Wisconsin Made Tracker	$9,000
15 American Made SW 245 mono modules	$6,000
Inverter	$3,000
Additional Parts	$5,000
Labor	$6,000
Total	**$29,000**

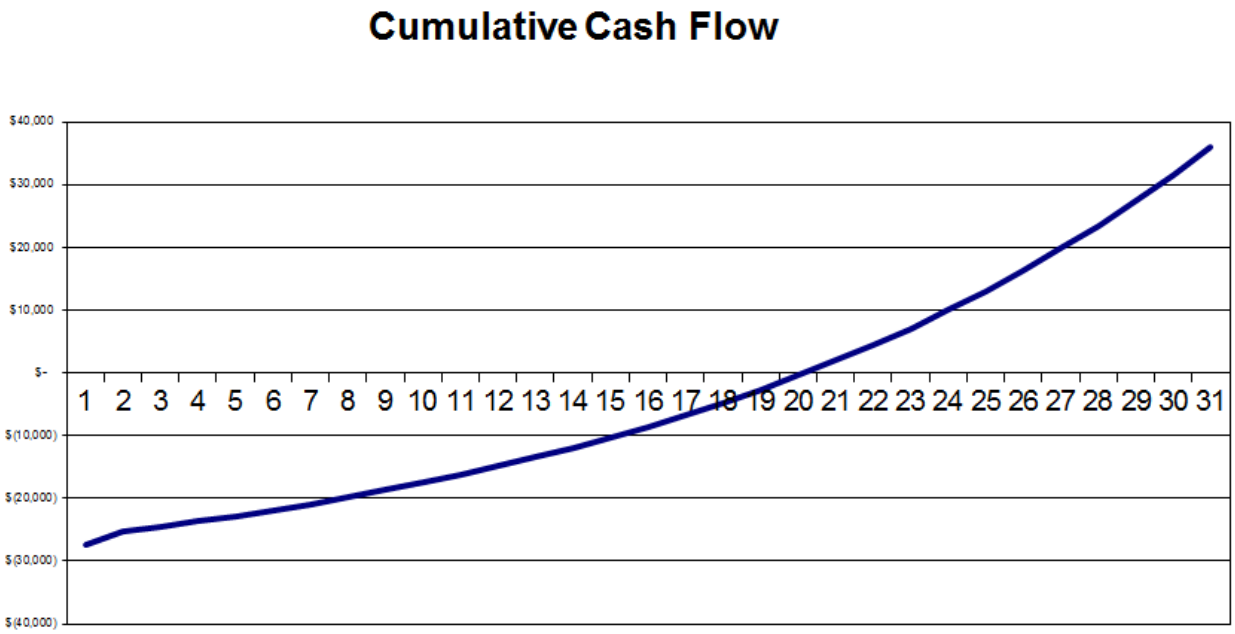
3675 W Ground Mount

Ground Mount	$1,000
15 American Made SW 245 mono modules	$6,000
Inverter	$3,000
Additional Parts	$5,000
Labor	$6,000
Total	**$21,000**

Cost modeling: 3675W Dual Axis Tracker

Energy Production, Cost, Economics and Environment	
Production	
Solar electric systems rated module capacity (kW dc)	3.68
Estimated output year one (kWh/yr)	6,011
Cost	
Estimated installed cost	$28,999
Focus Incentive	$3,000
Federal Tax Credit	$0
Other first cost incentives	$0
System cost after all incentives	$25,999
Value of year 1 to year 10 power production	$9,718
Economics	
Years to cost recovery, "0" Means > 30 years	20.0
Environment	
CO2 emission reduction per year (tons/year)	6.7

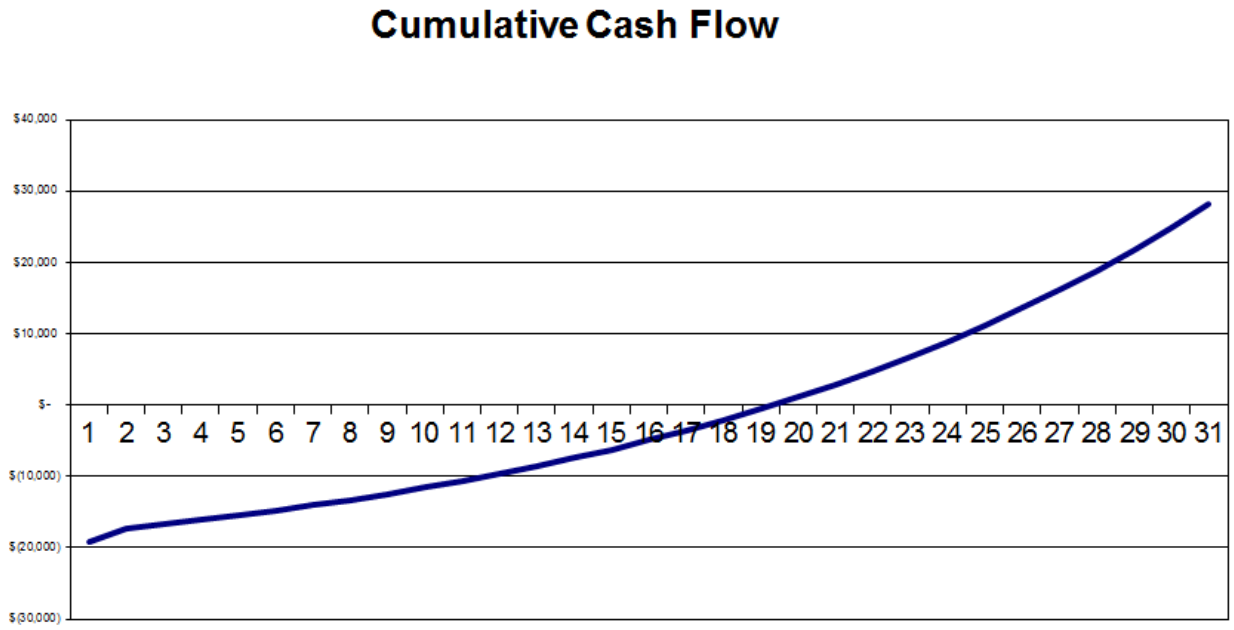
Key Assumptions	
Cost of System Per kW (dc)	$7,891
Electricity rate year one ($/kWh)	$0.12
Solar electric buyback rate	NA
Estimated electricity price inflation rate (%/yr)	7.00%
Expected output degradation (%/year)	0.50%



Cost modeling: 3675W Dual Ground Mount

Energy Production, Cost, Economics and Environment	
Production	
Solar electric systems rated module capacity (kW dc)	3.68
Estimated output year one (kWh/yr)	4,477
Cost	
Estimated installed cost	$20,495
Focus Incentive	$2,600
Federal Tax Credit	$0
Other first cost incentives	$0
System cost after all incentives	$17,895
Value of year 1 to year 10 power production	$7,238
Economics	
Years to cost recovery, "0" Means > 30 years	19.0
Environment	
CO2 emission reduction per year (tons/year)	5.0

Key Assumptions	
Cost of System Per kW (dc)	$5,577
Electricity rate year one ($/kWh)	$0.12
Solar electric buyback rate	NA
Estimated electricity price inflation rate (%/yr)	7.00%
Expected output degradation (%/year)	0.50%



Maintenance and Insurance:

Maintenance is expected to be minimal, especially with fixed, non-tracking, arrays. If the system utilizes a tracker or trackers, annual maintenance is expected to be one quarter of one percent of the system cost and is included in the cost analysis above. No additional insurance expense is factored for, as it assumes the existing policy will satisfy such requirements. This may need to be confirmed.

Summary:

This is an excellent site for PV with many simple options. The payback period will be under 20 years.

Follow Up:

A. Energy efficiency is always a cheaper option than installing more capacity. In addition to using efficient appliances, lighting is another area where surprising savings can be realized by switching from incandescent to Compact Florescent Lights (CFLs) in fixtures that are on more than 1 hour per day. For example, kitchen lighting that utilizes 5- 75 watt bulbs and is on for an average of 6 hours per day (think winter), uses 5 * 75 * 6 * 365 = 821kwh/yr. The same lighting with CFLs would use 25% of that or 205 kwh/yr. That is a savings of 51kwh/month and $20.00/year for just one room.

B. If you want to do a more detailed load analysis on your own, get a watt meter. You can plug any electrical appliance into this meter and then plug the meter into the wall. The watt meter will then measure the amount of electricity used for the length of time that it is plugged in. Make sure that you leave it plugged into the appliance long enough to get a good sampling of its normal energy use. For example, 24 hours on a refrigerator may not be enough if you use it more frequently on the weekend than you do during the week; maybe a week would be better. Try to find out how much each appliance is contributing to your consumption of electricity. Watt meters are inexpensive and available at some big box and hardware stores, and in some cases you can check one out at your local library. Once you understand where your electricity is going, you will be able to determine if replacing the appliance or switching to another form of fuel, such as LP or natural gas, would be a good option in the long run.

C. Another good source of energy efficiency tips is on the we-energies web site. www.we-energies.com/residential/energyeff/101tips.htm and http://we-energies.com/residential/ecosts/ecosts.htm .

D. If in Focus on Energy territory, investigate the home performance program through Focus (1-800-762-7077) or go to their web site: www.focusonenergy.org and follow the links for > Home > Where You Live > Home Improvement > Home Performance with ENERGY STAR .

E. You may also want to consider a solar hot water system which preheats the water before it goes to the hot water heater so that the water heater has much less, if any, heating to do. Solar thermal systems are more forgiving of shade and have the fastest payback times of any renewable energy system. Contact Focus on Energy for more information on solar thermal systems.

F. Decide if the economics of a PV system work out to your satisfaction based on all the costs and incentives, and the energy savings provided in this report. Keep in mind that in the long term, it is likely electrical rates will continue to rise.

Next Steps:

1. If you do choose to go ahead with a PV system, contact several of the qualified full-service PV installers in the area to get actual price estimates. A 'Solar Electric Site Summary' is provided at the end of this report and may be useful in obtaining bids. This is a link to eligible installers: http://www.focusonenergy.com/files/Document_Management_System/Renewables/W_RW_NAME_SolarElecFSISummer06.pdf

2. It would be a good idea to go see some solar installations and talk to the owners. One such opportunity would be to participate in the Solar Homes Tour taking place in Wisconsin every October.

3. Complete the Cash Back Rewards application and submit to Focus on Energy. Once approved, you will have 1 year to install the system. A copy of the application is supplied with this report. If another copy is needed, contact Wisconsin Focus on Energy at (800)762-7077, or go to their web site www.focusonenergy.com.

4. Check with your insurance agent to make sure your home's liability coverage will be sufficient to meet those required by the utility's co-generation contract, typically a minimum of $300,000 in liability coverage.

5. Obtain and complete your co-generation contract. Your installer will be helpful in filling out such forms and obtaining any required permits.

6. **Insure that all utility agreements, financial incentive paperwork, and any other required approvals/permits are submitted prior to purchasing any equipment or signing any contracts.**

Educational Resources:

- Focus on Energy web site (www.focusonenergy.org) great for lots of information on Renewable Energy.
- For more information on state incentives for renewable energy – www.dsireusa.org
- Home Power Magazine/Website (www.homepower.com) – case studies and stories of renewable energy installations around the country.
- Midwest Renewable Energy Association (www.the-mrea.org) – hands-on workshops in wind energy, PV systems, solar hot water, and more.
- Consumer Guide to Buying a Solar Electric System –www.nrel.gov/docs/fy04osti/35297.pdf http://www.homepower.com/files/beginner/SolarElectricBasics.pdf

Disclaimers:

- Bids developed based on this information will be approximate.
- Other circumstances may influence the price of the system.
- Errors in the information provided here will result in inaccurate price estimates.

It is strongly recommended that the selected installers visit the site before developing their final bid.